GALGOTIAS UNIVERSITY
Uttar Pradesh
CREATING KNOWLEDGE

3.4.7

E-content developed by Teachers

Galgotias University

Plot No. 2, Yamuna Expressway,
Opposite, Buddha International Circuit,
Sector 17A, Greater Noida,
Uttar Pradesh 203201, India

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1. For e-PG-Pathshala

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A Gateway to all Post Graduate Courses

An MHRD Project under its National Mission on Education through ICT (NME-ICT)

Subject: **Criminology**

Production of Courseware

- Content for Post Graduate Courses

Paper : **Forensic Science and Forensic Medicine**

Module : Origin of species from biological fluids, Blood grouping (ABO, MN, Rh) from dried blood stains

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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Origin of species from biological fluids, Blood grouping (ABO, MN, Rh) from dried blood stains
Module Id	------
Objectives	Learning Outcome: • To make the learners understand the source of different biological fluid and its forensic significance. • To help the learners in determination of species to which the biological fluid belongs. • To educate the learners to the procedure of determination of blood grouping (ABO, MN, Rh factor) from dried blood stains. • To teach the learners understand the composition and identifying features of different biological fluids.
Prerequisites	General understanding about different biological fluids like blood, semen, saliva, urine, milk etc.
Key words	Origin of species, Blood grouping, ABO, MN, Rh factor

Determination of origin of species

Before the invention of DNA fingerprinting, forensic serology was important tool for criminal investigation. To find out the actual source of body fluids specially blood, semen, veginal secretions, milk, saliva etc.. which are utmost important clue left behind the scene of crime. Biological sample collected from scene of crime first has to identify, then it is essential to establish whether it is of human origin or non human origin. In the cases of non- human origin, we have to find out the species it belongs. The most frequent encountered species in the cases of non human origin are dog, cat, cattle, fowl, got, rat and rabbit. The specific antibody plays key role in identification of species, the antigen or specific proteins present in the bloodstains or other body fluid/tissues get bind to the specific antibodies which help in detection of species.

Procedure:-

The species specific proteins/antigens from the bloodstain/fluid or tissue are extracted in 0.85% normal saline or in 5% ammonia extract. Ammonia solution is better extract for old blood stains or stains on fibers and calcified tissues.

Bloodstains extract

1. Small quantity of the bloodstain taken was dipped in minimum amount of 0.85% normal saline or 5% ammonia solution.

2. Incubate for 60-90 minutes for proper extraction or till brown coloured solution, after centrifugation supernatant can be used.

How to prepare extract from Calcified/keratinized tissues?

1. Macerate the bone or nail tissue to get a very fine powder.
2. Dip the pulverized tissue in 5% ammonia solution.
3. After overnight incubation use the supernatant for determination of origin of species.

Preparation of extract from soft tissues

1. Take small fraction of the tissue and add one drop of normal saline/ 5% ammonia solution.
2. Pulverize tissue systematically and incubate up to 90 minutes.
3. After centrifugation use the supernatant.

Methods for detection of origin of species

1. Precipitin Tube Method

- Take different precipitin tube for different anti sera and label it properly.
- Add a drop of the bloodstain/ fluid/ tissue extract in the each tubes.
- Add one drop of antiserum of different species origin like anti Human serum, anti Fowl serum, anti Dog serum, anti Cow Serum, anti Goat serum etc. along the walls of tube and leave undisturbed for 30 minutes at room temperature.
- Observe a white ring at the interface of two solutions.

2 .Double Diffusion method

When an antigen (blood stain/fluid/tissue etc.) binds to the specific antibody/anti sera by diffusion reaction inside the gel, a precipitin arc forms.

Procedure:-

1. Prepare 1% agarose gel in normal saline.
2. Pour it over a levelled petri dish or glass slide to make a 1-2mm thick agar layer. Wait until the agar solidifies.
3. Punch wells in gel, each about 5 mm apart, in a hexagonal way.
4. Seal the bottoms of punched wells with dilute agar (0.5%).

5. Fill the central well with tissue extract and peripheral wells with different antisera for species origin (anti Human serum, anti Fowl serum, anti Dog serum, anti Cow Serum, anti Goat serum etc.).

6. Cover the petri dish and keep gel in a moist chamber for overnight.

7. Examine gel for the presence of specific precipitin arcs respective to origin of species.

3. Cross over electrophoresis

Principle

Agarose gel prepared in electrophoretic buffer should be use for cross over electrophoresis. The sample in question or blood stain/fluid/tissue extract is treated as antigen due to presence of negative charge and placed in the cathodic well. Antiserum/Antibody having positive charge is kept at anodic well. The □-globulin antibodies migrate toward opposite charged cathode, while the other serum proteins/ antigen migrate towards anode when electric current is supplied. A precipitin reaction can be observed between the two wells when an antigen combines with its specific antibody.

Procedure:-

1. Prepare 1% agarose gel in gel buffer.
2. Pour it over in a leveled glass slide to make 1-2mm thick agar layer, wait until the agar solidifies.
3. Punch wells in pairs, each about 5 mm apart.
4. Add few drop of sample/antigen extract in the well near to cathode end and species specific antiserum/antibody (anti Human serum, anti Fowl serum, anti Dog serum, anti Cow Serum, anti Goat serum etc.) in the well near to anode.

Arrangement of cathode and anode with respect to antigen/extract can be in following fashion.

	Extract	**O** **O**	Anti Human Serum	
Cathode (-Ve)	Extract	**O** **O**	Anti Fowl Serum	***Anode (+Ve)***
{ANTIGEN}	Extract	**O** **O**	Anti Dog Serum	{ANTIBODY}

5. Place the slide on the electrophoresis chamber and connect the gel to tank buffer chambers by two pieces of filter papers (wick) on each side.
6. Run the electrophoresis for 20 minutes at 150 volts.
7. Remove the slide and observed it with the help of lamp for a fine white line of precipitate between opposite wells.

Staining with amido Black stain

Procedure

1. Dip the slide in saline for overnight at RT to wash out any unreact proteins.
2. Rinse the slide in distilled water for 60 min at room temperature to remove any saline.
3. Take out the slide and cover with a piece of damp filter paper and dry it in hot air oven.
4. When dry remove the filter paper, and wash the plate under running tap water to remove fragments of filter paper.
5. Dip with amido Black stain for 10 minutes and transfer to destain solution till the background is clear and precipitin bands are stained a deep blue/black.

Chemical requirements for cross over electrophoresis

Tank buffer* (pH- 8.6)	Sodium barbiturate Diethylbarbituric acid Calcium lactate Add Distilled water to make one Litre	8.1g 1.38g 0.39g
Gel buffer* (pH 8.6)	Sodium barbiturate Diethylbarbituric acid Calcium lactate Add Distilled water to make one Litre	7.01g 1.38g 1.03g
Support medium	1% Agar or agarose in Gel Buffer	
Voltage	150V for 20 minutes	
Stain (amido black) #	Naphthalene black 10B Methanol Glacial acetic acid Distilled water	0.1 g 50mL 10 mL 50mL
Destaining solution	Methanol Glacial acetic acid Distilled water	1 Litre 200 mL 1 Litre

*Barbital buffer can be substituted with the following Tris- glycine buffer:

Tank Buffer (pH- 8.4): 0.037 M Tris 4.50g

0.29M Glycine 21.8g

Dissolve in distilled water, adjust pH with HCl and make final volume 1 litre.

Gel Buffer (pH- 8.4): Same as tank buffer.

Coomassie Brilliant Blue (R- 250) (1g in 500mL of Destain solution) stain can be used instead of Amido Black.

BLOOD GROUPING

A blood group is a characteristic of individuals' red blood cells; define in terms of specific substances commonly known as antigens present on the surface of the cell membrane. The two most important classifications to describe blood type are ABO and Rhesus factor (Rh factor). There are 46 other known antigens in humans, most of which are much rarer than ABO and Rh.

Blood type

Characteristic	**A**	**B**	**AB**	**O**
Ag on RBC	A	B	Both A and B	Neither A nor B
Ab in plasma	Anti-B	Anti-A	Neither anti A nor anti-B	Both anti-A and anti-B

Ag = antigens, Ab = antibodies

1. How to collect blood sample for blood grouping?

1. Sterlize the finger tip with alcohol swab and prick it with a disposable needle.
2. Collect the blood in a tube having normal saline.
3. Centrifuge the contents at 3000rpm for 1-2 minute.
4. Wash the blood cells 2-3 times by discarding the supernatant and resuspending the blood cells in fresh normal saline.
5. Prepare 2% or 0.2% (as per requirement) cell suspension in normal saline.

ABO grouping of dried blood stain

In case the blood stain is not completely dried and having microbial growth over the stains, the stains can be kept at 100^{o}C for 60 min to destroy the microbes then proceeded for typing.

1. Blood grouping of bloodstains by Lattes test

This method is very use full for the identification of mixture of blood stains, since it is based on the identification of antibody present in the blood stains not the antigen.

Procedure:-

1. Prepare the extract of blood stain in normal sline.

2. For 0.5 cm^2 bloodstain 2 drops of normal saline is needed and incubate it for 60 min.

3. Squeeze the stain and centrifuge the extract and take the supernatant.

4. Take one clean dry cavity tile and mark two cavities as A and B.

5. In a cavity slide mark A and B and put one drop of bloodstain extract in each cavity.

6. Add one drop of 2% cell suspension of A and B cells in the respective cavities. Mix it and rotate the tile for five minutes.

7. Observed the cavity slide for agglutination macroscopically as well as microscopically.

Agglutination in cavity A	B	Antibody present	Blood group
-	+	Anti B	A
+	-	Anti A	B
-	-	NIL	AB
+	+	Anti A & Anti B	O

Note: - This method is less sensitive, since antibodies are less stable in comparison to antigens and can be better typed for the fresh stains.

2. Absorption Elution Method

1. Take three test tubes and mark it as A, B and H.

2. Take about 2 mm^2 blood stain or 2- 5mm long threads in each test tube.

3. Dip the fabric in anti- A serum, anti- B serum and anti- H lectin respectively for overnight at 4^0C.

4. Wash the fabric 3-4 times with ice chilled normal saline, finally at last add one drop of fresh normal saline.

5. Cap the test tubes with cotton swab and incubate in water bath at 56^oC for 20 minutes.

6. Add one drop of 0.2% indicator cells A, B and O in the respective tubes and keep at 4^0C for 30 min.

7. Centrifuge, shake well and observe the contents for agglutination both macroscopically and microscopically.

Agglutination in cavity A	B	H	Blood group
+	-	- or +	A
-	+	- or +	B
+	+	- or +	AB
-	-	+	O

- **Preparation of Anti- H Lectin**

1. Soak about 2g seed of Ulex europaeus in 10ML of normal saline for overnight.

2. Macerate seeds and agitate paste for an hour. Centrifuge at 3,000rpm for 5 minutes and discard sediment.

3. If supernantant is cloudy, centrifuge at about 10,000rpm for 15minutes and use the supernatant.

4. Check the specificity of the lectin with group O cells & titrate. Anti- H lectin with minimum titre of 32 should be used for grouping reactions.

3. Absorption Elution Method: Howard Martin

1. Take a cellulose acetate sheet (thickness 0.4mm or more) and mark as A, B and H. stick 1 cm long bloodstained thread with acetone to each of 3 areas.

2. Allow the threads to fix on the sheet for 15 minutes.

3. After 15 minutes put one drop of the anti- A serum, anti- B serum and anti- H lectin respectively on the fixed threads

4. Put the sheet in a moist chamber for overnight at 4^{o}C in the refrigerator.

5. Take out from the refrigerator and rinse off the excess antisera and blot the threads dry with a paper towel by inverting the plate face down on a paper towel and rubbing the back of the glass plate with another towel.

6. Incubate at 4^{0}C for 2 hours. Longer wash times will not have a negative effect on the results provided the temperature does not exceed 40C. Shorter wash times may result in incomplete rinsing of unbound antibody.

7. Remove and dry with a paper towel as previously above. Add one drop of appropriate 0.2% indicator cells to each thread.

8. Keep in moist chamber and elute in 56^0C incubator for 20 minutes.
9. Place the sheet in a moist chamber and rotate on rotator for 30 minutes.
10. Read results microscopically.

4. Absorption Elution: Ammonia Method

This method is useful for very old or insoluble bloodstains or when typing on substrates which do not lend themselves to Howard-Martin absorption elution technique.

1. Extract the stain with 4-5 drops of 5% ammonia solution and add 1 drop of the extract in each of three wells of cavity slide marked A, B, and H.
2. Heat-fix the extract for 60 minutes at 56^0C.
3. Add one drop of anti- A serum, anti- B serum and anti- H lectin respectively to each well and allow to absorb for 5 minutes in a moisture chamber at RT.
4. Rinse off the antiserum and put in a normal at 4^0C for 10 minutes. Saline should be changed frequently.
5. Carefully blot dry each well and add one drop of respective 0.2% cell suspension to each well.
6. Keep slides in moist chamber at 37^0C for 15 minutes for the elution process.
7. Transfer the slide to RT moist chamber and rotate for ten minutes.
8. Read results microscopically.

5. Mixed Agglutination Method

1. Take three clean and dry test tubes and mark them A, B and H.
2. Put around 2 mm^2 of blood stain or 2- 5mm long threads in each test tube.
3. Dip the fabric in anti- A serum, anti- B serum and anti- H lectin respectively and keep at 4^0C for overnight.
4. Remove the antiserum and give 3-4 wash with ice chilled normal saline.

5. After the last wash remove whole of the normal saline and add one drop of 0.2-0.5% A, B and O indicator cells in the respective tubes.

6. Cap the test tubes with cotton swab and keep in water bath at 50^0C for 10 minutes.

7. Keep tubes at 4^0C for half an hour, centrifuge, shake and examine the contents for agglutination attached to fabrics, both macroscopically and microscopically.

Agglutination in cavity			
A	B	H	Blood group
+	-	- or +	A
-	+	-or +	B
+	+	-or +	AB
-	-	+	O

Rh Typing

1. Take a clean and dry cavity slide and mark as C, c, D, E & e.

2. Place one drop of anti C serum, anti c serum, anti D serum, anti E serum and anti e serum in the respective cavities.

3. Add one drop of 2% cell suspension in each cavity and mixed and rotate the tile for 5 minutes at room temperature.

4. Examine for agglutination both macroscopically as well as microscopically.

5. If there is no agglutination, keep the tile at 37^0 C for 15 minutes, rotate and reexamine for agglutination. Presence of agglutination indicates the presence of respective antigen.

MN Typing

1. Take a clean and dry cavity slide and mark as M and N.

2. Wash the R.B.C in normal saline thrice.

3. Add one drop of the appropriate antiserum in the wells.

4. Add one drop of 2.0% cell suspension of R.B.C.
5. Rotate the cavity tile at room temperature for five minutes.
6. Observe for agglutination both macroscopically as well as microscopically.

Precaution: - Properly washed cells are absolutely critical in MN typing in order to avoid false positive results.

Agglutination in cavity M	N	Antigen on RBC's	Blood group
+	-	M	M
-	+	N	N
+	+	M, N	M,N

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A Gateway to all Post Graduate Courses

An MHRD Project under its National Mission on Education through ICT (NME-ICT)

Subject: **Criminology**

Production of Courseware

e- Content for Post Graduate Courses

Paper : **Forensic Science and Forensic Medicine**

Module : **Types of fingerprints, location, collection and preservation. Development: conventional and nonconventional methods.**

Role	Name	Affiliation
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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Types of fingerprints, location, collection and preservation. Development: conventional and nonconventional methods.
Module Id	CRIMINOLOGY/FSFM/XX
Objectives	Learning Outcome: • To make the learners understand about the fingerprint evidence. • To acquaint the learners with different types of scene of crime prints. • To make the learners understand the different methods of development of fingerprint evidence. • To acquaint learners with the scientific methods used to develop the scene of crime prints
Prerequisites	Fingerprint: pattern types, plain prints, rolled prints, fingerprint evidence.
Key words	Latent prints, Patent prints, plastic prints, powder method, silver nitrate method, ninhydrin method, iodine fuming.

1. Introduction:

At a scene of crime, the perpetrator tries to remove all possible physical evidences he/she may have left. In doing so the perpetrator forgets that during this removal process also he/she is leaving behind another physical evidence i.e. fingerprints.

At the scene of crime the perpetrator unknowingly leave behind the fingerprint impression, which are either visible or invisible to the naked eye. These prints are generally referred to as the chance prints, as they are left by chance at the scene of crime.

A fingerprint is usually formed by the papillary ridges leaving a deposit of perspiration on the surface with which the finger has been brought into contact. The perspiration or sweat is composed of 99% water and the remaining 1% includes inorganic and organic substances. Inorganic substances include sodium, potassium, magnesium, calcium, chlorides, sulphates and phosphates. Organic substances include amino acids, urea, uric acid, fats, oils, sugar, etc. The constituents of sweat react with different chemicals and form a coloured component making the invisible prints visible. Whenever a person touches a surface with one's finger an invisible impression of the finger is left on the surface due to the contact, which are then developed by the investigators or fingerprint experts and can be used for solving the crime.

2. Scene of crime prints:

Fingerprint evidence is the most common physical evidence found at the scene of crime, whose proper collection, preservation and identification can help the investigators to put the criminal behind the bars. Due to the amount and nature of this evidence it is extremely difficult for the criminal to remove all of them from the scene of crime. At the scene of crime the different types of fingerprint evidence that can be found are categorised into:

1. Visible prints
2. Invisible prints

Visible prints are those prints which are easily visible to the naked eye. These prints does not require any other external aid to make them visible. These prints are further categorised into:

1. Patent prints
2. Plastic prints

Patent prints or inked prints are those fingerprints which are coloured in nature, i.e. when any foreign colour substance gets adhered to the finger or hand of an individual who then uses the same coloured hand to touch a surface then a coloured impression of the ridges is left on the surface of contact. These prints are easily visible and can be directly photographed for the purpose of comparison. For example, prints of hand immersed with ink, blood, grease, etc.

Figure: Patent fingerprints a. on glass, b. on paper, both are immersed with blood. (https://s-media-cache-ak0.pinimg.com/originals/4f/09/cb/4f09cb2f96b780c68180bb322123d214.jpg)

Plastic prints are those fingerprints which are formed when an individual touches a pliable surface with his/her hands/fingers. In this case a mould of the print is casted on the surface of contact which is a negative impression of the original print i.e. the ridges becomes the furrows and the furrows become the ridges on the surface of contact. These prints are photographed under oblique light so that the ridges and furrows can be easily seen. Also for the purpose of comparison a cast of these prints is created so as to obtain a positive impression making the comparison process easy. For example, prints left on soap, molten wax, wet paint, wet putty, clay, etc.

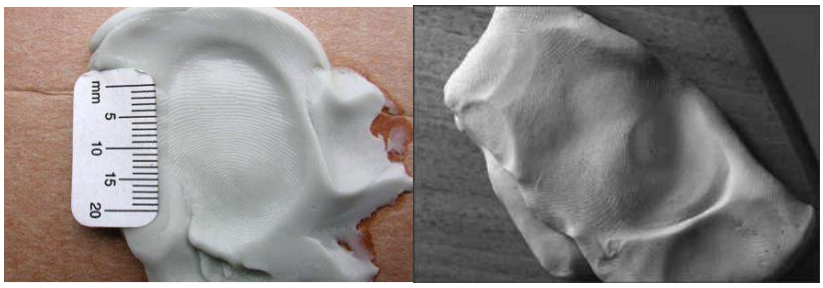


Figure: Plastic fingerprints a. on wet putty, b. on clay, both are photographed under oblique light (https://www.bevfitchett.us/forensic-science/images/3041_6_3-physical-matching-forensic.jpg)

Invisible prints are those prints which are not visible to the naked eye and needed be made visible by using some external scientific aid to make them visible. These invisible prints are also known as latent prints, where latent means hidden. These latent prints are the impression of the ridges of the perpetrator hands or fingers and are left behind on the surface of contact due to the presence of sweat. These prints are easily found at the smooth, polished surfaces which when touched by the finger, leave behind an invisible image of the hand known as latent fingerprint. For example, prints left on door knobs, glass, walls, table, etc.

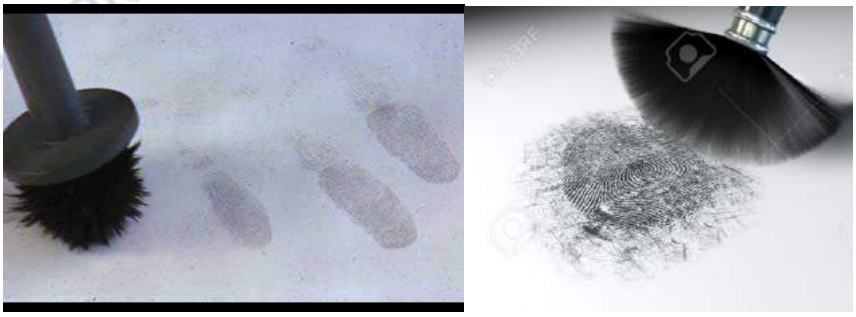
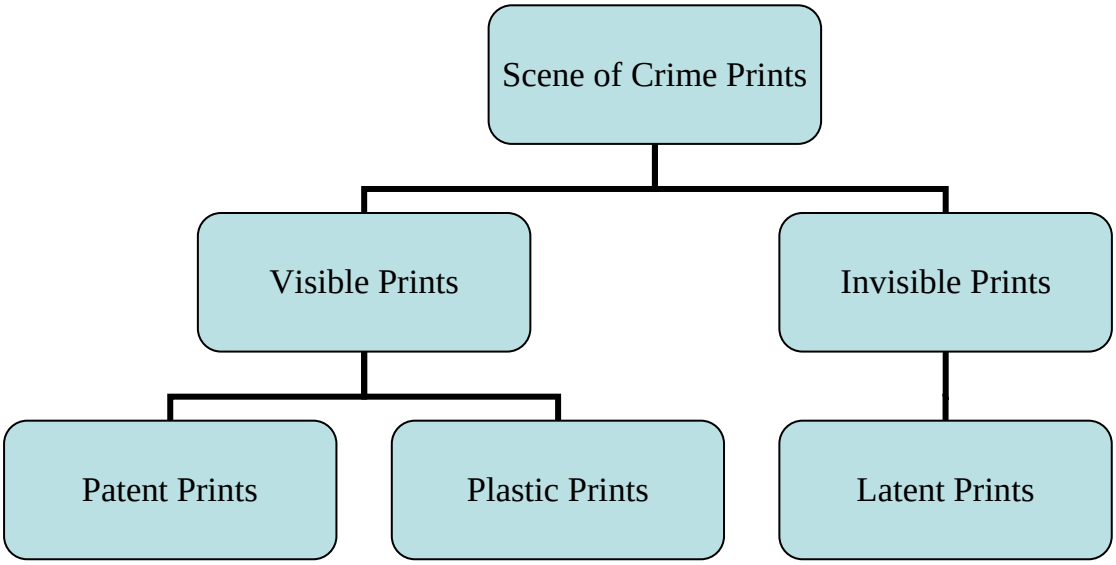


Figure: Latent fingerprints a. on car, b. on table, both developed using powder method (http://www.crime-scene-investigator.net/video-magnetic-powderlift.files/html5video/Magnetic_Powder_Lifting.jpg)



3. Location of Fingerprint evidence:

When a criminal enters a scene of crime he/she may touches a number of things and surfaces including the crime articles. Therefore, when an investigator is searching for the fingerprint evidence, he/she should firstly be try to reconstruct the events of crime, which will make it convenient for him/her to locate the fingerprint evidence and also in doing so he/she will not lose a spot where the fingerprint evidence might be left behind by the perpetrator. Secondly, the investigator must be quick to take the photographs of any of the fingerprint evidence of any kind whether latent, patent or plastic, he/she may come across. At the scene of crime the fingerprint evidence can be found at:

1. Glass object
2. Table top
3. Door knob
4. Window molding
5. Telephone
6. Finished leather
7. Paper

8. Cupboard
9. Safe
10. Refrigerator
11. Crime articles like knife, rope, guns, etc.
12. Pipes
13. Mirror, etc.

Fingerprints are generally located using various light sources, for example, oblique light, UV light, poly-light, poly-view, poly-ray, etc.

When a surface is viewed under oblique light then the latent prints which are present on that surface can be seen.

Poly-light is a heavy equipment which is difficult to carry at the scene of crime. It includes various lamps which corresponds to various light radiation and filters.

Poly-view is a high intensity light source which is used inn laboratories. It consist of various lamps which correspond to light radiations. Also it has special arrangement for inclining the light source.

Poly-ray is like a gun, quite handy and can be freely used at a scene of crime for searching latent prints. It can be operated using a battery, so it is carried to crime scene even in remote areas. It contains various light sources which corresponds to various light radiations but the inclination of the light in this instrument is not applicable.

Sometimes fingerprints are found on dusty surfaces. These prints are not to be treated with any powder or chemical. These prints are taken with the help of DLK (dust lift kit). With the help of this kit, dusty prints are lifted on aluminium foil by electrifying the surface with the help of a charger.

4. Collection and preservation of fingerprint evidence:

Collection and preservation of fingerprint evidence is a job that must be done with extreme precision and accuracy, reason being the process of comparison and identification of such prints lies entirely on the correctness of this process of collection and preservation. If anything goes wrong in this process then the entire

investigation may come to a standstill. Therefore, for doing this procedure of collection and preservation trained professionals should be employed.

The procedure to be followed for collection and preservation depends on the surface of the article on which the print is present.

1. **Print present on moveable surfaces:** for the prints which are present on movable surfaces, no attempt should be made to lift such prints, rather the entire article or that surface should be taken into account and packed carefully and dispatched to the forensic laboratory for further proceeding. But while packing care must be taken that the particular article in question should not break and also the surface on which the print is present should not come in contact with walls of the container in which it is packed otherwise the print might get damaged.

2. **Photography:** it is one of the most frequent technique used for preserving and collecting the fingerprint evidence, as the photographs can be easily taken and stored for a longer time span. While taking the photographs the lightening conditions should be appropriate and required filters should also be used to make the print clearly visible. Care should be taken while photographing the plastic prints, oblique lightening should be used for doing this.

3. **Lifting of fingerprint evidence:** when the prints are present on the immoveable articles then the prints are lifted using lifting tapes. While lifting of the prints care should be taken that excess of pressure should not be applied as it may result in smudging of prints. When the lifting is carried out care must be taken as to ensure that the tape should not get folded or has creases in the process. After lifting the tape should be pasted on perfectly smooth surface with a colour contrast of the colour in which the print is developed.

4. **Prints present on pliable surface:** when the prints are present on pliable surfaces, i.e. when the plastic prints are found at the scene of crime, they must be first photographed under the oblique light and then cast of them should be prepared to preserve such prints.

5. **<u>Fingerprints present in dust:</u>** sometimes fingerprints are found on the dust deposited on the surface of the articles. Such prints cannot be developed by powder or chemical methods. Prints like these are first photographed and then are lifted electrostatically on aluminium sheet or by using DLK (dust lifting kit).

5. Development of latent prints using conventional methods:

When the chance prints are of the category of latent prints i.e. invisible prints, then these prints are needed to be developed in order to be visualised with the naked eyes. Latent prints are formed due to the deposition of sweat on the surface of contact. This sweat is composed of numerous components such as water, urea, fats, oils, amino acids, chlorides and sulphates salts, etc., which when react with different chemicals forms coloured compounds which are visible to the naked eyes.

Development methods/techniques of latent prints are broadly classified inn two categories:

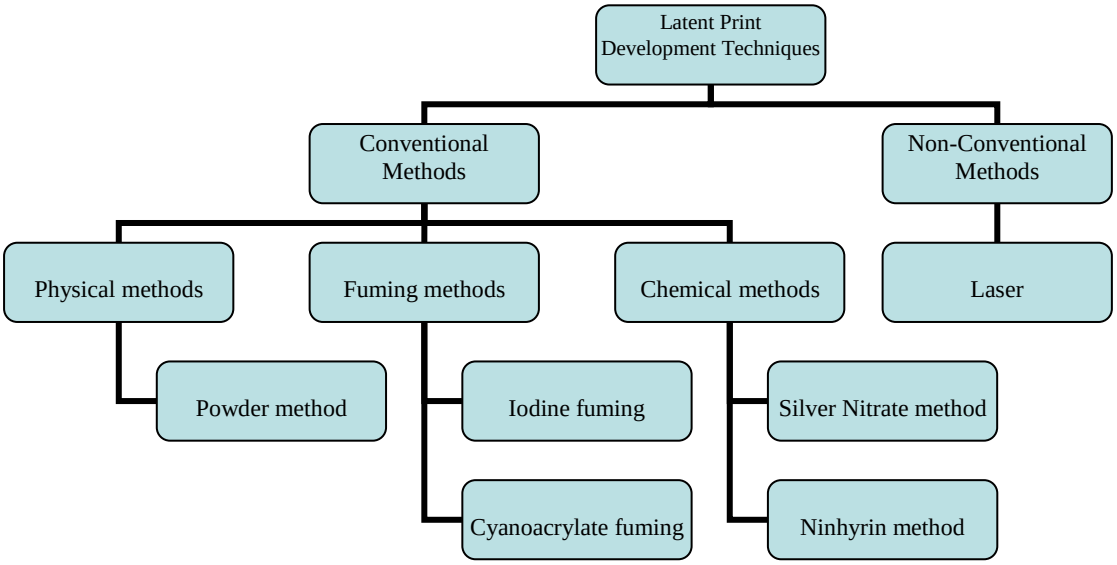
a. Conventional methods
b. Non-conventional methods

By conventional methods we mean those methods which are being used from a long period of time and are tested and relied upon by a number of experts. Non-conventional methods are comparatively new techniques which are recently developed and are used by some of the experts

Conventional methods includes:

(i) Physical methods
(ii) Fuming methods
(iii) Chemical methods

Non-conventional methods includes: Laser method.



PHYSICAL METHOD

The physical method of latent print development is basically carried out by using fingerprint development powders. These powders are chemically inert in nature, amorphous, dry and have uniform consistency in regard of the particle size. These powders are chemically stable compounds and are sticky in nature. When the prints are found on the non-porous surfaces such as glass, table –top, polished wood surfaces, window panes, door knobs, etc. The investigator uses the physical method – powder method to develop the latent fingerprint. This method works because of the process of adsorption, i.e. the physical interaction between the powder and the sweat. When the powder is applied on the surface with the presence of latent prints the powder gets stick on the print due to the water content in the sweat and because of this physical interaction the powder remains attached there and the latent prints can easily be visualised.

Commercially, a lot variety of the powders are available in different colours. The colour of the powder to be used by the investigator depends on the colour of the background surface on which the print is present. Generally for:

- Light coloured surfaces black powder is used.
- Dark coloured surfaces grey powder is used.
- Multi-coloured surfaces florescent powders are used.

FUMING METHOD

Fuming method is a method in which the direct application of the chemical on the contact surface is avoided and in place of that the fumes of the chemical to be used are made to come in contact with the surface and wherever the latent prints are present, due to chemical reaction between the fumes and the sweat the latent prints are developed as the result. Generally two types of fuming methods are used:

a. **IODINE FUMING:** in this method the fumes of iodine crystals are made to come in contact with the surface and due to the presence of the oils in the sweat, this iodine fumes forms a yellow brown coloured compound due to which the latent prints are developed.
b. **CYANOACRYLATE FUMING:** when the cyanoacrylate fumes come in contact with the amino acids present in the sweat, they form a chalky white coloured compound. This method is found quite useful when the prints are to be developed from fabrics, skin, etc. or the surfaces where the powder method cannot be used.

CHEMICAL METHOD

These methods are used in laboratories when the crime articles or suspected surfaces with the latent prints present on them are send to the laboratory for the development. The experts use these chemical methods to develop those prints. Generally employed chemical methods are:

a. **SILVER NITRATE METHOD:** in this method a 3% solution of silver nitrate ($AgNO_3$) is used which is sprayed on the surface with the print present on it. Due to the presence of sodium chloride (NaCl) in the sweat, the silver nitrate reacts with it and forms silver chloride which is when exposed to light form metallic silver which forms the outline of the ridges of the print to be developed. The drawback of this method is that the surface darkens because of the exposure of light therefore in this methods the expert has to very quick in taking the photographs of the prints as soon as they develop.

$$\mathbf{AgNO_3 + NaCl \longrightarrow AgCl + NaNO_3}$$

$$\mathbf{2AgCl + LIGHT \longrightarrow 2Ag + Cl_2}$$

b. **NINHYDRIN METHOD:** in this method, 1.5% solution of ninhydrin is used (which is made in ethyl alcohol, ether or acetone) to develop the latent fingerprints. The suspected surface is sandwiched between two filter papers which are soaked in ninhydrin solution. This arrangement is then kept in oven at 60 to 65^{o}Cfor 20 to 25 minutes to heat. The amino acids present in the sweat (which is present due to the latent fingerprint) react with ninhydrin and forms a purple-pink coloured dye and therefore the latent prints become visible in the purple-pink colour.

   This method is considered to be most effective one for developing the latent fingerprint as scientists have been able to develop fingerprint from a 5000 years old document using this technique. Therefore it is considered to be one of the most sensitive technique for the development off latent fingerprint.

NON-CONVENTIONAL METHOD

Non-conventional methods for development of latent fingerprints includes the use of laser.

In has been observed that when the laser (Ar-Laser) is focused on the surface bearing the latent fingerprint, then the fingerprint show florescence. This technique is found to be very useful in developing old fingerprints. Also, the type of surface of contact (on which the fingerprint is present) does not matter in this case, if the print is present it can be developed using laser. Another advantage of this technique is that the surface which is pre-treated by the conventional methods, even those surfaces when are subject to laser light, show fingerprint giving florescence meaning if the conventional methods are unable to develop the latent fingerprint, this non-conventional laser method can be used instead to develop the latent fingerprint.

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Paper : **Forensic Science and Forensic Medicine**

Module : **Vegetable and animal poisons: Abrus, calotropis, castor, croton, nux vomica, oleander, marking nut, Cantharides, scorpion, snake venom.**

Role	Name	Affiliation
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Content Reviewer		

DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Forensic Toxicology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Vegetable and animal poisons: Abrus, calotropis, castor, croton, nux vomica, oleander, marking nut, Cantharides, scorpion, snake venom.
Module Id	LAW/CJA/VIII /11
Objectives	Learning Outcome: • To make the learners understand about various types of poisonous plants. • To make the learners understand about various active constituents posses by plants and animals venom which are responsible for toxicity. • To ascertain the learners about the type of poisoning on the basis of pattern of toxicity caused.
Prerequisites	To aware about different types of poisons plants and active principles which are responsible for their toxic effects.
Key words	Plant poisons, active part, active principle, scorpion, cantharides and snake poison.

1. Introduction:

Plants are very important to human requirement as they are gaining importance in modern medicines due to their characteristic features of bioactivity. Though there are certain plants which are toxic due to their active constituents present in their different parts and cause damage to biological system during their exposure. Active constituent is a chemical compound present in the plant which is responsible for its toxic action and the part of plant which constitutes that active principle is known as active part. In this section, toxicity of *Abrus precatorius*, *Calotropis*, *Castor*, *Croton*, *Nux vomica*, *Oleander* and *Marking nut* have been discussed along with animal poisons such cantharides, scorpion and snake venom.

2. Vegetable poisons:

2.1. *Abrus precatorius*

Abrus precatorius is known for its irritant action. It is found all over the India. It is native to India and other tropical region of the world. All parts of this plant are toxic. However, seeds are commonly used as a poison.

Raw seeds are swallowed they are not poisonous. However, when extract of this seed is injected under skin in the form of 'sui' by pressing them into the skin of a person by holding them between the fingers its poisonous symptoms resemble those of viper bite. Injection of these suies result in local oedema, necrosis and hemorrhages from the site of injection. It causes agglutination of red blood corpuscles.This preparation is used for human as well as cattle poisoning. These suies are very fine, prepared by powdering the seeds followed by mixing with opium, onion, dhatura and spirit or water and then shaped into small sharp needles and are allowed to hard by drying in the sunlight[1].

[1] K Vij , Textbook of Forensic Medicine and Toxicology: Principles and Practice, Chapter 35 p. 476, Irritants of plant poisons, 5th edn., (Elsevier, 2011).

Fig. 1: Ripe *Abrus precatorius*[2]

Fig.2: Whole plant of *Abrus precatorius*[3]

Fig. 3: Seeds of *Abrus precatorius*[4]

[2] http://dir.indiamart.com/impcat/abrus-precatorius.html

[3] http://08hachi.blogspot.in/2011/08/rosary-pea-abrus-precatorius.html

[4] http://dir.indiamart.com/impact/abrus-precatorius.html

Botanical Name : *Abrus precatorius* **Family Name** : *Fabaceae* **Common Name** : Jequerity, Indian liquorice, gunchi or ratti etc[5].	
Plant Characteristics	It has 10-15 pairs of narrow leaves, small pinkish flowers with seedpods. When it is ripe, exposes 4-6 seeds within seedpods[5] [Fig. 1]. These seeds are bright red in color with black spot in one pole which weigh about 105 mg [Fig. 2]. Earlier these seeds were used for weighing of gold by goldsmiths[6].
Active Part	Whole plant is poisonous however seed is more poisonous. Size of seeds are as small as of a small pea which is about 0.80 cm long, 0.60 cm broad and have average wt. of 105 mg. Seeds are tasteless, odorless, oval and red in color with black spot on one pole[6] [Fig. 3].
Active Principle	Active principle is abrin, a toxalbumin[5].
Sign and symptoms	• The animal becomes apathetic and drowsy and is disinclined to take food. • In three or four days, it is unable to move, drops down, becomes comatose and dies. • The symptoms resemble those of viper snake bite, for which they may be mistaken. • Human poisoning is characterized by a local painful swelling, ecchymosis followed by necrosis. • The patient suffers from vertigo, cardiac arrhythmia, convulsion and death. • When ingested, there is a nausea, vomiting, abdominal pain, diarrhoea and collapse[1].
Fatal Dose : 1-2 seeds orally or 90-120 mg abrin by injection. **Fatal Period** : 1-5 days[6].	
Postmortem Appearances	• The injured site is swollen, inflamed with necrosis. • Fragments of sui are found in the wound. • Hemorrhagic patches are also seen under mucous membrane.

	• Internal organs are congested with hemorrhages[1].
Medicolegal aspects	• Suis are used to kill cattle. • Human poisoning is also recorded by keeping a sui-spike between fingers and giving a slap or injected into the contaminating wounds. • Malingerers use the powered seeds to produce conjunctivitis to escape duty or work. • *Abrus precatorius* is also used as an arrow poison[1].

[5] Kishor S. Chaudhari, R Sharma, Pradeep S. Pawar, and Vidyadhish A. Kashikar, Pharmacological activities of Abrus precatorius Linn. International Journal of Ayurvedic and Herbal Medicine, 2012, 2(2), 336:348

[6] http://www.planetayurveda.com/abrus_precatorius.htm

2.2. *Calotropis*

This plant grows almost everywhere in India and it is also known as madar. There are two varieties of *Calotropis* namely *Calotropis gigantean* and *Calotropis procera*.

Fig 4: *Calotropis* plant[7]

Botanical Name Variety I : *Calotropis gigantea* (Purple flower) Variety II : *Calotropis procera* (White flower) **Family Name** : *Apocynacea*e **Common Name :** Madar[8]	
Active part	An acrid milky juice is obtained by incision of leaves and stem and is when heated and allowed to stand, forms a clear serum which contains gigantin and is highly toxic[9]
Active principle	Uscharin, calotoxin, calotropin and gigantin[9].
Sign and symptoms	• Skin becomes red and vesicated when applied externally on skin. • When instilled into the eyes, it causes conjuctivitis which may result in permanent impairment of vision. • Internally, it acts as gastrointestine and cerebrospinal poison. • There is an acrid taste, burning pain in throat and stomach with nausea, vomiting and diarrhea followed by dilated pupils, convulsion, collapse and death. • When powdered madar root is used (snuffing), death ensues

	immediately[7].
Fatal dose : Uncertain **Fatal period** : 12 hrs[7]	
Postmortem appearances	• Froth at the nostrils, stomatitis, and acute inflammation of the alimentary tract with dilated dilated pupils. • Stomach may show an acute ulcer or perforation. • Viscera including brain and its meninges are congested[7]
Medicolegal aspects	Madar juice has been used: • Sometimes for infanticide • To cause abortion by ingestion or by local application on an abortion stick. • As a cattle poison • To produce artificial bruises • Rarely for suicide or homicide[7]

[7] http://www.arkive.org/sodoms-apple-milkweed/calotropis-procera

[8] L B Gaur, S.S Bornare, A.S Chavan, Mukh Ram, S P Singh, S.C Gaur and Sudhir Kumar, Biological Activities and Medicinal Properties of Madar (Calotropis Gigantean R.Br). Punarna V An International Peer Reviewed Ayurved Journa, 2013, 1(1), 11:19

[9] S Quazi, K Mathur, S Arora, *Calotropis Procera*: An Overview of Its Phytochemistry and Pharmacology, Indian Journal of Drugs, 2013, 1(2), 63-69

2.3. *Castor*

Castor plant grows naturally all over the India and also cultivated for its oil seeds known as Castor oil. It is almost 2-4 m in height and seeds are oval and glossy brown in colour. The entire plant is poisonous including Castor seeds. The oil is obtained after extraction of seeds, known as Castor oil which contains active principle called ricin, a toxalbumin and it also an irritant in action.

Fig. 5: *Castor* Plant[10]

Fig. 6: *Castro* seeds[11]

[10] http://www.library.illinois.edu/vex/toxic/castor/castor.html

[11] http://www.thedangergarden.com/2010/03/seeds.html

Botanical Name : *Ricinus communis* **Family Name :** *Euphorbiaceae* **Common Name :** Castor[12]	
Active part	Entire plant is poisons and seed contains Castor oil which contains ricin which is toxalbumin[12].
Active principle	Ricin[12]
Sign and symptoms	• Raw seeds when eaten, cause burning in throat, salivation, nausea, and painful vomiting, abdominl pain, bloody purging, followed by collapse. • Dehydration and cramps are common. • Coma and convulsions may precede death. • The dust from residue may cause dermatitis, conjuctivitis, rhinitis and occasionally asthma and allergy [13].
Fatal dose : About 10 seeds (6 mg of ricin). **Fatal period :** Several days after consumption[1].	
Postmortem appearances	• Fragments of seeds may found in stomach. • Bowel is inflamed and there are occasional erosions and submucous hemorrhages. • Mucosa of GI tract is congested, inflamed and also produced haemorrhages. • Hemorrhage may also found in internal organs[13].
Medicolegal aspect	• Accidental cases occur among children from eating seeds. • Administration in food with homicidal intent. • Powder of seeds causes local irritation of skin and mucous membrane of nose and eyes[13].

[12] P. L. Ladda, R. P. Kamthane and Resinus communis (Castor): An overview, International Journal of Research in Pharmacology & Pharmacotherapeutics, 3(2), 2014, 136-144.

[13] K. S. N. Reddy and O.P. Murty, The Essential of Forensic Science and Toxicology, Chapter 29 p. 479, 25th edi. (2006).

2.4. *Croton*

It grows all over the India. Croton oil is obtained by the extraction of the seeds. Its seeds resemble to the caster seeds having oval shape but different in their appearance as they are black and brown in colour with oily kernel and also have longitudinal line on them. The oil is brown in colour, viscid in appearance, unpleasant in smell and bitter in test[1].

Croton seeds[14]

Botanical Name : *Croton tiglium* **Family Name** : *Euphorbiaceae* **Common Name** : Jamal ghota[15]	
Active part	Croton seeds are poisons[15].
Active principle	Crotin, a toxalbumin. It is an irritant[15].
Sign and symptoms	• Poisoning of Croton is similar to poisoning of ricin. • The oil causes blistering after external exposure. • When taken orally, raw seeds cause excessive salivation, nausea, vomiting, and colicky abdominal pain, gastrointestinal irritation with bloody purging followed by collapse[1].
Fatal dose : 20 drops of oil (approximate 4 seeds) **Fatal period** : Death may occur in few hours to few days[1]	
Postmortem appearances	• Fragments of Croton's seeds may found in stomach. • Postmortem findings shows gastrointestinal tract is inflamed and

	congested[16].
Medicolegal aspects	• Croton oil is admininistered with food for homicidal intention. • Accidental poisoning is resulted from Croton oil as a purgative. • It also is used as abortifacient. • Wild tribes use oil as arrow poisons[1].

[14] http://toptropicals.com/catalog/uid/Croton_sylvaticus.htm

[15] J M Ganer, V V Nikam, Baragi Umapati C, 4Baragi Pramod C, International Pharmacognostic, Phytochemical and Physicochemical Investigation of *Croton Tiglium* Seeds. International Journal of Pharmacy, 2014, 4(3), 140-145

[16] N K Rao, Textbook of Forensic Medicine and Toxicology, Chapter 21, p. 369, Irritant Poioson, 2nd edi., (JP Brothers Medical Pulisher P. LTD, 2006)

2.5 *Nux vomica*

Nux vomica is also known as strycnos Nux vomica and it grows in tropical region throughout the India. It belongs to *Loganiaceae* family[17].

Seeds of *Strychnos Nux vomica*[18]

Botanical Name : *Strychnos Nux vomica* **Family Name** : *Loganiaceae* **Common Name** : Locally it's known as Kuchila, Kuchla etc[19].	
Active part	Seeds, leaves, bark and wood contain active principle[20].
Active principle	The seeds of *Nux vomica* are poisonous which contains active principle strychnine while leaves bark and wood contain brucine[20].
Sign and symptoms	Unbroken seeds of *Nux vomica* are not poisonous as hard pericarp is insoluble in digestive juices while, when seeds are broken or chewed, there is an intense bitter taste in mouth and symptoms appear within 15 min to an hour[20]. Strychnine is a powerful alkaloid. It stimulates all parts of central nervous system and particularly spinal cord and causes muscles to contract. This can lead to convulsions and death. • Muscles become so stiff and rigid that the body is arched. The facial muscles are also contracted Sometimes the chest is fixed so that breathing is difficult and therefore, cyanosis and blood

	stained froth may be seen at the mouth. • Death usually occurs due to asphyxia from spasm of respiratory muscles or from exhaustion due to repetition of spasms[21].
Fatal dose **Fatal period**	**:** Ingestion of one crushed seed (about 15-16 mg of strychnine). **:** 1-2 hrs[21].
Postmortem appearances	• Signs of asphyxia are common. • Rigor mortis sets in almost immediately after death and passes off early. • Strychnine resists putrefaction. Therefore, the remains of seeds may be found in viscera (stomach)[20].
Medicolegal aspects	• Mostly accidental. • Homicide is rare due to bitter taste. • Suicide is rare due to incredibly painful death. • Used as cattle poison, also used to kill stray dogs, as rodenticide and sometimes as an arrow poison[20].

[17] J Chen, Y Qu , D Wang, P. Peng, H Cai, Y Gao, Z Chen and B Cai, Pharmacological Evaluation of Total Alkaloids from Nux Vomica: Effect of Reducing Strychnine Contents. Molecules, 2014, 19, 4395-4408

[18] http://vnspice.com/strychnos-nux-vomica-seeds

[19] R. Bhati, A. Singh, V. A. Saharan, V. Ram and A. Bhandari, Strychnos nux-vomica seeds: Pharmacognostical standardization, extraction, and antidiabetic activity. J Ayurveda Integr Med. 2012, 3(2): 80–84.

[20] K Vij , Textbook of Forensic Medicine and Toxicology: Principles and Practice, Chapter 41 p. 521, Spinal poisons, 5th edn., (Elsevier, 2011).

[21] I. Makarovsky, G. Markel, A. Hoffman, O. Schein, T. Brosh-Nissimov, Z. Tashma, T. Dushnitsky and A. Eisenkraft, Toxic chemical compound: Strychnine – A Killer from the Past. Israel Medical Association Journal, 2008, 10, 142-145.

2.6. *Oleander*

There are two variety of *Oleander* exist in nature i.e. *Nerium odorum* and *Cerbera thevetia*. These plants grow widely in India. *Nerium odorum* bears white or pink flowers and known as true *Oleander* while, *Cerbera thevetia* bears yellow bell-shaped flowers and known as pila kaner. It and belongs to *Apocynaceae* family[22].

Nerium odorum

Cerbera thevetia

Botanical Name Variety I : *Nerium odorum* (While and pink flower) and Variety II : *Cerbera thevetia* (Yellow flower) **Family Name** : *Apocynacea* **Common Name :** Kaner	
Active part	Milky juice which exudes from all parts of plant[25].

Active principle	**Cerbera thevetia:** Thevetin, Thevetoxin, Cerberin (glycosides). **Nerium odorum:** The active principles are 3 glycosides, i.e. neriodorin, neriodorein and Karabin. • The principal action of neriodorin is similar to that of digitalis causing death from cardiac failure. • Neriodorein causes muscular twitching and tetanic spasms more powerful than those of strychnine.
Sign and symptoms	**Cerbera thevetia:** • Burning sensation in mouth with tingling of the tongue, dryness of throat, vomiting, diarrhoea, headache, dizziness, dilated pupils, irregular action of the heart, drowsiness, collapse, coma and death. • Tetanic convulsions are occasionally observed. **Nerium odorum:** • Vomiting, pain in abdomen and frothy salivation usually occur, followed by restlessness. There is difficulty in swallowing and often lock jaw. • The pulse is slow and weak, and a respiration is hurried. • Muscular twitching of the extremities results into tetanic spasms. • This is followed by coma and death from heart failure.
Fatal dose: **Fatal period:**	**Cerbera thevetia:** 8-10 seeds or 15-20 gm of root **Nerium odorum:** About 15 gm of root **Cerbera thevetia:** 24 hrs. **Nerium odorum:** 24 hrs.
Postmortem appearances	**Cerbera thevetia:** • Signs of gastrointestinal irritation, congestion of various organs, and endocardinal ecchymoses caused by bruising. • It resists putrefaction and can be detected even years after

	death in exhumed putrefied bodies. **Nerium odorum:** • Not specific. • Petechial hemorrhages on heart are a characteristic feature. • Nerium odorum resists heat and can therefore be detected even from the burnt remains of the dead body[Vij25].
Medicolegal aspects	• Suicide with roots leaves and seeds are common among village women. • The root is commonly used for procuring abortion. • Accidental poisoning is sometimes met when the decoction of leaves is applied externally to reduce swellings • Use as cattle poison has also been recorded.

[22] K. S. N. Reddy and O.P. Murty, The Essential of Forensic Science and Toxicology, Chapter 36 p. 538, 25th edi. (2006).

23http://www.kew.org/science-conservation/plants-fungi/nerium-oleander-oleander

24 http://www.delange.org/OleanderYellow/OleanderYellow.htm

[25] K Vij , Textbook of Forensic Medicine and Toxicology: Principles and Practice, Chapter 42 p. 525, Cardiac poisons, 5th edn., (Elsevier, 2011).

2.7. Marking nut

It is distributed in Himalayan region, tropical and central parts of India. It is closely related to the cashew[26]. Its Fruit is black which yields oily resin is often used as "marking ink" on clothes[1].

Fruits of *Marking nut*[27]

Botanical Name : *Semecarpus anacardium.* **Family Name** : *Anacardiaceae* **Common Name** : In Sanskrit it is known as Agnimukha and in Hindi as 'Bhilwa'. It is also known by some other names i.e. Bhela and Oriental Cashew[26].	
Active part	Fruit
Active principle	Semicarpol (monohydroxy phenol compound) & Bhilawanol (alkaloid)[1.]
Sign and symptoms	• When juice is applied on the skin, it causes irritation and painful blisters. The lesion resembles a bruise which may ulcerate later and slough. • When administered internally, it is causes less irritation. In larger doses, it causes blisters in the mouth and throat with severe gastroenteritis, followed by dyspnoea, cyanosis, tachycardia coma and death in some cases[1].
Fatal dose : 5 to 10 gm **Fatal period** : 12 to 1 hrs[1]	
Postmortem	The blister formation will be there. Blister fluid containing acrid

appearances	serum should be preserved in rectified spirit and sent to a forensic science laboratory for the analysis[1].
Medicolegal aspects	• The juice is used as an abortifacient by means of an abortion stick on to the uterus. • It is also used by malingeres to produce an artificial bruise to support a false charge. • Accidental poisoning may occur from internal administration by quack. • The juice can be thrown like vitriol on the face intentionally. • Homicidal poisoning by internal application is rare[1].

[26]M. Semalty, A. Semalty, A. Badola, G. P. Joshi and M. S. M. Rawat, *Semearpus anacardium Linn.:* A review. Pharmacogn Rev, 2010, 4(7): 88–94.

[27] http://dir.indiamart.com/impcat/bhilawa-seeds.html

3. Animal poisons:

In this section, animal poisons such cantharides, scorpion and snake venom have been discussed as below.

3.1. Scorpions

There are various species of scorpions but few of them are unsafe for human. Scorpions have a cephalothorax, an abdomen and segments in tail with venom secreting glands and one sting. Besides, the scorpion has two claws to grasp the prey.

Scorpion venom contains both haemotoxin and neurotoxin. It stimulates the release of catecholamines from the adrenal glands and release into the circulation and hence, affects the myocardium which results in cardiac arrhythmias, hypertension. After release of catecholamines, it results in hypotension and bradycardia[28].

Scorpion[29]

Scorpion venom	
Sign and symptoms	• There is local irritation manifested by redness and burning pain at the site of bite. • The presence of swelling and hemorrhages help in locating the site of bite. • Scorpion sting will have a single hole at the center of reddish area. • As consequences, there may be headache, giddiness, nausea, excessive sweating, fever, paralysis, cardiac problems, cynosis and muscular cramps followed by coma[13].

Fatal dose : Death is rare in adults while, in children it may causes fatality due to pulmonary oedema. **Fatal period :** Death may occur within an hour from pulmonary oedema[13].	
Postmortem appearances	• There is widespread hemorrhage. • Sting may be found at the site of bite. • Myocardial damage may also found[30].
Medicolegal aspects	• Poisoning from scorpion is accidental[30].

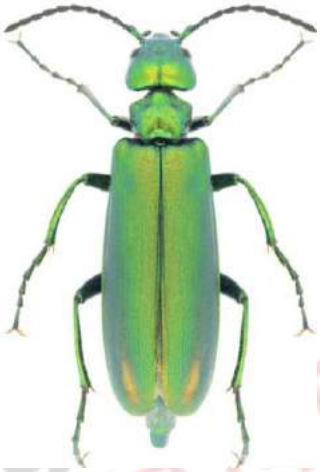
[28] K Vij , Textbook of Forensic Medicine and Toxicology: Principles and Practice, Chapter 36 p. 483, Irritants of animal origin, 5th edn., (Elsevier, 2011).

[29] http://www.factzoo.com/invertebrates/emperor-scorpion-glow-in-the-dark.html

[30]G. Biswas, Review of Forensic Medicines & Toxicology Including Clinical and Pathological aspects, Chapter 46 p. 464, 2nd edi. (Jaypee Brothers Medial Publisher P, 2012)

3.2. Cantherides

The Spanish fly or Blister Beetle is a type of insect. It contains active principle cantharidin which is an irritant. Cantharides may be administered in the form of powdered beetles, or the tincture and it readily absorbs from skin[28].



Cantherdes[31]

Cantharides	
Sign and symptoms	• When applied externally on the skin, it causes redness, burning pain followed by vesication. • On internal application, there is burning sensation in mouth, throat, pain in stomach and intense feeling of thirst. • There is difficulty in swallowing, nausea, vomiting with abdominal pain. • The urine is scanty and tinged with blood. • Abortion may occur in pregnant woman. • In fatal cases, coma with convulsions usually precedes death.
Fatal dose : **Fetal period :**	15 to 50 of cantharidine and one and half g to 3 g of cantharides. 24 to 36 hours
Postmortem appearances	• There is inflammation of mouth. Sometimes vesications may appear. • There may be swelling of mucous membrane of oesophagus with ulcer formation. • There may be congestion of mucous membrane of stomach

	which may be extended to the small intestine. • There is acute inflammation of kidney with the haemorrhages in renal, pelvis and bladder.
Medicolegal aspects	• Accidental poisoning may occur due to over dose application because of its aphrodisiac properties. • Homicidal poisoning is rare. • It is may be used as aphrodisiac. • It is also used as abortifacient[13].

[31] http://www.wisegeek.com/what-is-cantharidin.htm

3.3. Snake Venom

Snakes are classified into two groups, i.e. poisonous and non-poisonous. Poisonous snakes are further divided into three categories on the basis of poison secreted by them such as Elapids (neurotoxic venom), Vipers (vasculotoxic venom) and Sea snakes (myotoxic venom)[28].

Neurotoxic venom causes muscular weakness of legs and paralysis of muscles of face, throat and respiratory track while, vasculartoxic venom causes coagulation disorders and destroy endothelium of blood vessels. Myotoxic venom produces muscular pain, followed by myoglobinuria and later on by failure of respiration after 3-5 hrs in fatal cases.

Snake[29]

Snake venom	
Sign and symptoms	• The hallmark of attack of a snake is presence of fang marks. • After 1or 2 hrs of attack, generalized muscular pain and stiffness develop. • There will be slight burning at the site of bite followed by neurotoxic effects such as giddiness, lethargy, muscular weakness and paralysis. Weaknesses in the legs are manifested by staggereing. • There will be difficulty in speaking and swallowing. Ptosis and paralysis of ocular muscles may occur with slow and labored breathing. After couples of hours, respiration may cease and

	heart stops. • Skin and tissues shows necrosis surrounding the bite mark along with intense local pain, swelling, discoloration of skin and severe oozing of hemolytic blood. Blisters may appear sometimes. • Hemolysis may lead to hemoglobinuric nephritis. • Petechial hemorrhages, bleeding from the gums, and bleeding from mucous membrane of the rectum and other orifices of body are common. • Collapse sets in with cold calmly skin with rapid feeble pulse and dilated pupils, followed by coma and death. • Respiratory failure may occur[13].
Fatal dose : mg (dried form) Type of snake • 15 mg – Cobra dried cobra venom • 12 mg – King Cobra • 2.5 mg-6 mg – Common Krait • 40 mg – Russell's Viper • 8 mg – Saw-scaled viper **Fetal period** : Death occur from • Cobra venom- within a few min to few hours • Viper venom- in a few days • Sea snake bite is mostly not fatal[30].	
Postmortem appearances	• There will be the presence of fang marks which are about 1 cm to 2.5 cm deep depending upon the type of snake bitten with some swelling around the bitten part. • There are no characteristics findings indicating the cause of death except the signs of asphyxia. • There will be severe oozing of blood from puncture site. • There are hemorrhages in lungs membranes. Endocardial hemorrhages are seen especially in left ventricle. Petechiae are also found within kidney and mucousa of urinary bladder,

	stomach and intestines. • Arterioles and capillaries are characterized by blurred walls and swollen endothelial cells[13].
Medicolegal aspects	• Generally accidental • Rarely homicidal and suicidal. • Sometimes used to kill cattles[28].

[29] http://www.dkfindout.com/us/animals-and-nature/reptiles/cobras

A Gateway to all Post Graduate Courses

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Subject: **Criminology**

Production of Courseware

- Content for Post Graduate Courses

Paper : **Forensic Science and Forensic Medicine**

Module : **Determination of age, sex, Race and stature from human skeleton remains**

Role	Name	Affiliation
Principal Investigator	Prof. (Dr.) Ranbir Singh	Vice Chancellor, National Law University, Delhi
Co-Principal Investigator	Prof. (Dr.) G.S. Bajpai	Registrar, National Law University Delhi
Paper Coordinator	Prof. (Dr) Sally Lukose	Dean, School of Basic and Applied Sciences, Galgotias University
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Content Reviewer	Dr. Tanya Chauhan	Assistant Professor, LNJN-National Institute of Criminology and Forensic Science, Delhi.

DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Determination of age, sex, Race and stature from human skeleton remains.
Module Id	----------
Objectives	Learning Outcome: • To make the learners understand the basic of forensic anthropology. • To help the learners in determination of age from bones. • To educate the learners how to estimate the race and stature of individual from skeleton remains. • To teach the learners how the skeleton of male and female are differ.
Prerequisites	General understanding about anthropology and its forensic significance.
Key words	Anthropology, sex determination, age determination, stature, human skeleton.

1. Sex determination from skeleton remains:

Sex differentiation from skeleton does not appear until puberty. Until the puberty skeletons of two sexes differ only in size. Sex determination is dependable only if the vital parts of the skeleton are present in good condition. Pelvis and skull are the most important one for determining sex. The round of ball joints as well provides reliable means of determining sex.

Characteristic feature of skeleton		
	Male	**Female**
1.	Skeleton are bigger and stouter.	Skeleton comparatively smaller and slender.
2.	Muscular ridges, depression and process are more prominent.	Muscular ridges, depression and process are less prominent.
3.	Shaft of the long bones relatively rough and the articular surfaces and ends larger.	Shaft of the long bones relatively smooth and the articular surfaces and ends small.

Skull:

The adult female skull is usually lighter and smaller, 10% less spacious than that of the males. It is very difficult to determine sex of skull below the age of adolescence. The differentiating features between the two sexes are as follows:

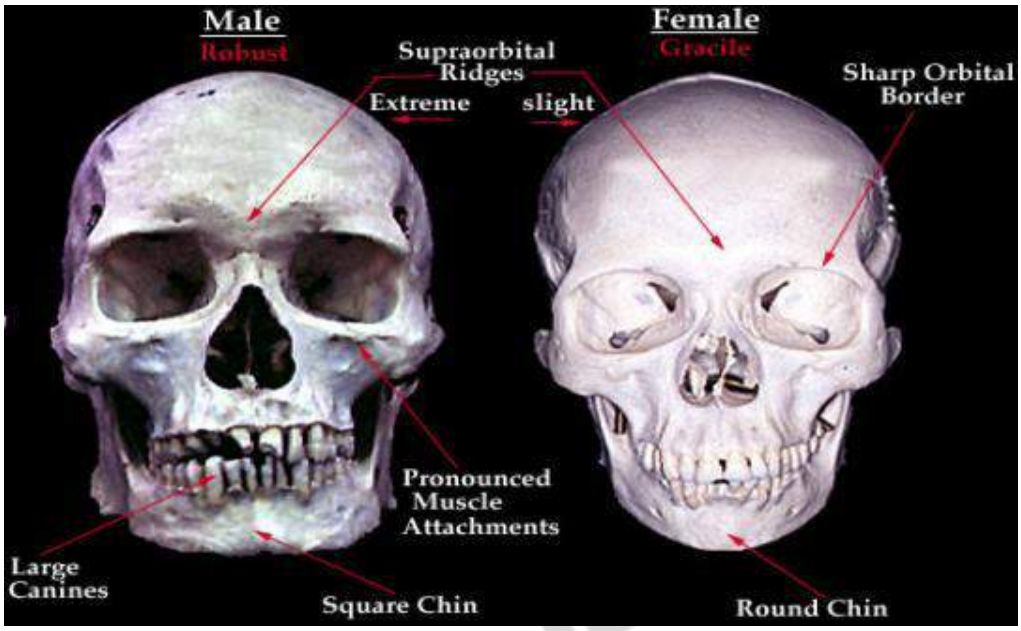


Fig: - DFS manual 2005.

2. Age Estimation from skeleton

(A) AGE OF INFANT BELOW 6 MONTH FROM SKELETON

(i) The ramous of the mandible is short, oblique and forms obtuse angle with the body.

(ii) The coronoid process projects about the level of the condyloid process.

(iii) The mental formation remains near the lower margin of the jaw.

(iv) The body is shallow.

(B) 6 MONTHS TO 2 YEARS:

(i) Outbreak of almost all the temporary teeth.

(ii) Emergence of ossification centers in the heads of humerus,

femur, ulna, tarsal and carpal bones.

(iii) Closure of the anterior fontanelle at about 3/2 years.

(C) 2 TO 6 YEARS:

(i) Appearance of centers of ossification in the epiphysis of long bones.

(ii) Closure of metopic suture.

(iii) Union of condylar part of occipital bone with the squama and basi-occiput.

(iv) Blending of greater and lesser tubercles to head of humerus.

(D) 6 TO 12 YEARS:

(i) Union of rami of ischium with pubis at the age of 7-9 years.

(ii) Ossification of pisiform bones occurs at the age of 9 to 12 years in females.

(iii) Union of lateral epicondyles of the humerus with the shaft.

(iv) Shedding of all temporary teeth and eruption of all permanent teeth except the 3rd molars at the age of 12 to14 years.

(v) Appearance of secondary sexual character around 12 years.

(E) 12 TO 18 YEARS:

(i) Fusion of upper end of Radius with shaft.

(ii) Fusion of Olecranon to the ulna.

(iii) Eruption of 3rd molar teeth with calcification of roots of all the previously erupted teeth.

(iv) Union of lower ends of Radius and Ulna with the respective shafts.

(F) 18 TO 25 YEARS:

(i) Fusion of epyphysis of long bones with their respective shafts.

(ii) Fusion of iliac crest with ilieum, ischial tuberosity with ischium.

(iii) Fusion of coracoid and acromion with their respective bodies.

(iv) Union of the epiphysis at sternal ends of the clavicles; the secondary centers in the pelvis and articular facets of ribs usually get completed at the age of 20-25 years.

(v) Bony replacement of the cartilage between the basiocciput and the basisphenoid commences at about 17th year in both sexes; union is completed by 22 years in females and 24 years in males usually.

(G) 24 TO 35 YEARS:

(i) Closure of the lambdoid suture is not complete before 50 years, though coronal sutures get closed at the age of 40 years.

At the age of 40 years, the articular surfaces of lumbodorsal vertebrae show lipping, loss of joint space, presence of punched out areas of osteoporosis.

X-ray examination shows such changes, first in the glenoid fossa of the scapulae; lipping becomes well advanced by 45-50 years but does not get complete before 60 years.

(I) ABOVE 50 YEARS:

(i) In old age the bone density is very low, long bones become lighter and brittle. Skull becomes thinner and lighter and hence is more liable to fracture from even slight violence.

(ii) Closure of mastoid, occipital, squamous and parietomastoid sutures will occur in very old age. Parietal suture may not even close throughout life.

(iii) Above 60-65 years, the angle of lower jaw opens out and the medico legal angles become obtuse.

(iv) Manubrium and body of sternum may fuse above 60 years.

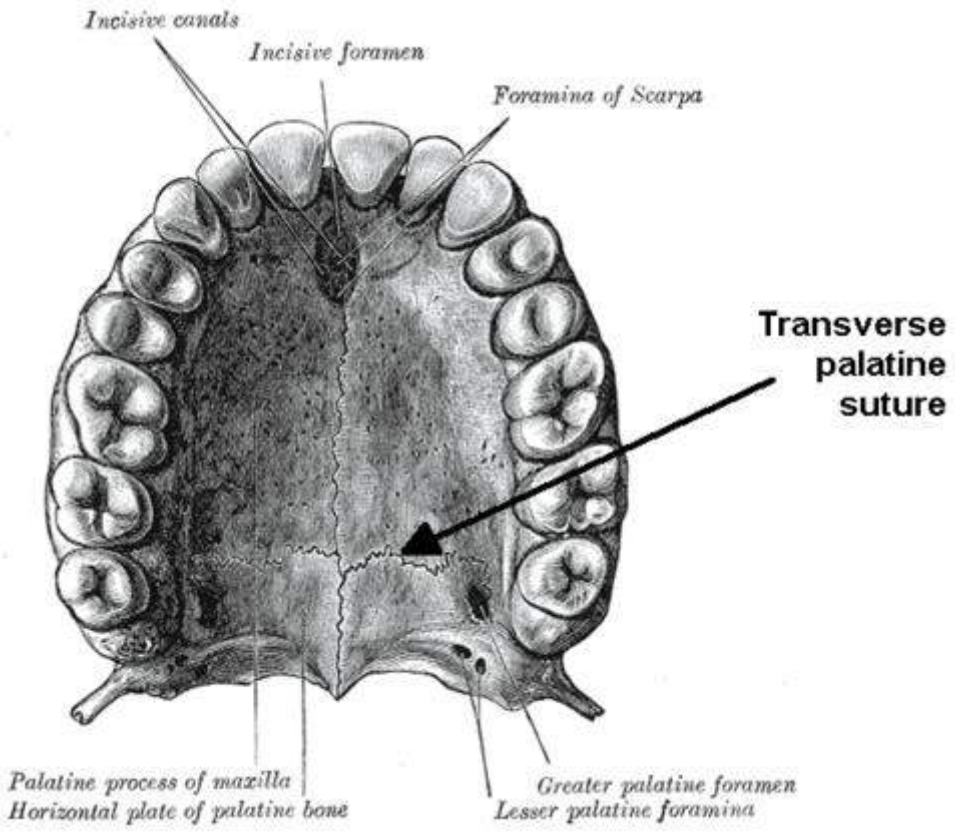
(e) The calcification of the laryngeal and costal cartilages becomes more apparent.

3. Determination of Race from skeleton remains

Racial differences in skeletal structure originally arose when small genetic changes developed in populations isolated by geography.

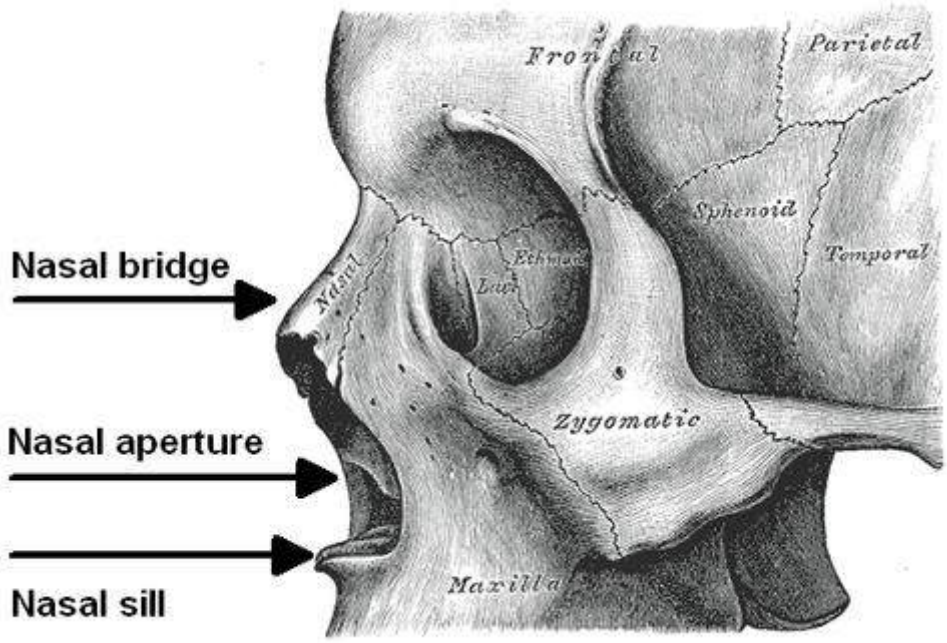
Now, as the migration increases worldwide and inter race marriage are also endorsed. Thus the people of different racial backgrounds intermix and the progeny of those individuals is harder to differentiate. Still there are some key features of the skull that can help forensic investigation:

I. Mouth: Whites tends to have smaller teeth, with significant crowding and impacted third molars, Blacks not often have crowding and the upper teeth often project outwards.

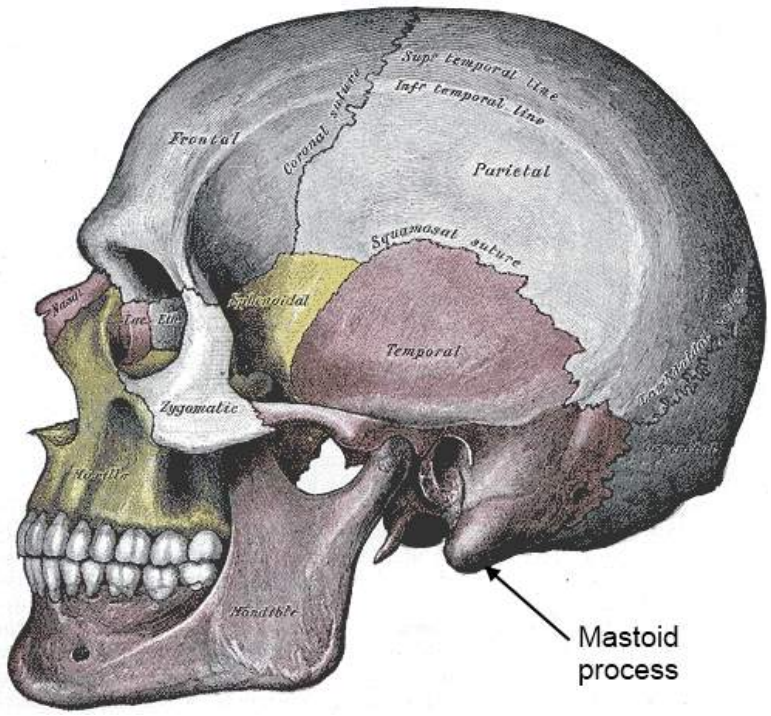


II. The palate: In American Indians, the palate is elliptical, with the 'U' shape angling in at the back teeth. In blacks, the palate is hyperbolic—a perfect 'U' shape with straight lines. And in whites, the palate is parabolic with the ends of the 'U' flaring outwards.

III. Incisors: American Indians (and East Asians, both of Mongoloid ancestry), have the incisors shovel-shaped. Black and whites both have blade-form incisors.



IV. The nose: Whites have long and narrow nasal aperture, with a high bridge and a sharp nasal sill. The nasal aperture of blacks has short and wide with a low bridge and a guttered or trough-like nasal sill. , the nasal aperture of American Indians is medium-sized with both a medium bridge and nasal sill.



V. The mastoid process: Blacks have the wide bony projection, whites have narrow and pointed. American Indians, a secondary smaller projection forms on the back surface of the mastoid process.

4. Estimation of Height from Long Bones

An approximate height of the deceased from the skeletal remains is obtained by multiplying the length (in inches) of a long bone with a suitable multiplication factor. These are the factors for long bones:

Long bone	Multiplication factor
Humerus	5.2
Radius	6.6
Ulna	6.0
Femur	3.7
Tibia	4.3
Fibula	4.4

The exact multiplication factor may vary from males to females and children for diverse groups of population.

References:-

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2. American academy of forensic science (www.aafs.org)
3. Shetty M, Premalatha K. ABO blood grouping from tooth material. J Indian Acad Forensic Med. 1972;32(4):336–38.
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Principal Investigator	Prof. (Dr.) G.S. Bajpai	Registrar, National Law University Delhi
Co-Principal Investigator		
Paper Coordinator	Prof. (Dr) Sally Lukose,	Dean, School of Basic and Applied Sciences, Galgotias University
Content Writer/Author	Ms Vinny Sharma	Assistant Professor, Division of Forensic Science, SBAS, Galgotias University
Content Reviewer		

DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Classification of Fingerprints Comparison of finger prints.
Module Id	CRIMINOLOGY/FSFM/XIX
Objectives	Learning Outcome: • To make the learners understand the numbering and naming of fingerprints for the classification purposes. • To acquaint the learners with the henry's classification system of fingerprints. • To acquaint the learners about the basis for comparison of fingerprints. • To inform learners about the process of comparison of fingerprints.
Prerequisites	Fingerprints – definition, pattern types, general and individual fingerprint characteristics.
Key words	Henry's system of classification, valued and non-valued patterns, suspect and standard fingerprints.

1. Introduction:

Fingerprints or finger impressions are unique and highly individualistic, even the same person cannot have the same fingerprints on two different fingers also they are different in monoclonal twins also.

Due such vast variation in the finger impressions a need to classify them was felt. Also for the purposes of comparison of scene of crime prints with the suspect's prints required a means of classification which ease the process of comparison. Apart from this section 75 IPC that has a provision for extended punishment for repeat offenders requires the search of pervious records of culprits and since fingerprints does not change with time therefore are a perfect medium to act as a basic searching tool for such records. This searching process again requires a classification method for classifying the recorded fingerprints records.

For the classification purposes the all the fingerprints of all the digits are recorded on the 10-digit fingerprint slip (sample below). The impressions recorded are both the rolled and plain impressions.

By rolled impressions we mean that the fingers are rotated from nail to nail from left to right to obtain the inked impression of the fingers. These rolled impression are widen and provides a detailed account of the fingerprints.

By plain impressions we mean that the inked prints are obtained by merely slapping the fingers perpendicularly on the record slip to obtain the prints. The purpose of taking these prints is to match the sequence of the rolled prints obtained earlier of the same individual.

CASE NO.:		TIME:		DATE:
INVESTIGATING TEAM:				
EVIDENCE NO.:		SIGNATURE OF OFFICER:		
ROLLED PRINTS				
RIGHT HAND				
RT	**RI**	**RM**	**RR**	**RL**
LEFT HAND				
LT	**LI**	**LM**	**LR**	**LL**
PLAIN PRINTS				
LEFT HAND			**RIGHT HAND**	
	LT	**RT**		

Figure: 10-digit fingerprint record slip.

2. Various system of fingerprint classification:

Fingerprints are classified on various basis by different researchers devising a different classification each time. There are approximately 50 different system of classification of fingerprints are available which are practiced by different countries. The most commonly used system for classification of fingerprints is the Henry's ten-digit classification system. This system is widely used across the world for the purposes of filing and searching of fingerprints records (discussed later).

Other than this system of classification some other system are also in use, for example,

- The Vcetich or Argentine system
- The Budapest or Hungarian system
- The Valladares system
- The Bertillon system
- The Daae system
- Then Klatt system
- The When system
- The Proivenski system
- The Brussels system

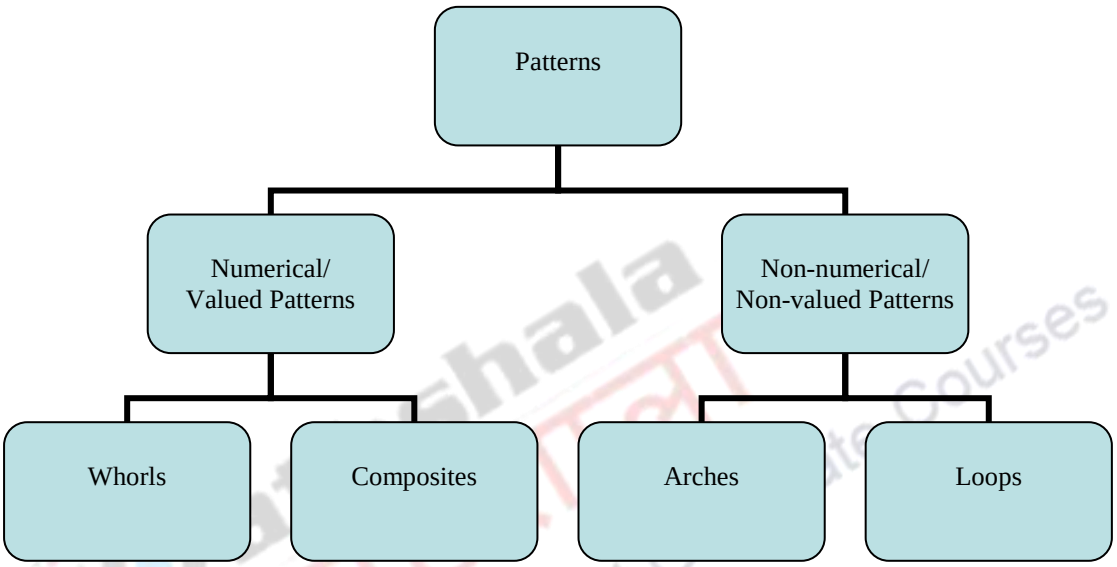
3. Henry's System of classification:

The classification system used in all parts of our country and elsewhere is based on henry system. The classification formulae consist of letters and numbers arranged in the form of a fraction with a numerator and denominator. The formula is based on a study of the ten fingerprints of an individual. Every individual pattern is first identified and marked on the slip. Then the classification formula is worked in a logical order in the following different steps:

1. Primary classification
2. Secondary classification
3. Sub-secondary classification
4. Final classification.

3.1 Primary classification:

To arrive at primary classification, patterns are first divided into numerical (or valued) and non-numerical (non-valued) patterns. Whorls and composite patterns are numerical (or valued) patterns, whereas arches and loops are non-numerical (or non-valued) patterns.



All the rolled impressions are numbered on a fingerprint slip from one to ten in the following order:

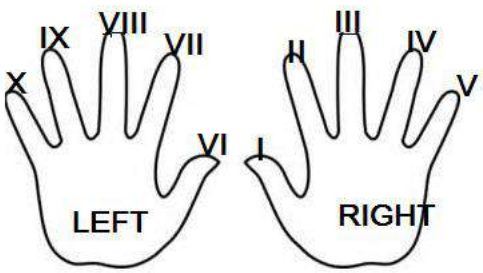
I – Right Thumb (RT) VI – Left Thumb (LT)

II – Right Index (RI) VII – Left Index (LI)

III – Right Middle (RM) VIII – Left Middle (LM)

IV – Right Ring (RR) IX – Left Ring (LR)

V – Right Little (RL) X – Left Little (LL)



Numerical values are assigned to the fingers in the following order:

I – Right Thumb (RT) = 16
II – Right Index (RI) = 16
III – Right Middle (RM) = 8
IV – Right Ring (RR) = 8
V – Right Little (RL) = 4
VI – Left Thumb (LT) = 4
VII – Left Index (LI) = 2
VIII – Left Middle (LM) = 2
IX – Left Ring (LR) = 1
X – Left Little (LL) = 1

Digit number	I	II	III	IV	V
Digit name	Right Thumb	Right Index	Right Middle	Right Ring	Right Little
Numerical value	16	16	8	8	4
Digit number	VI	VII	VIII	IX	X
Digit name	Left Thumb	Left Index	Left Middle	Left Ring	Left Little
Numerical value	4	2	2	1	1

If the pattern identified come under the valued/numerical pattern group then the value assigned will be taken into account. If the pattern identified come under non-valued/non-numerical pattern group then the vale assigned to these positions will not be taken into account and will be taken as zero (0).

After assigning the values, the values obtained for all the even numbered fingers are placed in the numerator, and the values obtained for all the odd-numbered fingers are placed in the denominator. To obtain the primary classification all the values in the numerator are totalled and 1 is added. Similarly, all the values in denominator are totalled and 1 is added. The fraction thus obtained constitutes the primary classification.

For numerator = RI, RR, LT, LM, LL

For denominator = RT, RM, RL, LI, LR

Formula,

Primary classification = RI+RR+LT+LM+LM+1/RT+RM+RL+LI+LR+1

As many as 2^{10}= 1024 combinations are possible through this classification.

3.2 Secondary classification: (or fulcrum classification)

The secondary classification subdivides large groups of fingerprint slips having the same primary classification. The secondary classification consists of the capital letter symbols for the patterns of the two index fingers, with the right index finger symbol appearing in the numerator and the left index finger symbol in the denominator. The five basic pattern types that can appear on index fingers are:

Arch (A), Tented arch (T), Radial Loop (R), Ulnar Loop (U) and Whorl (W).

For the purpose of this classification, composite patterns are classified as plain whorls under the symbol W. As many as 25 possible combinations are possible out of thus classification.

Formula:

Secondary classification = Pattern of RI/Pattern of LI

3.3 Sub-secondary classification:

The sub-secondary classification further subdivides large groups having same primary and secondary classification. The sub-secondary classification is represented by symbols that may be I, M, or O. These symbols are given to the index, middle and ring fingers of the right hand and make –up the numerator; the same fingers for the left hand make-up the denominator. These symbols are derived from the ridge tracing of the whorls appearing on the index, middle and ring fingers, or from the ridge counts of loops on these fingers.

In case of ridge counting,

For index finger: I = 1 to 5 ridge count

M = 6 to 12 ridge count

O = 13 and above ridge count

For middle finger: I = 1 to 6 ridge count

M = 7 to 13 ridge count

O = 14 and above ridge count

For ring finger: I = 1 to 7 ridge count

M = 8 to 14 ridge count

O = 15 and above ridge count

Formula:

Sub-secondary classification = Ridge tracing or count of: RI, RM, RR/ LI, LM, LR

3.4 Final Classification:

The final classification is a mere number, which denotes the actual ridge count for the patter of the little finger of right hand.

Formula:

Final classification = Ridge count (RL)

Henry Classification formulae:

- **Primary classification = RI+RR+LT+LM+LM+1/RT+RM+RL+LI+LR+1**
- **Secondary classification = Pattern of RI/Pattern of LI**
- **Sub-secondary classification = Ridge tracing or count of: RI, RM, RR/ LI, LM, LR**
- **Final classification = Ridge count (RL)**

5. Process of Comparison:

Fingerprints are infallible means of physical evidence. They are persistent and highly individualistic. They are left at the scene of crime by the perpetrator without his/her knowledge, unknowingly and by chance. The tendency of leaving a fingerprint at the scene of crime is enhanced due to the reason that they are left behind in the form of sweat deposited in the exact same manner as that the ridges are present and whicle committing the crime an individual perspires more as compared to the normal day-to-day scenario. Therefore, the frequency of finding a fingerprint at scene of crime is increased. The prints which are found at the scene of crime are termed as suspected prints and are need to be compared with the standard prints.

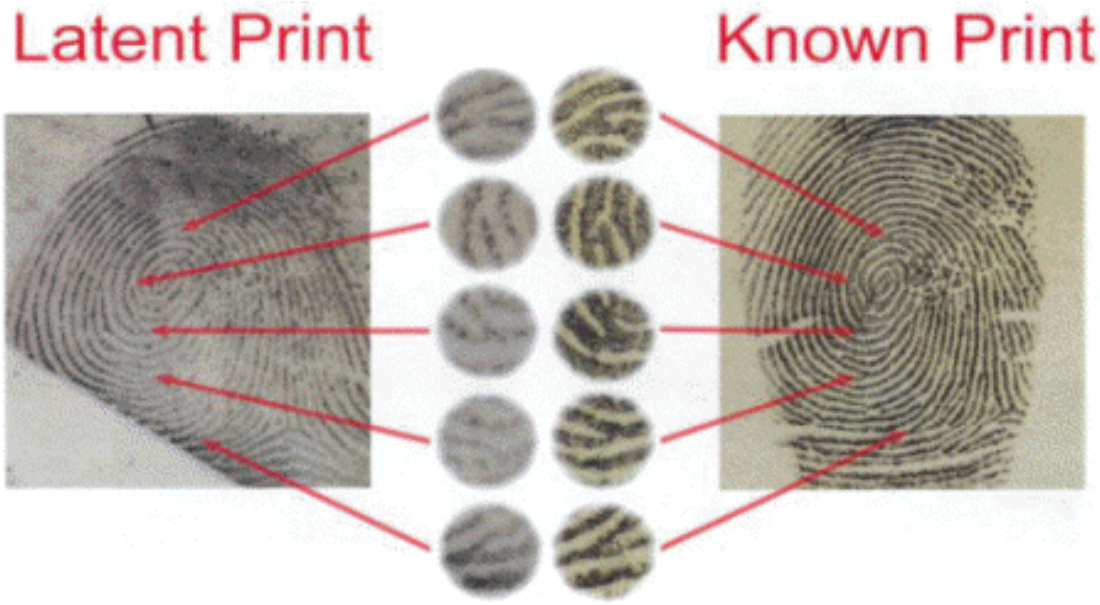
Suspected prints in other words are those prints whose identity is unknown, whereas standard prints are those prints whose identity is known.

Standard prints are obtained from the individuals on the standard 10-digit fingerprint slip, while taking the standard prints both rolled and plain prints are obtained. These slips are then used to compare with the suspect prints.

The evidentiary value of the fingerprint in the court of law lies on the top of all other scientific evidences.

The process of fingerprint comparison involves the photography of the prints, followed by the comparison of general and individual characteristics. The comparison process is majorly an elimination process. First the expert has to identify the pattern type of the suspected print followed by the type of core and delta, ridge count and ridge tracing. Then he/she start comparing it with the standard prints. Those prints with the same pattern type are considered and rest all are eliminated. After that the prints with similar delta and core type are considered rest are eliminated. Then the expert look for the similar ridge count and ridge tracing. In doing this the expert is eliminating the most unlikeable fingerprints which will not be matching with the suspected print. After comparing all the general characteristics, the expert is able to narrow down the list of standard prints with the most likeable prints remaining only.

The expert then look for the 8 ridge characteristics (minimum, as required by the law) in the suspect print and then he/she looks for the same ridge characteristics in the standard prints at the exact same location. When the expert does this he/she is able to tell the identity of the suspect print with a 100% match.



Comparison of suspect (latent) and standard (known) print.

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An MHRD Project under its National Mission on Education through ICT (NME-ICT)

Subject: **Law**

Production of Courseware

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Paper : **Forensic Science & Forensic Medicine**

Module : **Ammonium sulphate method, Stas-Otto method, dry ashing method, wet digestion, dialysis and total alcoholic extract method.**

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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Law
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Isolation of poisons from viscera: Ammonium sulphate method, Stas-Otto method, dry ashing method, wet digestion, dialysis and total alcoholic extract method.
Module Id	LAW/CJA/VIII /10
Objectives	Learning Outcome: • To make the learners understand about the extraction, isolation/ purification of poisons. • To make the learner aware about various methods of extraction for different classes of drugs. • To make the learners understand that extraction procedure depends upon physiochemical properties of poisons.
Prerequisites	To aware about different extraction procedures for the extraction of different classes of compounds/ drugs.
Key words	Extraction, isolation, purification, non-volatile organic poisons, volatile organic poisons, metallic poisons, anions etc.

1. Introduction:

There are various traditional as well as modern methods are employed for the extraction of poison from biological matter. The factors which affect the selection of method of extraction depends upon are type of poison, biological matter (matrix) constitute poison and quantity of matrix available for the analysis.

There are various types of poisons which have been discussed in earlier chapter. Depending upon the type of poison to be extracted from the given the matrix (biological matter intagged with poison), following are the methods used for extraction and isolation (purified) of poisons.

2. Isolation of non-volatile organic toxic poisons

2.1. Ammonium Sulphate Method:

Ammonium sulphate method is used the screening non-volatile drugs such as barbiturates, alkaloids, tranquilizers etc and the procedure involved is as follow:

Visceral tissues (about 50- 100 gms.) are cut into small pieces, macerated, mixed with of 5 % acetic acid (100 ml and are taken into a 600 ml beaker.

↓

To make a saturated solution, solid ammonium sulphate is added to it with frequent shaking. About 20 gms. of solid ammonium chloride are also added to it.

↓

Then it is heated on boiling water bath for 3 h
(in suspected case of acetone poisoning, temperature should not exceed 60°C).

↓

This mixture is then cooled and filtered (F1).

↓

The residue on the funnel is again extracted with two portions of 100 ml of 5% acetic acid and filtered as earlier (F2).

↓

The above filtrates (F1 & F2) are pooled in a 500 ml separating funnel (Step-1).

↓

The residue slurry on filter paper is washed with diethyl ether (100 ml) and collected in other container.

↓

The ether fraction so obtained is added to the aqueous acidic extract in the separating funnel (Step-1) and shaken vigrously for 5 minutes and separated [Acid-Ether (E1)].

↓

100 ml of ether is again added to the acidic layer, shaken vigrously for 5 minutes and separated (Acid-E2).

↓

The above ether layers [Acid-Ether (E2)] are combined.

↓

Note: This acidic ether extract is tested for aspirin, barbiturates, salicylic acid, meprobamates, benzodiazepines, lysergides, etc.

The aqueous solution remaining in the separating funnel after separation of acidic drugs (Acid-ether layer) is made alkaline by addition of ammonium hydroxide and it is extracted thrice with 100 ml portions of chloroform ether mixture (1 : 3)

(Organic layer) [Step-2].

↓

Note: The aqueous layer is retained for the extraction of opium alkaloids.

The organic layers after separation [obtained at Step-2] are combined and washed with 50 ml of distilled water. It is extracted thrice with 25 ml of 10% sulphuric acid.

↓

The sulphuric acid fractions are combined and taken into another separating funnel. (Organic layer is discarded). To it 50 ml mixture of chloroform-ether (1 : 3) is added to it. To make the solution alkaline dilute ammonium hydroxide solution is added it and shaken for 5 minutes [Step-3].

↓

The organic layer [obtained at Step-3] is separated. The extraction is repeated thrice.

The organic layer after separation are combined, washed with l50 ml of water, dried by passing through anhydrous sodium sulphate and evaporated to dryness.

↓

Note: This extract is tested for aconite, , datura, opium alkaloids, amphetamines, methaqualone, meprobamate and etc.

The acid – ether extract may be further be separated into following three fractions:

(i)

The acid-ether layer is shaken with 25 ml of 5% sodium bicarbonate solution.

↓

The aqueous layer is removed and taken into another separating funnel.

↓

Acidified with dilute sulphuric acid and again extracted with 25 ml of ether.

↓

This ether fraction is passed through hydrous sodium sulphate and dried.

↓

Note: The residual fraction 1 contains salicylates.

(ii)

The ether layer (of acid ether fraction) after washing with sodium bicarbonate is extracted twice with 25 ml portions of N-sodium hydroxide solution.

↓

The aqueous layer are separated from ether layer, combined and taken into another separating funnel.

↓

Made acidic by adding dilute sulphuric acid and extracted twice 25 ml ether.

↓

Then this ether fraction is washed with 25 ml of distilled water and then dried by adding anhydrous sodium sulphate and evaporated to dryness.

↓

Note: The residuul fraction 2 contains purified form of barbiturates.

(iii)

The ether layer is washed with water after extracting with NaOH and then evaporated to dryness.

↓

Note: The residue fraction 3 contains carbamates, meprobamate and other neutral drugs.

2.2.1. Stas-Otto Process[1]:

50 gm of biological material is macerated with sufficient quantity of spirit (about 2-3 times the weight of material) and acidified with tartaric acid in a flask.

↓

This mixture is then heated on steam bath for 1-2 hours with frequent shakings at fixed intervals. The extraction is carried out for about 24 hours with steam off.

↓

Filtration is then carried out using filter paper. The filtrate obtained is evaporated and the residue is again extracted with acidified alcohol, filtered and washed with hot rectified spirit.

↓

The filtrates are combined and evaporated in a porcelain basin on the steam bath to a syrupy mass.

↓

To this about 100 ml of rectified spirit is added slowly with constant stirring. (If the alcohol is added rapidly, the insoluble matter will become sticky and resulted into loss of alkaloids).

↓

It is warmed with stirring for about half an hour and then filtered. This process is repeated again for one more time then alcoholic extracts are combined and evaporated to dryness.

↓

The residue is dissolved in about 50 ml of water acidified with dilute sulphuric acid and filtered after about an hour. The poisons are thus come in aqueous layer and transferred to a separating funnel and extracted with about 25 ml ether, chloroform etc.

[Acid solution contains colouring matters, toxic oils, resins, salicylic acid and its derivatives (aspirin, salol etc.), barbiturates, sulphonal, acetanilide, narcotine and alkaloids of ergot, certain glycosides such as thevetin which has escaped initial treatments for purification.]

↓

The acid aqueous solution is then made alkaline by adding sodium carbonate or ammonia solution to separate the free base from its salt.

↓

The alkaline solution is then extracted with 25ml chloroform in the same way. It will constitute all the alkaloids except morphine (only traces are extracted) and those feebly basic compounds which are partially extracted in the acidic layer. The extraction is repeated 2 or 3 times.

↓

In suspected case of morphine poisoning, it can be extracted at this stage by adding amyl alcohol or mixture of chloroform-ether in 3:1 ration or chloroform -alcohol mixture in 9:1 ratio.

↓

The chloroform or amyl alcohol fractions are combined, evaporated to dryness and now it is ready for further purification and analysis.

↓

It is purified by dissolving it in about 20 ml of water acidified with sulphuric acid and then filtered. This filtrate is again extracted with chloroform, first in acid and then in alkaline medium as earlier. These extracts are evaporated to dryness for analysis.

[1.] http://wincenprado.tripod.com/toxicology.html

2.2.2. Modified Stas-Otto Procedure :

Modification in Stas-Otto method has been carried out to minimise the chances of loss of poison at each step as Stas-Otto method involves so many steps which may also result in complete loss of poison. Therefore, the method has been modified with the minimum following steps[2].

Extraction of biological material is carried with absolute alcohol (to prevent hydrolysis) at room temperature (temperature should not exceed 40°C) for suspected case of aconite, belladonna, datura or cocaine poisoning. The fraction so obtained is evaporated under reduced pressure and following points are taken into consideration while extraction.

- The extraction with rectified spirit is carried out for 48 hours if biological material is preserved in saturated saline solution.
- As stomach contents consist of too much fluid, the extraction should be done with absolute alcohol for 3 or 4 times.
- In case of extraction of stomach wash, add absolute alcohol just 2 times the quantity of stomach wash, acidified with tartaric acid and allowed to evaporate on a steam bath.
  (For filtration, Buchner funnel is preferred).
- Agitation (2-3 time in the beginning and not exceeding 12 times at the end with organic solvents such as ether or chloroform or amyl alcohol) is carried out to prevent loss due to emulsion formation. In case of formation of emulsion, it is evaporated on a steam bath and then residue is taken in fresh solvent.

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2. http://shodhganga.inflibnet.ac.in/bitstream/10603/77515/8/08_chapter%202.pdf

2.3. Isolation of Toxic Cations (Metals)

2.3.1. Dry Ashing Method[3]:

10-50 gm of biological material is taken into a silica crucible and heated in a Bunsen burner to remove the moisture content and to partially destroy the organic material.

↓

The crucible is then kept in a muffle furnace and the temperature is raised up to 550°C to perform incineration of the organic matter for one hour.

↓

After incineration, the crucible is taken out.

↓

The color of the residue is noted at this stage (when it is hot).

(In the presence of zinc, residue shows yellow color while in presence of copper, residue is bluish green in colour)

↓

The residue is then boiled with 10 ml of 4N hydrochloric acid in silica basin and then it is filtered.

↓

The clear acidic solution so obtained is tested for the presence of metallic poisons such as arsenic, mercury, lead, copper, bismuth, zinc, barium etc. by group analysis or using micro methods, chromatographic techniques etc.

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3. N. R. Bader, sample preparation for flame atomic absorption spectroscopy: an overview, Rasayan J.com, CODEN: RJCABP, 4(1) 2011, 49-55, ISSN: 0974-1496

2.3.2. Wet Digestion Method[4]:

50 gm of visceral tissues/10 ml of blood is taken into a Kjeldahl flask and 20-40 ml of concentrated nitric acid is added to it and heated with care in a small flame when the mass begins to liquefy.

↓

The heating is continued till liquefaction of material is not completed and is carried out in the presence of brown fumes of NO_2 in the flask.

↓

At this stage about 20-30 ml of concentrated sulphuric acid is added and the flask is heated over a wire gauge and conc. nitric acid is also added drops wise (using dropping funnel) at the rate of about 10 drops/minute so that it result in the continuous production of brown fumes in the flask.

↓

Heating is continued until all organic matter is destroyed and at this stage liquid becomes clear and colorless or straw colored.

↓

To find out whether oxidation is complete or not, flask is heated without adding any HNO_3, if there is any un-burnt organic content left, the liquid begins to darken and if the digestion is completed, no darkening takes place.

↓

In the earlier case, when the organic matter is not completely oxidised, addition of HNO_3 and heating should be continued.

↓

To expel the nitric acid completely, heating is continued for 15 minutes more.

↓

After cooling, 25 ml of saturated ammonium oxalate solution is added and is boiled until SO_3 fumes appear. This confirms complete removal of HNO_3.

↓

It is then cooled, diluted with an equal quantity of water and carefully transferred into a beaker. The beaker is heated on a hot plate or sand bath to expel the excess H_2SO_4.

↓

The solution is then cooled and diluted with distilled water in such a manner that the strength of acid is remain about10%.

↓

Precipitate may be formed which contains salts of lead, bismuth, tin, barium, strontium or silver etc. The precipitate is filtered and tested for these metals by group analysis and quantitative analysis if required.

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4. https://www.scribd.com/doc/310201137/Toxicology-Manual, Laboratory procedure manual forensic toxicology, Directorate of Forensic Science, MHA, Govt. of India

2.4. Isolation of Toxic Anions

Dialysis Method[5]:

10 gm of the tissue is chopped into small pieces and placed in a cellophane membrane bag.

↓

The bag is slowly rotated in a beaker containing 100 ml of distilled water employing an electrical motor

↓

The separation of particles in a liquid is carried out on the basis of the their ability to pass through this membrane.

↓

After one hour, water of the beaker is taken out and replaced by fresh water and the bag is rotated for another half an hour.

↓

This water is then taken out, pooled with the previous fraction and evaporated to a small fraction using water bath.

↓

If required, it is filtered and tested for the presence of toxic anions such as halides, azides etc.

5. G. Sarathchandra, A. Albert, A.T. Venugopalan, Manual on Analytical Toxicology, Tamilnadu Veterinary & Animal Sciences University. Toxicology Unit, Central University Laboratory, Centre for Animal health Studies, Madhavram Milk Colony, Madras.

2.5. Total Alcoholic Extraction:

10 gm of the tissue is copped into small pieces or biological material is taken in an evaporation dish to remove moisture completely on hot water bath.

↓

It is then macerated with rectified sprit with twice the quantity of biological material and transferred to an Erlenmeyer flask.

↓

To it 0.5 ml of acetic acid is added and fitted with a reflux condenser.

↓

It is then refluxed on boiling water bath for 4 hours, cooled and then filtered.

↓

The filtrate is evaporated to dryness.

↓

This total alcoholic extract is evaluate for the presence of mainly indigenous poisonous drugs such as croton, castor, bhilawan, kaner, madar, mushrooms,oduvan etc.

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Subject: **Criminology**

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Paper : **Forensic Science and Forensic Medicine**

Module : **Drugs of abuse: Classification of drugs, opium, barbiturate, cannabis, cocaine, LSD, NDPS act.**

ज्ञान-विज्ञान विमुक्तये

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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Drugs of abuse: classification of drugs, opium, barbiturate, cannabis, cocaine, LSD. NDPS act.
Module Id	
Objectives	Learning Outcome: • To make learners understand the impact of drug abuse • Name and classify the commonly abused drugs • Describe Narcotic Drugs and Psychotropic Substances Act. • Describe the laboratory tests normally used to perform a routine drug identification analysis
Prerequisites	General understanding of Forensic Science and its application in crime solving.
Key words	Drug, Abuse, Narcotic, Sedative, Barbiturate, Cocaine, LSD, Opium, Identification

1. Introduction:

Drug abuse is an important issue nowadays. Keeping in mind, the large number of populations getting in trap of drugs abuse, there requires a great deal of understanding on how they affect human beings. This knowledge helps law enforcement agencies in recognizing the type of drug consumed by the person and to assess whether drug abuse is involved in the crime. Such knowledge is also required by medical practitioner to assist the addict in undergoing treatment for deaddiction and toxicity.

About 190 million people all over the world consume one drug or the other. In India, an increasing use of illicit drugs has been reported since many decades. Although, the World Health Organization notes significant difficulty in estimating drug usage and addiction rates in India, some resources point to number over 3 million drug addicts in India.[2] Along with various issues arising from drug addiction and usage including health and social, HIV is a significant issue with over 2.4 million people infected in India. This places India as the third-highest country in terms of rate of infection in the world.

This module contains description about classification of drugs, their nature and effects on human being. This knowledge is forensically important to enforce law in crimes where drug abuse is a key element.

2. Definition of Drug

A drug can be defined as a natural or synthetic substance that is used to produce physiological or psychological effects in humans or other higher order animals. However, with the differential effects from use and abuse of drug, drugs, to some, may be as a necessity for sustaining and prolonging life; to others, drugs provide an escape from the pressures of life; to still others, they are a means of ending it.

3. Classification of Drugs

Drugs are classified in many ways, on the basis of their usage, pharmacological action, etc. These categories help to understand better about the drug consumed based on their behaviour, appearance, effects, etc.

Understanding how different classes of drugs can affect individuals helps law enforce -ment officers react to, control and question suspects in drug-related cases.

For example, a person who has taken a stimulant drug such as methamphetamines will react or respond to police differently than a person who has consumed a narcotic or marijuana.

3.1. Narcotic Drugs

The term narcotic is derived from the Greek word *narkotikos*, which implies a state of lethargy or sluggishness. As per pharmacological definition, narcotic drugs are analgesic substances that bring relief from pain and produce sleep by depressing the central nervous system. However, the regular use of a narcotic drug leads to physical dependence, with all its dire consequences.

The source of most narcotics is opium, a gummy, milky juice exuded through a cut made in the unripe pod of the poppy (*Papaver somniferium*), a plant grown mostly in parts of Asia. Opium is brownish in color and has a *morphine* content ranging from 4 to 21 percent. Morphine is then used to produce its derivative, *heroin,* which is the most commonly used drug by addicts. Heroin's high solubility in water makes its street preparation for intravenous administration rather simple. *Codeine* is also one of the derivative from opium, but it is commonly used as a cough suppressant in prescription cough syrup. Codeine, only one-sixth as strong as morphine, is not commonly used as drug by addicts.

3.1.1. Heroin

Heroin is one of the most recognized and widely abused drugs. The correct chemical nomenclature for heroin is O_3, O -diacetylmorphine. The first synthesis of heroin i.e., diacetylmorphine reported in the literature was in 1875 by two English chemists, G.H. Beckett and C.P. Alder Wright. In 1898 in Eberfield, Germany, the Farbenfarbriken vorm Friedrich Bayer and Company produced the drug commercially for patients suffering from lung diseases such as tuberculosis. The Bayer Company also advertised heroin as a cure for morphine addiction. The analgesic properties of the drug were very effective. However, the addictive properties were quite devastating.

The “Golden Triangle” areas of Burma, China, and Laos are the three major source countries in part of the world for the production of illicit opium. Of these three countries, 60 to 80% of the total world supply of heorin comes from Burma. India is also known to be one of the primary consumers of heroin and the largest grower of licit opium in the world, which is used to make a range of prescription medications. However, there are reports by law enforcement agencies that the licit opium is being diverted to illegal markets inside India and for trafficking beyond its borders for synthesis of morphine and its derivatives. Additionally, India is also at increased treat of drug abuse due to its geographical location between the two largest illicit opium growers, Burma and Afghanistan and use as a major trafficking route between the two.

A form of heroin known as brown sugar is commonly used in the country, which is made of a mixture of heroin which typically ranges between 20 to 60 percent purity, and adulterants in the form of chalk, zinc or other chemicals. Due to cheap price and easy availability, this drug is very popular in India among wide variety of people. Recent trend suggests that not only adults but children as young as 13 are falling in trap of drug addiction. Due to less purity and toxic adulterants present, there are serious adverse effects from taking this drug.

This process of heroin production involves following steps:

(1) The opium poppy (*Papaver Somniferum L.*) is cultivated

(2) The poppy head is scored and the opium latex is collected

(3) Isolation of morphine from the latex

(4) Treating morphine with an acetylating agent such as acetic anhydride.

Acetylation of Morphine to Diacetylmorphine (Heroin) involves placing dried morphine into a reaction vessel and adding excess acetic anhydride (Figure 1). Sometimes a co-solvent is also used. The mixture is heated to boiling and stirred for varying periods of time ranging from 30 min up to 3 or 4 h. The vessel and contents are cooled and diluted in cold water. A sodium carbonate solution is then added until precipitation of the heroin base is complete and settles to the bottom of the reaction

vessel. The heroin base is then either filtered and dried, or undergoes further processing to enhance the purity or to convert the base to heroin hydrochloride.

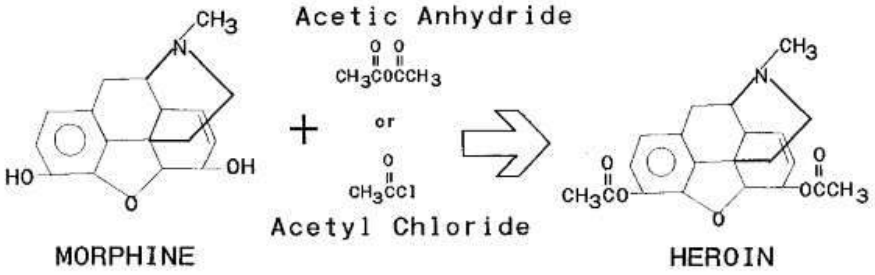


Figure 1: Clandestine Laboratory synthesis of heroin

There is another class of narcotic drugs which are not naturally derived from opium. However, because they have similar physiological effects on the body as the opium narcotics, they are commonly called as *opiates*. OxyContin is one such synthetic opiates which was previously approved as pain killer by the U.S. Food and Drug Administration in 1995. The active ingredient in OxyContin is oxycodone, a synthetic closely related to morphine and heroin in its chemical structure. *Methadone* is another well-known synthetic opiate which is used to eliminate the addict's desire for heroin while producing minimal side effects.

3.2. STIMULANTS

As the name suggests, stimulants increase alertness, attention, and energy, as well as elevate blood pressure, heart rate, and respiration. Stimulants, are sometimes called "uppers,". The most commonly used street drugs that fall into this category are cocaine and amphetamines.

3.2.1. Cocaine

Cocaine, a stimulant drug is one of the alkaloidal substances present in the coca leaf. Cocaine is extracted from the leaves of the *Erythroxylon coca*, coca plant grown in tropical Asia and the Andes mountains of South America. While cultivated in many

countries, Peru and Bolivia are the world's leading producers of the coca plant. Cocaine is present in the coca leaves from these countries at dry weight concentrations of from 0.1 to 1%. The average concentration of cocaine in the leaf is 0.7%.

At one time, cocaine had wide medical application as a local painkiller or anaesthetic. However, this function has now been largely replaced by other drugs, primarily procaine and lidocaine. Cocaine is also a powerful stimulant to the central nervous system, and its effects resemble those caused by the amphetamines—namely, increased alertness and vigor, accompanied by the suppression of hunger, fatigue, and boredom. Most commonly, cocaine is sniffed or "snorted" and is absorbed into the body through the mucous membranes of the nose.

The method of isolating cocaine from the coca leaf does not require a high degree of technical expertise or experience. All of the known production techniques involve three primary steps: (1) extraction of crude coca paste from the coca leaf; (2) purification of coca paste to cocaine base; and (3) conversion of cocaine base to cocaine hydrochloride.

One form of cocaine that has gained widespread popularity in the drug culture is known as *crack*. The process used to make crack is simple. Ordinary cocaine is mixed with baking soda and water into a solution that is then heated in a pot. This material is then dried and broken into tiny chunks that dealers sell as crack rocks. Crack is freebase cocaine and is sufficiently volatile to be smoked, usually in glass pipes. Crack, like cocaine that is snorted, produces a feeling of euphoria-a feeling of increased energy, of being mentally more alert, of feeling really good. The faster the cocaine level rises in the brain, the greater the euphoria, and the surest way to obtain a fast rise in the brain's cocaine level is to smoke crack. Inhaling the cocaine vapor gets a large wallop of the drug to the brain in less than fifteen seconds—about as fast as injecting it and much faster than snorting it. Crack. However, euphoria fades quickly as cocaine levels drop, leaving the user feeling depressed, anxious, pleasure less. The desire to return to a euphoric feeling is so intense that crack users quickly develop a

habit for the drug that is almost impossible to overcome. Only a small percentage of crack abusers will ever be cured of this drug habit. While there is no evidence of physical dependency accompanying cocaine's repeated use, cocaine produces the strongest psychological compulsions for continued use.

3.2.2. Amphetamines

Amphetamines are a group of synthetic drugs that stimulate the central nervous system. They are commonly referred to in the terminology of the drug culture as "uppers" or "speed." Methamphetamine is a major problem throughout the world and there are increasing reports of its use in India. The first clandestine methamphetamine laboratory was discovered in 2003, and many more have been found since then. India is a key producer of precursor chemicals for methamphetamine which include ephedrine and chemicals that are used in the processing. The majority of these chemicals are trafficked to major manufacturing countries like China, Thailand, Mexico and America.

Ordinarily, therapeutic doses of 5–20 milligrams per day, taken orally, provide a feeling of well-being and increased alertness that is followed by a decrease in fatigue and a loss of appetite. However, these apparent benefits of the drug are accompanied by restlessness and instability or apprehension, and once the stimulant effect wears off, depression may set in.

Methamphetamine use is linked to many serious physical and mental health concerns including violence, paranoia, insomnia, organ damage and brain damage. Amphetamine drugs are often used by the working class poor as a stimulant to help them work harder, for longer and require less food. Using drugs for this purpose is incredibly dangerous and can lead to major problems with families and communities. Not only are they highly addictive but their use can damage motor skills, response times, problem solving skills and cause sexual dysfunction.

A new smokable form of methamphetamine known as "ice" is reportedly in heavy demand in some countries. Ice is prepared by slow evaporation of a

methamphetamine solution to produce large, crystal-clear “rocks.” Like crack cocaine, ice is smoked and produces effects similar to those of crack cocaine, but the effects last for a longer period of time. Once the effects of ice wear off, users often become depressed and may sleep for days. Repeated use of amphetamines leads to a strong psychological dependency, which encourages their continued administration.

3.3. Depressants

A depressant, or central depressant, is a drug that lowers neurotransmission levels, which is to depress or reduce arousal or stimulation, in various areas of the brain. Depressants are also occasionally referred to as "downers" as they lower the level of arousal when taken. Depressants are widely used throughout the world as prescription medicines and as illicit substances. Eg., Barbiturates.

3.3.1. Barbiturates

Barbiturates create a feeling of well-being, and produce sleep to the individual. Like alcohol, barbiturates suppress the vital functions of the central nervous system. Collectively, barbiturates can be described as derivatives of barbituric acid, which was first synthesized by a German chemist, Adolf Von Bayer, more than a hundred years ago. Twenty-five barbiturate derivatives are currently used in medical practice in the United States; however, five—amobarbital, secobarbital, phenobarbital, pentobarbital, and butabarbital—tend to be used for most medical applications. Slang terms for “barbs” usually stem from the color of the capsule or tablet (for example, “yellow jackets,” “blue devils,” and “reds”).

Normally, barbiturate users take these drugs orally. The average sedative dose is about 10–70 milligrams. When taken in this fashion, the drug enters the blood through the walls of the small intestine. Some barbiturates, such as phenobarbital, are absorbed more slowly than others and are therefore classified as long-acting barbiturates. Undoubtedly, the slow action of phenobarbital accounts for its low incidence of abuse. Apparently, barbiturate abusers prefer the faster-acting ones—secobarbital, pentobarbital, and amobarbital. When taken in prescribed amounts,

barbiturates are relatively safe, but in instances of extensive and prolonged use, physical dependence can develop.

3.4. Hallucinogens

These are group of drugs that can cause marked alterations in mood, attitude, thought processes, and perceptions. Perhaps the most popular and controversial member of this class of drugs is marijuana. Other drugs which come in this class include lysergic acid diethylamide (LSD), mescaline, phencyclidine (PCP), psilocybin, and methylenedioxymethamphetamine, also known as MDMA or Ecstasy.

3.4.1. Marijuana

Cannabis is an incredibly popular and widely used drug in India and is known as ganja, charas or bhang. India has a long history of cannabis use, and the drug is one of the five sacred plants mentioned in the Hindu texts, the Vedas. It is typically associated with the Hindu deity Shiva, who is believed to like the hemp plant. The drug is often smoked or drunk in a beverage at Hindu ceremonies. Cannabis is combined with a mixture of milk or yoghurt and boiled with nuts and spices to make a refreshing beverage. This drink is consumed by many all over the country, especially by labor workers who find the relaxing properties beneficial.

Despite its widespread and accepted use, cannabis is illegal to use and possess in any form. Some figures place regular cannabis users as high as 10 million in India, many of these among the working poor. Many of these heavy users are dependent on the drug and suffer from major health problems including respiratory disorders, memory impairment, mental disturbance, digestive tract problems, major weight loss and problems with sleep. Almost half that number may be regular users.

Marijuana is a preparation derived from the plant *Cannabis*. Most botanists believe there is only one species of the plant, *Cannabis sativa L*. The marijuana preparation normally consists of crushed leaves mixed in varying proportions with the plant's flower, stem, and seed (See Figure 2). The plant secretes a sticky resin known as *hashish*. The resinous material can also be extracted from the plant by soaking in a

solvent such as alcohol. On the illicit-drug market, hashish usually appears in the form of compressed vegetation containing a high percentage of resin.

Figure 2: Marijuana preparation

Marijuana is a weed that grows wild under most climatic conditions. The plant grows to a height of 5 to 15 feet and is characterized by an odd number of leaflets on each leaf. Normally, each leaf contains five to nine leaflets, all having serrated or saw-tooth edges, as shown in Figure 3.

Figure 3: A photograph showing Marijuana leaves

In 1964 scientists isolated the chemical substance largely responsible for the hallucinogenic properties of marijuana. This substance is known as *tetrahydrocannabinol*, or THC. The THC content of *Cannabis* varies in different parts of the plant, generally decreasing in the following sequence: resin, flowers, and leaves. Little THC is found in the stem, roots, or seeds. The potency and resulting effect of the drug fluctuate, depending on the relative proportion of these plant parts in the marijuana mixture.

The potency of marijuana depends on its form. Marijuana in the form of loose vegetation has an average THC content of about 3–4.5 percent, while hashish preparations average about 2–8 percent. Another form of hashish is known as *liquid hashish* or *hashish oil*. Hashish in this form is normally a viscous substance, dark green with a tarry consistency. Liquid hashish is produced by efficiently extracting the THC-rich resin from the marijuana plant with an appropriate solvent. Liquid hashish typically varies between 8 and 20 percent in THC content. Because of its extraordinary potency, one drop of the material can produce a "high." Ordinarily a drop is placed on a regular cigarette or on a marijuana cigarette before smoking.

No current evidence suggests that experimental or intermittent use causes physical or psychological harm. Marijuana does not cause physical dependency. However, the risk of harm lies instead in heavy, long-term use of the drug, particularly of the more potent preparations. Heavy users can develop a strong psychological dependence on the drug. Some effects of marijuana use include increased heart rate, dry mouth, reddened eyes, impaired motor skills and concentration, and frequently hunger and an increased desire for sweets. Long-term chronic marijuana use is associated with a motivational syndrome characterized by apathy; impairment of judgment, memory, and concentration; and loss of interest in personal appearance and the pursuit of conventional goals.

3.4.2. LSD

LSD is synthesized from lysergic acid, a substance derived from ergot, which is a type of fungus that attacks certain grasses and grains. Its hallucinogenic effects were first described by the Swiss chemist Albert Hofmann after he accidentally ingested some of the material in his laboratory in 1943. The drug is very potent; as little as 25 micrograms is enough to start vivid visual hallucinations that can last for about twelve hours. The drug also produces marked changes in mood, leading to laughing or crying at the slightest provocation. Feelings of anxiety and tension almost always accompany LSD use. Although physical dependence does not develop with continued use, the individual user may be prone to flashbacks and psychotic reactions even after use is discontinued.

4. Drug Control Law in India- Narcotic Drugs and Psychotropic Substances (NDPS) Act, 1985

4.1. Elements of NDPS Act

The NDPS Act 1985 sets out the statutory framework for drug law enforcement in India. The main elements of the control regime mandated by the Act are as follows:

1. Control and regulation of NDPS: The cultivation, production, manufacture, possession, sale, purchase, transportation, warehousing, consumption, inter-State movement, shipment and import and export of narcotic drugs and psychotropic substances is prohibited, except for medical or scientific purposes and in accordance with the terms and conditions of any license, permit or authorization given by the Government. (Section 8)

2. Power of CG: The Central Government is empowered to regulate the cultivation production, manufacture, import, export, sale, consumption, use etc of narcotic drugs and psychotropic substances. (Section 9).

3. Power of SG: State Governments are empowered to permit and regulate possession and inter-State movement of opium, poppy straw, the manufacture

of medicinal opium and the cultivation of cannabis excluding hashish. (Section 10).

4. Prohibition of trade outside India: All persons in India are prohibited from engaging in or controlling any trade whereby narcotic drugs or psychotropic substances are obtained outside India and supplied to any person outside India except with the previous authorisation of the Central Government and subject to such conditions as may be imposed by the Central Government. (Section 12).

5. Assessment of NDPS as controlled substance by CG: The Central Government is empowered to declare any substance, based on an assessment of its likely use in the manufacture of narcotics drugs and psychotropic substances as a controlled substance. (Section 9-A).
6. Assets derived from drugs trafficking are liable to forfeiture (Chapter V-A).
7. Power to appoint officers: Both the Central Government and State Governments are empowered to appoint officers for the purposes of the Act. (Sections 4, 5 and 7).
8. The NDPS Act is in effect a comprehensive code not only for the control and regulation of Narcotics Drugs and Psychotropic Substances; but also for the control of selected chemicals - commonly known as precursors - which can be used in the illicit manufacture of narcotic drugs and psychotropic substances, as well as for the investigation and forfeiture of drug related assets.

A number of agencies both at the Centre and in the States have been empowered to enforce the provisions of the Act. These agencies include

the Department of Customs and Central Excise,
the Directorate of Revenue Intelligence,
the Central Bureau of Narcotics and
the Central Bureau of Investigation at the Central level
State Police and Excise Departments at the State level.

Section 4(3) of the Act envisages the creation of a Central Authority to coordinate the activities of the various Central and State agencies involved in drug law enforcement, to implement India's obligations under various international conventions, and to coordinate with international organizations and authorities in foreign countries in the prevention and suppression of the illicit traffic in narcotic drugs and psychotropic substances. In terms of this provision, the Narcotics Control Bureau was set up by the Central Government in 1986 with the broad remit to coordinate drug law enforcement nationally.

4.2. Investigative procedures

Chapter V of the NDPS Act (Sections 41 to 68) sets out the powers as well as the procedures for the investigation of offences under the Act. This Chapter empowers officers duly authorized by the Central Government or a State Government to issue warrants, to enter and search premises, to stop and search conveyances, to seize narcotic drugs and psychotropic substances, to take statements and to arrest persons suspected of having committed an offence, punishable under the Act.

The power to issue search and arrest warrants, is in terms of Section 41, been vested both in Magistrates as well as in specially designated (Gazetted) officers of the Central and State Governments. This is designed to ensure both timely and effective action in response to any information.

In addition, both the Central and the State Governments are authorized to entrust any Officer duly empowered under the Act with the powers of an Officer-in-Charge of a Police Station for the investigation of offences under the Act.

4.3. Offences and Penalties

Chapter IV, (Sections 15 to 40) sets out the penalties for offences under the Act. These offences are essentially related to violations of the various prohibitions imposed under the Act on the cultivation, production, manufacture, distribution, sale, import and export etc. of narcotic drugs and psychotropic substances.

All these offences are triable by Special Courts and the punishments prescribed range from imprisonment from 10 to 20 years for first offences to 15 to 30 years for any subsequent offences together with monetory fines. In addition to persons directly involved in trafficking narcotic drugs and psychotropic substances, any person who finances trafficking or harbours a person involved in trafficking, or abets, or is a party to a criminal conspiracy, including a criminal conspiracy to commit an offence outside India, is also liable to the same scale of punishments. The Act was amended in May 1989 to mandate the death penalty for second offences relating to contraventions involving more than certain quantities of specified narcotic drugs and psychotropic substances. The Act, however, makes a distinction between possession for personal consumption and trafficking, the punishment for the former being limited to between six months and one year only.

4.4. Precursor Control

The 1988 U.N. Convention against Illicit Traffic in Narcotic Drugs and Psychotropic Substances to which India is a signatory, requires Parties to impose controls on the manufacture, internal distribution and import and export of chemicals which can be used in the illicit manufacture of narcotic drugs and psychotropic substances.

In exercise of its powers under the Act, the Central Government has so far notified Acetic Anhydride, which is used in the processing of opium into heroin, N-Acetylanthranilic acid which is used in the illicit manufacture of Methaqualone and Ephedrine and Pseudoephedrine, which are used in the illicit manufacture of amphetamine type stimulants, as controlled substances.

5. Identification of Drugs

Any forensic lab should be equipped with reagents and instruments to analyse identification of drug. The task of a drug analyst is very crucial knowing that the drugs in markets are highly variable. This is made further complex by newly developing drugs which are modifications of already known drugs. These drugs are designed to confer difficulty in their identification at laboratories.

To perform drug identification, the analyst must employ series of tests which range from screening i.e., preliminary or non-specific to confirmatory or specific tests. The screening tests reduce the possibilities for a definite group of drugs to a small and manageable number. These tests are considered important in case of negative result and so their value lies in having excluded certain drugs from further consideration. Once the number of possibilities is substantially reduced, the second phase of the analysis is conducted which is confirming the drug's identity. This consists of confirmatory tests that identifies a substance. The analytical scheme sometimes consists of a series of nonspecific or presumptive tests followed by confirmatory tests. Forensic chemists normally rely on several tests for a routine drug-identification scheme: color tests, microcrystalline tests, chromatography, spectrophotometry, and mass spectrometry.

5.1. Color Tests

This consists of subjecting the sample to a series of color tests that produce characteristic colors when brought into contact with specific chemical reagents. Not only do these tests provide a useful indicator of a drug's presence, but they are also used by investigators in the field to examine materials suspected of containing a drug. Five primary color test reagents are as follows:

1. *Marquis* (2 percent formaldehyde in sulfuric acid). The reagent turns purple in the presence of heroin and morphine and most opium derivatives. Marquis also becomes orange-brown when mixed with amphetamines and methamphetamines.

2. *Dillie-Koppanyi* (1 percent cobalt acetate in methanol is first added to the suspect material, followed by 5 percent isopropylamine in methanol). This is a valuable screening test for barbiturates, in whose presence the reagent turns violet-blue in color.

3. *Duquenois-Levine* (solution A is a mixture of 2 percent vanillin and 1 percent acetaldehyde in ethyl alcohol; solution B is concentrated hydrochloric acid; solution C is chloroform). This is 2. *Dillie-Koppanyi* (1 percent cobalt acetate in methanol is first added to the suspect material, followed by 5 percent isopropylamine in methanol).

This is a valuable screening test for barbiturates, in whose presence the reagent turns violet-blue in color.

4. *Van Urk* (1 percent solution of p-dimethylaminobenzaldehyde in 10 percent concentrated hydrochloric acid and ethyl alcohol). The reagent turns blue-purple in the presence of LSD. However, owing to the extremely small quantities of LSD in illicit preparations, this test is difficult to conduct under field conditions.

5. *Scott Test* (solution A is 2 percent cobalt thiocyanate dissolved in water and glycerine [1:1]; solution B is concentrated hydrochloric acid; solution C is chloroform). This is a color test for cocaine. A powder containing cocaine turns solution A blue. Upon addition of B, the blue color is transformed to a clear pink color. Upon addition of C, if cocaine is present, the blue color reappears in the chloroform layer.

5.2. Microcrystalline Tests

A technique considerably more specific than color tests is the microcrystalline test. In this test, a drop of a chemical reagent is added to a small quantity of the sample of drug on a microscopic slide. After a short time, a chemical reaction ensues, producing a crystalline precipitate. The size and shape of the crystals, under microscope examination, are highly characteristic of the drug. These tests are rapid and often do not require the isolation of a drug from its diluents; however, because diluents can sometimes alter or modify the shape of the crystal, the examiner must develop experience in interpreting the results of the test. The microcrystals of cocaine and methamphetamine is shown in Figure 4.

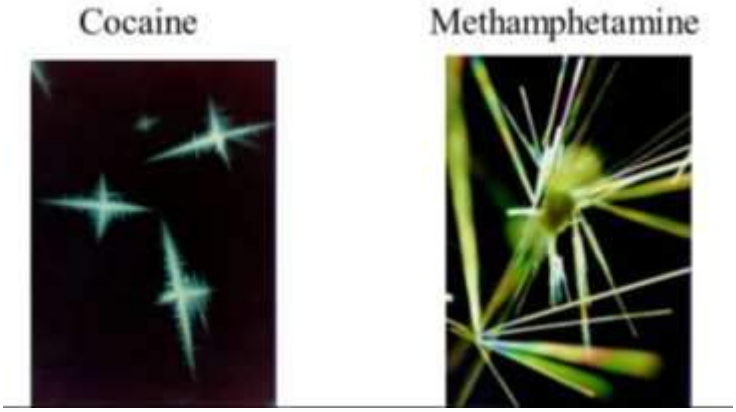


Figure 4: Microcrystals of Cocaine and Methamphetamine

5.3. Chromatography

Chromatography is a good method of choice for separation of components of a mixture. This technique separates mixtures on the basis of their distribution between affinity for stationary liquid phase and a moving gas phase. Many compounds have a tendency to become closely associated with other compounds through attractive forces, while others do not. This attraction or tendency for association is often called *affinity*. Chromatography utilizes the differences in affinity of compounds for separation. Thin-layer and gas chromatography are especially well suited to the needs of the drug analyst, because they separate drugs from their diluents while providing for their tentative identification.

TLC of drugs is used as a presumptive test to provide an indication of the nature of the drug under question. To perform TLC, the sample must first be dissolved in a solvent – unless it is already in a liquid state – and then it can be spotted onto a TLC plate along with a known standard and run under a solvent system.

It is useful for identification because many of the colour change presumptive tests used will only provide an indication of a certain active group in the molecule. This variation produces visible differences as well as difference in *Rf* (Retention Factor) value. *Rf* value is the ratio of distance travelled by sample to distance travelled by solvent on TLC plate. Since there can be some overlap of *Rf* values and confusion in

colour judgement, TLC is considered as a presumptive test to inform further analysis rather than producing a definitive result on its own.

In gas chromatography, separation is on the basis of affinity with phases called as mobile phase and stationary phase. The mobile phase is nothing but a gas called the *carrier gas*, which flows through a column. The carrier gas is chemically inert and is generally nitrogen or helium. The stationary phase is a thin film of liquid within the column. Because chromatography requires a comparison of *Rf* values between questioned and known drugs, the analyst must have some clue to the identity of the illicit material before using these techniques. Hence, in a typical drug analysis, chromatography accompanies and complements color and crystal tests.

5.4. Spectrophotometry

Selective absorption of UV and IR light by drugs provides a valuable technique for characterizing drugs. The ultraviolet spectrum is not conclusive for positive identification of a drug, because other materials may very well produce an indistinguishable spectrum. Nevertheless, UV spectrophotometry is often a useful technique for establishing the probable identity of a drug. For example, if an unknown substance yields a UV spectrum that resembles that of amphetamine, thousands of substances are immediately eliminated from consideration, and the analyst can begin to identify the material from a relatively small number of possibilities.

The pattern of an infrared spectrum is unique for each compound and can thus serve as a "fingerprint" of the compound. The combination of preliminary screening tests with a final verification by infrared spectrophotometry offers an ideal approach to drug identification. Unfortunately, the technique does present some problems because the substance to be identified must be as pure as possible. This requirement often necessitates lengthy purification steps to prepare the sample for IR analysis. For this purpose, GC is used initially to purify the drug from hindering components to produce a GC-IR spectra. The GC-IR spectra of methamphetamine is shown in Figure 5.

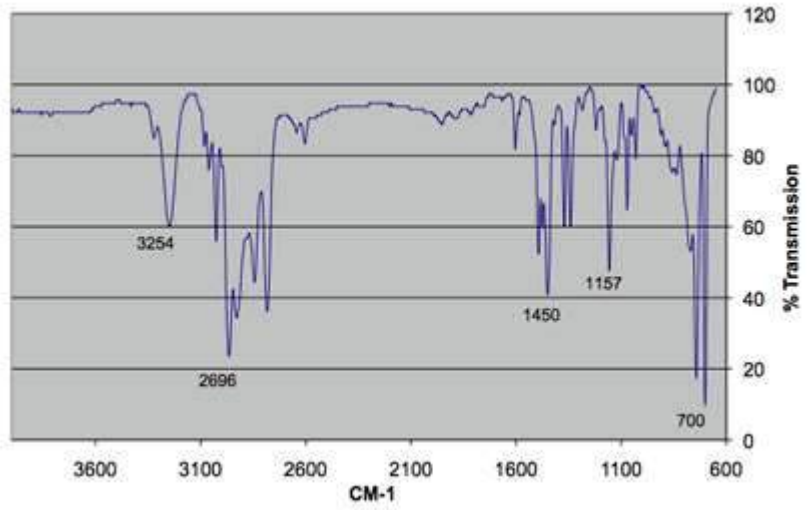


Figure 5: GC-IR Spectra of Methamphetamine

5.5. Mass Spectrometry

The technique of chromatography is particularly suited for analyzing illicit drugs, because it can readily separate a drug from other substances that may be present in the drug preparation. Chromatography does, however, have the drawback of not being able to provide a specific identification of the material under investigation. This deficiency has been overcome by linking the gas chromatograph to a mass spectrometer to yield a very powerful combination known as *gas chromatography/mass spectrometry* (GC/MS). As a sample emerges from the gas chromatograph, it immediately enters the mass spectrometer.

In the mass spectrometer, the material enters a high-vacuum chamber where a beam of high-energy electrons is targeted at the sample molecules. The electrons collide with the molecules, causing them to lose electrons and to acquire a positive charge (commonly called ions). These positively charged molecules or ions are very unstable or are formed with excess energy and almost instantaneously decompose into numerous smaller fragments. The fragments then pass through an electric or magnetic field, where they are separated according to their masses generating a highly characteristic line pattern where each line represents a fragment of a different mass (actually the ratio of mass to charge), and the line height reflects the relative

abundance of each fragment. The unique feature of mass spectrometry is that under carefully controlled conditions, no two substances produce the same fragmentation pattern. This generates a pattern like “fingerprint” of the substance which is unique, with a few exceptions. With data obtained from a GC/MS determination, a forensic analyst can, with one instrument, separate the components of a complex drug mixture and then unequivocally identify each substance present in the mixture.

Summary

A drug can be defined as a natural or synthetic substance that is used to produce physiological or psychological effects in humans. Drugs are classified on the basis of their effects on humans. Narcotic drugs relieve pain by depressing the central nervous system and may cause physical dependence on regular use. The most common source of narcotic drugs is opium. Morphine is readily extracted from opium and is used to synthesize heroin. Opiates, which include methadone and oxycodone, are not derived from opium, but they have the same physiological effects on the body as do opium narcotics.

Depressants are another class of drugs which slows the action of central nervous system. These include alcohol (ethanol), barbiturates, tranquilizers, and various substances that can be sniffed. Stimulants include amphetamines, sometimes known as “uppers” or “speed,” and cocaine, which in its free-base form is known as *crack*.

Another class of drugs is hallucinogens which cause marked alterations in mood, attitude, thought processes, and perceptions. Marijuana is the most controversial drug in this class because its long-term effects on health are still largely unknown. Other hallucinogens include LSD, mescaline, PCP, psilocybin, and MDMA (Ecstasy).

Each country has its federal laws to regulate and control drugs transport and abuse. In India, Narcotic Drugs and Psychotropic Substance act established in 1985, controls and regulate drugs in India. Whenever any questioned sample of drug is seized, it is sent to laboratory for identification. Since unknown substance may any one of a thousand of drugs, the analyst employs screening tests to reduce these possibilities to

a small number. This is done by subjecting the sample to a series of color tests that produce characteristic colors for the more commonly encountered illicit drugs. Microcrystalline tests which are more specific than color test are also conducted to identify sample on the basis of characteristic crystal formed with specific reagents. Once the preliminary analysis is completed, a confirmation is pursued using combination of techniques such as chromatography and spectrophotometry. Typically Gas chromatography is used for separation of drug compound from the mixture and infrared spectrophotometry or mass spectrometry is used to specifically identify a drug substance.

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Collection and analysis of Biological evidences: Blood, semen, saliva, sweat, Hair
Module Id	

Goals of Biological Evidence Collection

1. Each individual stain should be collected separately. Do not collect or package two separate stains together in the same container.
2. Do not allow evidence samples to come into contact with any surface, which contains residue from another biological sample (e.g. dirty tweezers, bloodstained glove, contaminated work surface).
3. Use tweezers with smooth, easy-to-clean working surfaces.
4. Tools (e.g. tweezers, scissors) can be cleaned by thoroughly rinsing with a stream of distilled water and drying thoroughly with paper tissue. Repeat this process twice before using tool to manipulate another sample.
5. Do not talk or cough over biological evidence.
6. Small biological evidence (e.g. 2-mm size bloodstain or hair) is most susceptible to contamination.
7. Put on a new pair of gloves before handling these small stains. Consider wearing a mask.
8. Package all biological evidence in **paper** bags or envelopes. Do **not** use plastic.
9. Handle the sample in a manner, which minimizes deterioration of the sample.
10. When feasible, take object with stain. Do not remove stain. If stain can be easily dislodged (e.g. stain is on non-porous surface), protect it from contact with another object. One way this can be done is by immobilizing the evidence item in a cardboard container.
11. If evidence stains are found on objects that can be cut (e.g. a rug), the evidence stain can be removed by cutting it out with a pair of clean scissors.

Remember to also take an "unstained" control cutting (e.g. the substrate without the stain) from the object.

12. If object cannot be moved, use a **slightly dampened** substrate (cotton swab or piece of plain, cotton cloth or gauze) to collect stain. Remember to collect an unstained control by swabbing an unstained area of the evidence object as very few stains can be safely collected by scraping them.
13. The size of the stain should influence the size of a substrate used to collect the stain. Thus, use a small part of a swab or a small piece of cotton cloth or piece of gauze to collect a small stain. Do not smear a small stain over a large surface.
14. Use a minimum amount of distilled water to dampen the swab or cloth/gauze substrate.
15. To keep the stain concentrated, collect the stain on the smallest area of the swab or cotton cloth.
16. Wet blood should be dried first and then scraped or can be collected on a swab.
17. Blood-stained materials must be stored in paper bags or manila envelopes.
18. Blood-soaked clothing must not be stored in air-tight containers because the trapped moisture may cause the growth of mildew & mold and destroy the blood.
19. All clothing in fact, must be air-dried and individually stored in paper bags.
20. If bloodstained materials are stored in airtight containers, the accumulation of moisture may encourage the growth of mold, which can destroy the evidential value of blood.
21. For damp or bloody items one should use:
    a) Brown paper bags of appropriate size
    b) Earthguard bags
    c) Butcher paper that can be folded and properly taped shut.

SWEAT

Sweat is the watery fluid produced and excreted by the sweat gland. Sweat glands are simple tubular glands (almost two to four million sweat glands) found in almost every part of the skin.

Sweat glands are stimulated in response to

a) high temperature.
b) exercise.

c) hormones.
d) emotional stress (emotionally induced sweating is restricted to palms ,soles , armpits and forehead while temperature induced sweating causes sweating throughout the body).

Composition of sweat

Sweat is composed mainly of water and 0.2 – 1% solutes, such as; sodium, potassium lactate, urea, ammonia etc

Mechanism of sweat secretion

When the sweat glands are stimulated the secretory portion of the sweat gland secrets a fluid which is absorbed by the gland cells from the interstitial fluid and is produced and secreted into the gland lumen by active secretory activity of the epithelial cells lining the coiled portion of the sweat gland. As the precursor flows through the duct portion it is modified by the reabsorbtion Na^+ and Cl^- .

Function of sweat

1- Thermoregulation:- The principle function of sweat. Sweating allows the body to rid itself of excessive heat production, through the evaporation of water which brings about cooling of the body.

2- Sweat accounts for a large proportion of the water that remains on the skin, forming part of the hydrolipid film which is the indispensable protective covering keeping the skin in good condition and, allowing it to perform its many essential functions.

3- It plays a minor excretory role (some drugs and toxins are excreted in sweat).

HAIR

1. Hair should be stored in unbreakable plastic pill bottles with pressure lids or in Manila envelopes, screw-cap glass vials, or cardboard pillboxes.

hair analysis can be a forensic tool because human hairs are routinely shed and can be discovered at a crime scene. Examination of hair found at the scene and compared with hair from a known source may be helpful to the extent that it reflects similarities. The extent of the similarity in those samples and the examiner's ability to discover and compare those similarities is the principal issue when hair analysis is offered in a criminal case.

Microscopic Hair Analysis

Traditionally, forensic evidence comparing human hair was based on a microscopic comparison of the evidentiary sample with a known sample from the defendant. To make a microscopic hair comparison, a control group of hairs from a known source must be properly collected by pulling or combing hairs from a subject. That requires a total of fifty hairs from different areas of the scalp or a total of twenty-five hairs from a pubic region. The samples are then examined macroscopically for gross feature comparison, such as color, form, and thickness. In the microscopic stage, hairs are mounted on slides using a mounting medium that has the same refractive index as the hair. The hair analyst then attempts to identify the part of the body from which the hair might have come, based on certain area characteristics.

Features of the hair are divided into "major and secondary characteristics." Major characteristics include color, treatment, pigment aggregation, shaft form, pigment distribution, medulla appearance, hair diameter, medullary index, and the presence or absence of a root or shaft. Secondary characteristics include cuticular margin, pigment density, pigment size, tip shape, and shaft diameter. The examiner then formulates an opinion as to exclusion or consistency.

SEMEN

Normal male can ejaculate 2.5-6 ml of seminal fluid. Each ml contains 100 million or more spermatozoa. Many of the cases sent to a forensic laboratory involve sexual offenses, making it necessary to examine exhibits for the presence of seminal stains.

PRESUMPTIVE TESTS

Acid Phosphatase Test (Walker Test or Brentamine spot test)

The male prostate gland produces and secrets into semen a high amount of the enzyme acid phosphatase (AP). In the presence of Alpha-Naphthyl acid phosphate and Brentamine Fast Blue, AP will produce a dark purple color in less than a minute.

Precautions: The shade of purple color will depend on the activity of the enzyme, which can be negatively impacted by the age of the stain and the storage conditions. This test is highly presumptive because vaginal secretions and other bodily fluids contain detectable levels of this enzyme as well.

Alternative Light Sources

Under specialized lights, semen will fluoresce due to the presence of molecules such as Flavin and Choline-conjugated proteins. This color will vary from blue to yellow depending on the light equipment used.

Precautions: This detection technique is highly presumptive because many molecules (natural and artificial) will fluoresce in a similar way as semen. Also, not all semen stains will fluoresce. Exposure to different environments, different types of fabrics, and different fabric treatments can affect this fluorescent activity.

Prostate Specific Antigen

Test detects prostate specific antigen (PSA). PSA is produced in high amounts by male prostate gland.

Precautions: This antigen can also be found in very small amounts of fecal material and sweat. Studies also indicate that PSA can exist in female urine and breast milk. Caution is urged when interpreting positive PSA results which are not confirmed by actual presence of sperm.

CONFIRMATORY TESTS

Christmas Tree Stain

Positive visual identification of sperm cells using a stain. Two main reagents are used consecutively to produce this distinctive stain: Picroindigocarmine stains the neck and tail portions of the sperm in green and blue, while the Nuclear Fast Red (AKA Kernechtrot) gives the sperm heads a read color and the tip of the heads a pink color.

Precautions: Sperm cells deteriorate quickly after ejaculation. Sperm survival will depend on the surrounding environment and type of surface. The sperm tails are the most susceptible to damage and will break down first. Therefore, the analyst must be trained to make visual distinctions between sperm heads and other types of cells in the mix. Other cells will also stain red

RSID Test for Semen

Identifies the presence of the seminal vesicle-specific antigen, or semonogelin. This antigen is unique to human semen; therefore, there is no cross reactivity with other bodily fluids in males and females or with semen from other mammals. This test can also identify semen even if the stain was stored in less favorable conditions.

Saliva

Saliva is a watery substance formed in the mouths of humans and animals, secreted by the salivary glands. Human saliva comprises 99.5% water, plus electrolytes, mucus, white blood cells, epithelial cells (which can be used to extract DNA), glycoproteins, enzymes (such as amylase), antimicrobial agents such as secretory IgA and lysozyme. The enzymes found in saliva are essential in beginning the process of digestion of dietary starches and fats. These enzymes also play a role in breaking down food particles entrapped within dental crevices, thus protecting teeth from bacterial decay. Saliva tests can reveal certain disease markers, viral infections, and the presence of therapeutic as well as illicit drugs in the body.

PRESUMPTIVE TESTS

Phadebas Test

A chemical reagent called Phadebas is used to detect the enzymatic activity of the alpha-amylase enzyme, which is found in saliva. This enzyme is found in other organisms as well. In humans, there are four variants of alpha-amylase, two of which are found in saliva, and the other two are secreted by the pancreas. This test is presumptive because it will give a positive result if the alpha-amylase enzyme from any organism is present.

CONFIRMATORY TESTS

Phadebas Test and RSID Test for Human Saliva

The RSID Test for Human Saliva detects the alpha-amylase molecule itself, and specifically, the alpha-amylase from human saliva (in comparison to the testing for enzymatic activity as seen in the Phadebas test). Performing both of these tests is considered a confirmatory test

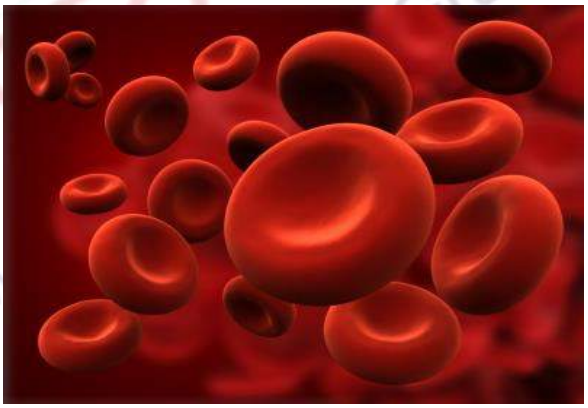
Precautions: The RSID test has produced positive reactions in samples containing alpha-amylases from mammals such as gorillas and rats. Positive reactions were also noted in other bodily fluids, such as semen, blood, vaginal discharge, sweat, and breast milk. High reactivity of this test is observed in samples containing human feces. Reactivity was also noticed in urine samples. Improper swabbing and other factors relating to personal hygiene, personal behavior, and indirect saliva transfer from mouth to surface can result in "false" positives.

Blood

Blood is a body fluid in humans and other animals that delivers necessary substances such as nutrients and oxygen to the cells and transports metabolic waste products away from those same cells. Blood is circulated around the body through blood vessels by the pumping action of the heart. Blood performs many important functions within the body including supplying of oxygen to tissues (bound to hemoglobin, which is carried in red cells)

It is composed of blood cells suspended in blood plasma. Plasma, which constitutes 55% of blood fluid, is mostly water (92% by volume)[1] and contains dissipated proteins, glucose, mineral ions, hormones, carbon dioxide (plasma being the main medium for excretory product transportation), and blood cells themselves.

Blood consists of 7% of the human body weight. The average adult has a blood volume of roughly 5 litres which is composed of plasma and several kinds of cells. These blood cells consist of erythrocytes (red blood cells, RBCs), leukocytes (white blood cells), and thrombocytes (platelets). By volume, the red blood cells constitute about 45% of whole blood, the plasma about 54.3%, and white cells about 0.7%.



Species of origin test

The Ouchterlony test is used to determine if a blood sample is human or animal through the comparison of its reactions to specific antibodies. A sample of the unknown bloodstain is placed in a well in an agar gel. Antibodies from human and animal sources of blood are placed in other wells in the gel. Antigens from the sample and the antibodies will spread out of their respective wells and will pair up to form an immune complex if the antigen and antibody are from the same animal

source. The immunne complexes can be observed as a line in the gel, thus indicating the source of the blood.
Precautions: A control sample consisting of a sample from the unstained area near a stained area of interest must be tested. It may take several hours up to 72 hours for the reaction to occur. This test requires expertise in interpretation.

ABO typing - identifies a person's blood type

ABO typing requires a multi-step procedure in which the sample is observed reacting with Anti-A and Anti-B antibodies. Next, the liquid part of the blood without cells, the serum, is mixed with blood that is known to be Type A or Type B and the reaction is observed.

Precautions: Appropriate negative controls must be run as false positives are possible, especially with Type B blood. Stains on denim fabric or soiled shoes may also yield false positives. Weak results may be read differently by analysts, so it is essential to have a second analyst read the results.

PRESUMPTIVE TESTS

Phenolphthalein Test (Also known as the Kastle Meyer Test)

A Phenolphthalein solution is used to show the possible presence of blood based upon a peroxidase reaction of hemoglobin which produces a pink color.

Precautions: This test is presumptive because it has produced false positives from other substances, such as saliva, pus, malt extract, vegetable extracts, and the salts of certain heavy metals. A false positive reaction has also been observed with rust.

Luminol Test

A chemical compound, known as Luminol, is used in solution or sprayed onto suspected surfaces. This compound gives a strong blue fluorescence when viewed with a UV light. The Luminol reacts with hematin, a substanced formed as bloodstains age, and produces a luminescence which is best observed in the dark. The luminescence lasts for several minutes and can be photographed. Aged bloodstains tend to give more intense and longer-lasting luminescence than fresh blood, and can be re-sprayed with Luminol to be viewed again.

Precautions: False positives have been observed with the presence of copper salts. Most brass, bronze, and similar alloys which contain copper gave a false positive reaction, which is important to consider when dealing with locks, door handles, and other fixtures made of these materials.

Alternative Light Sources

Alternative Light Sources such as the CrimeScope use ultraviolet, visible or infrared light to cause certain substances to fluoresce (glow) or absorb light (darken). Blood stains will darken rather than glow when certain light wavelengths are used. See the user's manual for the alternative light source for more information.

CONFIRMATORY TESTS

Takayama Test

Through the application of a specific solution developed by Takayama, hemochromogen crystals form by treating a small amount of blood or a stain fragment. The crystals are observable under a microscope and look like salmon-pink rhomboid crystals. This test does not require heating, and can be used on older samples.

Precautions: This test requires a relatively large amount of sample (0.1 mg hemoglobin).

RSID Test for Human Blood

This test uses two specialized antibodies to detect the presence of human Glycophorin A which is found in red blood cell membranes. The antibodies are applied to the suspected sample by using a strip test assay. At the end of the test, certain markings will indicate whether human blood was detected or if the test failed.

Precautions: This test should be evaluated exactly 10 minutes after the addition of the sample. An appropriate sample size and dilution of the sample must be used. Kits should be stored at room temperature and buffers should be stored at 4 C.

ABAcard HemaTrace test strips

HemaTrace test strips are used to detect blood by indentifying the presence of human hemoglobin. The test strip contains an antihuman hemoglobin antibody. A blood sample is applied to the bottom of the test strip. If human hemoglobin is present, then a mobile antibody-antigen complex will be formed. This complex will then migrate through the test strip to a test window. This window will indicate if there is a positive result for human hemoglobin with a pink dye band.

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Indian evidence act: section 45, 46, 47, 48, 49, 50 and 51. Cr.P.C.- Section 293. Expert witness and admissibility of evidence.
Module Id	

The Indian Evidence Act, 1872

The **Indian Evidence Act**,originally passed in India by the Imperial Legislative Council in 1872, during the British Raj. It comprises a set of rules and allied issues governing admissibility of evidence in the Indian courts of law.

This Act introduced a standard set of law applicable to all Indians. The law is mainly based upon the firm work by Sir James Fitzjames Stephen, who could be called the founding father of this comprehensive piece of legislation.

The Indian Evidence Act, 1872, is divided into three parts has eleven chapters and 167 sections. This act came into force on 1st September 1872.

After independence of India on 15 August 1947, the Act continued to be in force throughout the Republic of India and Pakistan, except the state of Jammu and Kashmir. Then, the Act continues in force in India.

Few important sections of the said act are discussed below:

Section 45

Opinions of experts —When the Court has to form an opinion upon a point of foreign law or of science or art, or as to identity of handwriting [or finger impressions], the opinions upon that point of persons specially skilled in such foreign law, science or art, [or in questions as to identity of handwriting] [or finger impressions] are relevant facts. Such persons are called experts.

Illustrations

(a) The question is, whether the death of A was caused by poison. The opinions of experts as to the symptoms produced by the poison by which A is supposed to have died are relevant.
(b) The question is, whether A, at the time of doing a certain act, was, by reason of unsoundness of mind, incapable of knowing the nature of the Act, or that he was doing what was either wrong or contrary to law. The opinions of experts upon the question whether the symptoms exhibited by A commonly show unsoundness of mind, and whether such unsoundness of mind usually renders persons incapable of knowing the nature of the acts which they do, or of knowing that what they do is either wrong or contrary to law, are relevant.

(c) The question is, whether a certain document was written by A. Another document is produced which is proved or admitted to have been written by A. The opinions of experts on the question whether the two documents were written by the same person or by different persons, are relevant. Comments Conflict of opinion of Experts When there is a conflict of opinion between the experts, then the Court is competent to form its own opinion with regard to signatures on a document; Kishan Chand v. Sita Ram, AIR 2005 P&H 156. Expert opinion admissibility Requirement of expert evidence about test firing to find out whether double barrel gun is in working condition or not, not necessary; Jarnail Singh v. State of Punjab, AIR 1999 SC 321. The evidence of a doctor conducting post mortem without producing any authority in support of his opinion is insufficient to grant conviction to an accused; Mohd Zahid v. State of Tamil Nadu, 1999 Cr LJ 3699 (SC). Opinion to be received with great caution The opinion of a handwriting expert given in evidence is no less fallible than any other expert opinion adduced in evidence with the result that such evidence has to be received with great caution; Ram Narain v. State of Uttar Pradesh, AIR 1973 SC 2200.

Section 46

Facts bearing upon opinions of experts—Facts not otherwise relevant, are relevant if they support or are inconsistent with the opinions of experts, when such opinions are relevant.

Illustrations

(a) The question is, whether A was poisoned by a certain poison. The fact that other persons, who were poisoned by that person, exhibited certain symptoms which experts affirm or deny to be the symptoms of that poison, is relevant.
(b) The question is, whether an obstruction to a harbour is caused by a certain sea-wall. The fact that other harbours similarly situated in other respects, but where there were no such sea-walls, began to be obstructed at about the same time, is relevant. COMMENTS tc "COMMENTS" Admissibility The science of identification of footprints is not a fully developed science and therefore if in a given case, evidence relating to the same is found satisfactory it may be used only to reinforce the conclusions as to the identity of a culprit already arrived at on the basis of other evidence; Mohd. Aman v. State of Rajasthan, (1997) 4 Supreme 635.

Section 47

Opinion as to handwriting, when relevant—When the Court has to form an opinion as to the person by whom any document was written or signed, the opinion of any person acquainted with the handwriting of the person by whom it is supposed to be written or signed that it was or was not written or signed by that person, is a relevant fact. Explanation.—A person is said to be acquainted with the handwriting of another person when he has seen that person write, or when he has received documents purporting to be written by that person in answer to documents written by himself or under his authority and addressed to that person, or when, in the ordinary course of business, documents purporting to be written by that person have been habitually

submitted to him. Illustration The question is, whether a given letter is in the underwriting of A, a merchant in London. B is a merchant in Calcutta, who has written letters addressed to A and received letters purporting to be written by him. C is B's clerk, whose duty it was to examine and file B's correspondence. D is B's broker, to whom B habitually submitted the letters purporting to be written by A for the purpose of advising him thereon. The opinions of B, C and D on the question whether the letter is in the handwriting of A are relevant, though neither B, C nor D ever saw A write.

Section 48

Opinion as to existence of right or custom, when relevant—When the Court has to form an opinion as to the existence of any general custom or right, the opinions, as to the existence of such custom or right, of persons who would be likely to know of its existence if it existed, are relevant. Explanation.—The expression "general custom or right" includes customs or rights common to any considerable class of persons. Illustration The right of the villagers of a particular village to use the water of a particular well is a general right within the meaning of this section.

Section 49

Opinions as to usages, tenets, etc., when relevant—When the Court has to form an opinion as to— the usages and tenets of any body of men or family, the constitution and government of any religious or charitable foundation, or the meaning of words or terms used in particular districts or by particular classes of people, the opinions of persons having special means of knowledge thereon, are relevant facts.

Section 50

Opinion on relationship, when relevant—When the Court has to form an opinion as to the relationship of one person to another, the opinion, expressed by conduct, as to the existence of such relationship, or any person who, as a member of the family or otherwise, has special means of knowledge on the subject, is a relevant fact: Provided that such opinion shall not be sufficient to prove a marriage in proceedings under the Indian Divorce Act, 1869 (4 of 1869) or in prosecutions under section 494, 495, 497 or 498 of the Indian Penal Code (45 of 1860). Illustrations

(a) The question is, whether A and B were married. The fact that they were usually received and treated by their friends as husband and wife, is relevant.
(b) The question is, whether A was the legitimate son of B. The fact that A was always treated as such by members of the family, is relevant. Comments Contradiction in evidence of relationship of witness of triffle nature, not material in a partition suit; Gowhari Das v. Santilata Singh, AIR 1999 Ori 61.

Section 51

Grounds of opinion, when relevant—Whenever the opinion of any living person is relevant, the grounds on which such opinion is based are also relevant. Illustration An expert may give an account of experiments performed by him for the purpose of forming his opinion.

The Code Of Criminal Procedure, 1973

Section 293

Reports of certain Government scientific experts.

(1) Any document purporting to be a report under the hand of a Government scientific expert to whom this section applies, upon any matter or thing duly submitted to him for examination or analysis and report in the course of any proceeding under this Code, may be used as evidence in any inquiry, trial or other proceeding under this Code.

(2) The Court may, if it thinks fit, summon and examine any such expert as to the subject- matter of his report.

(3) Where any such expert is summoned by a Court and he is unable to attend personally, he may, unless the Court has expressly directed him to appear personally, depute any responsible officer working with him to attend the Court, if such officer is conversant with the facts of the case and can satisfactorily depose in Court on his behalf.

(4) This section applies to the following Government scientific experts, namely:-

(a) any Chemical Examiner or Assistant Chemical Examiner to Government;

(b) the Chief Inspector of- Explosives;

(c) the Director of the Finger Print Bureau;

(d) the Director, Haffkeine Institute, Bombay;

(e) the Director[1], Deputy Director or Assistant Director] of a Central Forensic Science Laboratory or a State Forensic Science Laboratory;

(f) the Serologist to the Government.

Expert Witness

1. A person whose level of specialized knowledge or skill in a particular field qualifies them to present their opinion about the facts of a case during legal proceedings.

In other words an **expert witness can be defined as** a person whose opinion by virtue of training, education, certification, experience or skills, (technical, scientific or other) is accepted by the judge as an expert.

An expert offers special expertise in a particular field. As an expert witness however, he or she needs to offer additional skills and abilities – courtroom skills and report writing, for example -- which can be enhanced by training and developed over time.

When in court, the expert witness methodically presents opinion evidence based on evidence of fact. The subsequent report which the expert witness also prepares would be written within a specified time scale in compliance with specific legal guidelines.

Admissibility of evidence

Admissible evidence is any document, testimony, or tangible evidence used in a court of law. Evidence is typically introduced to a judge or a jury to prove a point or element in a case. Criminal Law: In criminal law, evidence is used to prove a defendant's guilt beyond a reasonable doubt.

Relevance

For evidence to be admissible, it must tend to prove or disprove some fact at issue in the proceeding. However, if the utility of this evidence is outweighed by its tendency to cause the fact finder to disapprove of the party it is introduced against for some unrelated reason, it is not admissible. Furthermore, certain public-policy considerations bar the admission of otherwise relevant evidence.

Reliability

For evidence to be admissible enough to be admitted, the party proffering the evidence must be able to show that the source if the evidence makes it so. If evidence is in the form of witness testimony, the party that introduces the evidence must lay the groundwork for the witness's credibility and knowledge if he attests to. Hearsay is generally barred for its lack of reliability. If the evidence is documentary, the party proffering the evidence must be able to show that it is authentic, and must be able to demonstrate the chain of custody from the original author to the present holder. The trial judge performs a "gatekeeping" role in excluding unreliable testimony. The United States Supreme Court first addressed the reliability requirement for experts in the landmark case *Daubert v. Merrell Dow Pharmaceuticals, Inc.* 509 U.S. 579 (1993).

The Court laid out four non-exclusive factors that trial courts may consider when evaluating scientific expert reliability:

(1) whether scientific evidence has been tested and the methodology with which it has been tested;

(2) whether the evidence has been subjected to peer review or publication;

(3) whether a potential rate of error is known; and

(4) whether the evidence is generally accepted in the scientific community

Admissibility and Inadmissibility

Evidence generally falls into four categories:

- Real

- Demonstrative
- Documentary
- Testimonial

Real evidence is any actual object that was directly involved in an event in the case. It could be the weapon used to murder a victim, like a gun or a hammer, or the tool used to break into a house, like a crowbar.

Demonstrative evidence, on the other hand, is an illustration of evidence -- something like a map of the crime scene.

Documentary evidence, also a type of real evidence, describes letters, contracts, newspapers or anything that contains human language.

Testimonial, or **anecdotal evidence**, is oral or written evidence from victims, suspects and witnesses involved with the case.

All of the above types of evidence need to follow the **rules of admissibility**, which are there to make sure that anything introduced to the court as evidence meets three criteria:

- Relevance
- Materiality
- Competence

Relevant evidence proves or disproves a fact of a crime, but it doesn't necessarily prove anyone's guilt or innocence -- it's simply a broad term that describes any piece of evidence related to the case. A tool stained with a suspect's blood might be relevant, for example, but so is the person who sold that tool to the suspect. However, testimony from a toddler discussing a broken house contract would be deemed irrelevant and therefore inadmissible because a child would be too young to understand the case.

Material evidence, on the other hand, needs to prove an essential fact of the case. For example, if a lawyer attempts to prove that the drapes in the room of a murder scene were blue, chances are a judge will deem such evidence immaterial. The room itself may be relevant to the case, but it's likely the color of the drapes doesn't have anything to do with the murder. Finally, **competent evidence** is an object or testimony proven to be reliable, like matching fingerprints, the results of a DNA test, or an expert on footwear impressions. An expert giving an opinion that isn't generally accepted in his field, on the other hand, is neither competent nor admissible.

There's an endless amount of inconsistency and several exceptions, but one of the most important rules of evidence is the **hearsay rule**. This rule prohibits secondhand testimony, or evidence of

the "he said, she said" variety, during a trial. If an eyewitness to an accident tells his friend the details after the event, the eyewitness's friend's testimony would be hearsay and considered inadmissible.

A judge can dismiss evidence for several other reasons. A presentation will take an unnecessarily long time; upsetting photographs will unfairly incite a jury, or forensics experts might have gathered evidence illegally. However, the main reason for declaring inadmissibility is to make sure evidence is reliable and fair to both sides of a case.

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Paper : **Forensic Science and Forensic Medicine**

Module : **Speaker identification and tape authentication.**

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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Speaker identification and tape authentication.
Module Id	CRIMINOLOGY/FSFM/XXXII
Objectives	Learning Outcome: • To make the learners understand the process of voice production • To make the learners understand the forensic importance of voice analysis and speaker identification • To acquaint the learners with the process of speaker identification • To make the learners understand the process of tape authentication
Prerequisites	General understanding of the human anatomy, organs and brief knowledge pf phonetics
Key words	Anatomy of voice, mechanism of voice production, speaker identification, tape authentication, forensic phonetics

Introduction:

The human voice is unique and distinguishing characteristic of humans which make them stand apart from the entire animal kingdom. The ability of flexibility of the human voice allows us to portray our thoughts, emotions, joys, and fears. Each voice is unique in itself and acts as one of the identifying characteristic of an individual.

The voice is produced when muscles press air from the lungs through the larynx. The vocal cords vibrates, and interrupt the air and produce a periodic pressure wave. The pressure impulse are called pitch impulse. The frequency of the pressure signal is the pitch frequency or fundamental frequency. The frequency of the pressured signal is the part that define the speech melody. The frequency of the vocal cord is determined by serval factors: the tension exerted by the muscles, its mass and its length. These factors vary between sexes and according to age. The pressure impulse are stimulating the air in the oral tract and for certain sounds also the nasal tract. When the cavities resonate, they radiate a sound wave which is the speech signal. Both tracts (Vocal and nasal) act as resonators with characteristic resonance frequencies called **formant frequency**. These formant frequencies are used for identifying and individualization of a particular voice. It is possible to change the cavities of the mouth by moving the jaw, tongue, velum, lips and mouth helping us in producing various sounds.

Forensic Phonetics focuses on the analysis of spoken communication for the purposes of justice, for identification of suspected speaker of a questioned voice or speech sample. It includes speaker identification, enhancing and decoding spoken messages, analysis of emotions in voice, authentication of recordings and related.

The Forensic Phonetics comprises of two major elements. First which involves the analysis (usually electro-acoustical) of those speech signals which have been transmitted and stored and second is that of analyzing the communicative acts themselves (Hollien 1990). The first of these two domains addresses the enhancement of speech intelligibility, speech decoding (including accuracy of transcripts), the authentication of recordings and the like. The second area involves issues such as

recognition of speakers from their voices, identification of the health, emotional or psychological states of the talker and the analysis of speech for evidence of deception.

Tape-authentication involves the forensic analysis of standard monophonic and stereophonic cassette and micro-cassette tape recordings. The time-domain waveform for recorded signatures are analyzed in terms of relative timing offset for determining azimuth of the record head used in making a specimen tape. Additionally, excursion of the erase signature into the guard band region is a reliable indicator of an original versus a copied erase signature.

2. Production of Voice - voice organs, voice anatomy, mechanism of voice production:

Voice Organs: The main components of the human speech system are: The lungs, trachea (windpipe), larynx, pharyngeal cavity (throat), oral or buccal cavity (mouth), nasal cavity (nose). Normally the pharyngeal and the oral cavity are grouped into one unit called the oral tract. The nasal cavity is normally called the nasal tract.

Voice Anatomy: Sound consists of variations in pressure caused by the movement of molecules, in order for these to start moving, there must be a source of energy; in human beings this role is played by the respiratory organs. In most cases, speech sounds rely on air supplied by the lungs. During inhalation (or *inspiration*), the diaphragm contracts (and moves down), whereas the rib cage is elevated as a result of the action of the muscles between the ribs, thus enlarging the thorax. As the compartment enlarges, the lungs expand, which, in turn, results in the pressure inside the lungs dropping below the air pressure that surrounds us (known as the *ambient* or *atmospheric* pressure). It is through the inflow of air that the two pressures are equalized. Conversely, when we breathe out, i.e. during exhalation (or *expiration*), there is a downward movement of the rib cage and a relaxation of the diaphragm, which then returns to its normal dome shape; this results in a reduction of the thoracic

cavity, and the *compression* of the lungs, which, in turn, leads to an increase in the pressure inside them. And as the pressure inside the lungs is higher than the atmospheric pressure, air flows out in order to equalize both pressures. The entire process of breathing in and out is known as the respiratory cycle. At rest, this takes place some 12-15 times a minute, while it increases to thirty times during strenuous exercise, etc.

However, during phonic respiration, i.e. our breathing during speech, the *inhalation* time is reduced (sometimes to as little as half a second), whereas the *exhalation* time is increased to about 5-10 seconds, though in rapid, excited speech – when we wish to convey more speech – it can go up considerably.

The larynx and vocal folds

The larynx is popularly known as the Adam's apple. It lies immediately below the root of the tongue and is composed of a framework of cartilages, connected by means of joints and fibrous bands (*ligaments*) and membranes. The larynx has both *speech* and *physical* (i.e. anatomical) functions. Its main physical functions are to protect the entry to the lower air passages, and to prevent food, etc. from going down the trachea. To understand the speech function of the larynx i.e. its role as sound producing organ of the vocal apparatus, we need to discuss its major components.

The larynx includes two big cartilages in the larynx. The lower one is called the cricoid cartilage, which is situated just above the highest ring in the trachea. Resting on this cartilage is the so-called thyroid cartilage, which is made up of two square-shaped cartilages that are joined at the front of the larynx. At the top of where the two surfaces join together, there is a small V-shaped gap. This is actually what is known colloquially as the *Adam's apple*. Inside the 'box' formed by the thyroid and cricoid cartilages we find the vocal folds (- lips/ - cords), i.e. two three-sided pyramid-shaped muscles, which project into the cavity of the larynx. The vocal folds are stretched across the larynx from front to back. The opening between the vocal folds is called the glottis. At the front they are joined together and fixed to the inside of the thyroid cartilage, whereas at the back they are attached to a pair of small cartilages, the arytenoid cartilages. These are the most vital organs of speech since it is they that move the vocal folds; the arytenoids articulate with the cricoid through a joint which

allows them to rotate and slide, and thus to open and close the glottis, helping in voice production.

Mechanism of Voice Production: The production of the voice is a complex interaction among a number of different body systems. The lungs serve the role of the activator in human voice production. As one breathes in, negative pressure is produced that actually pulls air into the lungs. As we expire or exhale, that air serves as the source of power for setting up the vibration of the vocal folds. The vocal folds themselves serve as the vibrators, and it is the fine control of the movements of the vocal folds that allows for the flexibility of the speaking and singing voice.

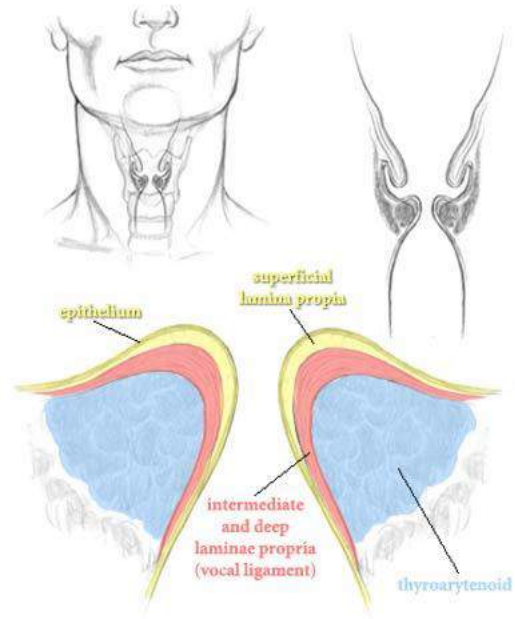

Diagram of Vocal Folds

In the body, the face and sinuses and the chest serve as resonators, which give the voice its timbre or character. In addition to these three important areas, other body parts and systems play important roles. Tension in the jaw or neck will reduce flexibility and increase the onset of fatigue. The voice is strongest when the body is in the upright position (not many opera roles allow the figure to recline) and musculoskeletal problems can affect the best posture. In addition, the diaphragm and abdomen are important in the support of the voice, so abdominal conditions such as

cramping or bowel disorder may have a negative impact on voice. The psychological system is important in the confidence one has in his or her voice, as can be seen by the fluttering of the voice when a person is nervous or anxious. Finally, refined coordination of muscle movement and sensory control are adjusted by the neurological system.

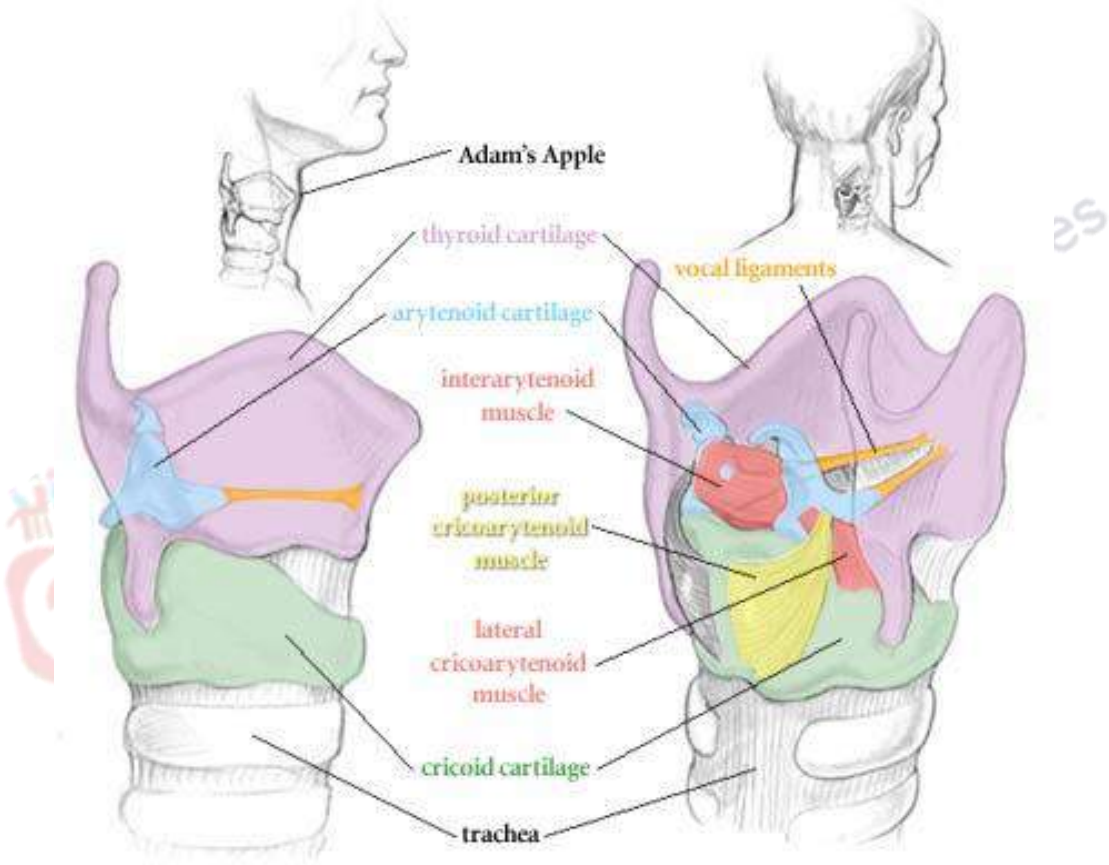

Diagram of Voice Box Cartilages and Muscles
Voice box muscles are named according to the cartilages to which they are attached.

3. Speaker identification:

Speaker recognition comprises those activities which attempt to link a speech sample to its speaker through its acoustic or perceptual properties. Speech signal provides information regarding speaker characteristics, spoken phrase, speaker emotions,

additional noise, channel transformations etc. The process of Speaker recognition has two broad application areas, explicitly, Speaker identification and Speaker verification. Speaker identification deals with identifying a speaker of a given utterance amongst a set of known speakers. The unknown speaker is identified as the speaker whose model best matches the input utterance. Speaker verification is a more direct and converged effort leading to either acceptance or rejection of the claimed identity of a speaker.

Components of Speaker Recognition

The main components of speaker recognition system are feature extraction and classification. The classification module is further divided into two parts: pattern matching and decision.

Feature extraction

This is the foremost step in the process of speaker recognition. This segment processes the acquired data, i.e., a set of feature vectors or parameters from the speech signal representing some speaker-specific information, which results from complex transformations occurring at different levels of the speech production: semantic, phonologic, phonetic, and acoustic. There are different ways to categorize the features. From the viewpoint of their physical interpretation, following categories have been proposed:

1. Short-term spectral features–These features, as the name suggests, are computed from the short frames of about 20 to 30 milliseconds in duration. They are usually the descriptors of the resonance properties of the supralaryngeal vocal tract.
2. Voice source features –These features characterize the glottal excitation signal of voiced sounds such as glottal pulse shape and fundamental frequency, and it is reasonable to assume that they carry speaker-specific information.
3. Spectro-temporal features-It is very much a rational assumption that the spectro temporal. Signal details such as formant transitions and energy modulations contain useful speaker-specific information.
4. Prosodic features-Prosody refers to non-segmental aspects of speech, including syllable stress, intonation patterns, speaking rate and rhythm. These features depends upon the long segments like syllables, words, and utterances and reflects

differences in speaking style, language background, sentence type and emotion of the speaker.

5. High level features–These features attempt to capture conversation-level characteristics of speakers, such as characteristic use of words (‘‘uh-huh”, “you know”, “oh yeah”, etc.). Other features are the dialect of any language used in the conversation by the speaker, accent of the speaker and the style of speaking.

Pattern matching and decision

The pattern matching module deals with comparison between the estimated features to the speaker models. Some of the pattern matching methods used in speaker recognition include Hidden markov models (HMM), dynamic time warping (DTW), neural networks and vector quantization (VQ) [20]. In case of verification, this module provides an expert with a similarity score between the test sample and the claimed identity. While, in case of identification, the module gives similarity score between the test sample and all the available samples in the database. The evaluation of these scores is done using decision module and the results are accordingly presented.

Various approaches to speaker recognition system

In the discipline of speaker recognition a wide range of methods and procedures are adopted by the experts for identification.

Auditory analysis

Such type of analysis involves a group of trained phoneticians giving their judgement regarding the similarity and dissimilarity between the two speech events, after hearing the samples again and again to find out some similarities in their linguistic, phonetic and acoustic features. Human listeners are robust speaker recognizers when presented with the degraded speech. Listener performance free from all types of limitations like the signal to noise ratio, speech bandwidth, the amount of speech material, distortions occurring in the speech signals as a result of speech coding, transmission systems, etc. In this technique, different utterances of the speakers are segregated in respect of each speaker by way of repeated listening of recorded conversation. The segregated conversations of each speaker are repeatedly heard to identify linguistic features and

phonetic features like articulation rate, flow of speech, degree of vowels and consonant formation, rhythm, striking time, pauses etc. There are cues in voice and speech behaviour, which are individual and thus make it possible to recognize the familiar voices. Experts working in several governments forensic laboratories including laboratories in Germany, Austria, Sweden, the Netherlands and Spain, and in private practice in countries like the United Kingdom and Germany, are still practising this phonetic-acoustic technique for identification. However, with any human decision process, it is generally believed that the auditory analysis by a listener leads to a subjective decision.

Spectrographic approach or voiceprint identification

This involves the semi-automatic measurements of particular acoustic speech parameters such as vowel formants, articulation rate, which is sometimes combined with the results of auditory phonetic analysis by a human expert. In 1941, an electro mechanical acoustic spectrograph was developed by Dr. Raleph Potter, Bell Telephone Laboratory, with an idea to convert sounds into pictures. A sound spectrograph is an instrument which is able to give a permanent record of changing energy-frequency distribution throughout the time of a speech wave. The spectrograms are the graphic displays of the amplitude as a function of both frequency and time. Examiners visually inspect and compare similarities or differences of patterns of the energy distribution in the spectrograms. It is generally believed that formant structures and other spectral characteristics which are evident from a spectrogram are unique for each individual. The most widely used features are fundamental frequencies, formant bandwidths, formant frequencies, spectral composition of fricatives and plosives for individual segments, and transitions. However, the main drawback of this voiceprint analysis is that the spectrograms of the speech signal from same individual will show large intraspeaker variations, because of the fact that no speaker actually is capable of producing two identical speech utterances.

4. Tape authentication

In many cases, an audio forensic expert is called upon to examine taped evidence to provide an opinion on whether or not a tape has been "edited" or "doctored" in any way. Specifically, this translates into an analysis of the temporal sequence of events found on the tape that correspond to record start, pause, and stop operations of one or more tape recording devices. This typically includes the analysis of "record event signatures" corresponding to the interaction of the tape surface with the electrical activation and deactivation of AC-bias record and erase heads, and/or contact with a permanent magnet erase head. The analysis includes aural analysis ("*critical listening*"); visual analysis of the time-domain waveform ("*waveform analysis*"); and via visual analysis of the bitter pattern of the magnetized surface of the tape ("*magnetic development*"). The bitter pattern, a visual representation of the magnetized portions of the tape rendered visible through a low-power microscope, results from the application of micron-sized iron particles in a liquid suspension to the tape known as "ferro fluid". A camera or video recorder can be used to document the event. In addition to examining record event signatures to determine continuity or editing, audio forensic experts are also sometimes asked to confirm if an evidence tape is an original recording, or a copy. Evidence of an original versus a copied tape usually results from similar record event signature analysis, whenever possible. While it is possible to determine that a record stop event is a copy via the analysis techniques just described, an audio forensic expert can never determine with absolute certainty if a recording is truly "original"; one can only state that the recording is consistent with an original recording. As an example, an original recording can be recorded to a computer, digitally edited, and then played back to a cassette recorder containing a tape with "leader" at the start and end. The leader cannot be recorded upon since it has no metallic surface that can be magnetized. The action of the tape recorder corresponding to the record start and record stop events cannot be observed via either waveform or magnetic development analysis.

Another area of authentication not considered here is matching a tape to a specific tape recorder used to make the evidence recording. It is on occasion useful for an attorney to have an audio forensic expert impugn the reliability of a witness's

testimony in cases where a specific tape recorder is claimed to have been used to make a specific evidence tape. Intra-machine variability viewed with inter-machine variability makes it far easier for an expert to eliminate a specific machine rather to identify it. Finally, the forensic audio expert and legal practitioners must bear in mind the difference between what has been termed “Technical Authentication” versus “Legal Authentication”. While related, the audio forensic expert is not required nor are they responsible to legally authenticate evidence in the legal sense. Technical authentication is within the expertise of the audio forensic expert.

A Gateway to all Post Graduate Courses

An MHRD Project under its National Mission on Education through ICT (NME-ICT)

Subject: **Law**

Production of Courseware

e- Content for Post Graduate Courses

Paper : **Forensic Science & Forensic Medicine**

Module : **Forensic Toxicology and Classification of Poisons**

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Content Reviewer		

DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Law
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Forensic Toxicology and Classification of Poisons
Module Id	LAW/CJA/VIII /9
Objectives	Learning Outcome: • To make the learners understand about the concept of forensic toxicology. • To make the learner aware about various branches of toxicology such as analytical toxicology, clinical toxicology, veterinary toxicology, aquatic toxicology, environmental toxicology etc. • To make the learners understand how poisons can be classified in various categories. • To aware the learners about the mode of action of different poisons.
Prerequisites	To aware about the different branches of toxicology and how the toxic compounds can be categorized into different groups depending upon their properties.
Key words	Forensic toxicology, poison, corrosives, irritant, asphyxiants, cerebral poison, cardiac poison, spinal poison, peripheral poisons, metallic, non-metallic, anions, animal poisons, vegetable poisons, volatile, non-volatile, gaseous poisons, pesticides, drugs etc.

1. Introduction:

Toxicology is the study of adverse effects of chemical substances on biological system due to their exposure. It includes study of mode of action, symptoms, detection and treatments of toxic agent in biological system.

2. Branches of toxicology

There are various branches of toxicology i.e. analytical toxicology, clinical toxicology, forensic toxicology, veterinary toxicology, aquatic toxicology, environmental toxicology, etc. These branches have been summarised in following figure.

2.1. Analytical toxicology: Analytical toxicology is deals with evaluation of toxic substance present in biological specimen as well as in raw form. Evaluation involves detection, identification and quantification of poisons using various analytical techniques[1].

2.2. Clinical toxicology: Clinical toxicology is deals with diagnosis and treatment of human poisoning.

2.3. Forensic toxicology: Forensic toxicology deals with the analysis of toxic substances which involve various methods to study these poisonous substances to aid the legal investigation to know the cause of poisoning. It is medico-legal aspect of clinical poisoning[2].

2.4. Veterinary toxicology: Veterinary toxicology is the specialised branch of toxicology which deals with study, diagnosis and treatment of various toxic compounds in animal kingdom[3].

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1. R. J. Flanagan, A. Taylor, I. D. Watson, R. Whelpton, Fundamental of Analytical Toxicology, (John Wiley & Sons Ltd., 2007).

2. https://toxlearn.nlm.nih.gov/htmlversion/module1.html

3. R.C. Gupta, Veterinary Toxicology Basic and Clinical Principles, Chapter 1, 1st edi., (Elsevier, 2007).

2.5. Aquatic toxicology: Aquatic toxicology deals with adverse effect caused by toxic substance on aquatic system[4].

2.6. Environmental toxicology: Environmental toxicology deals with the ill-effects of environmental toxicants on human, animal, plants and the environment. Environmental toxicants are the compounds which are released into environment from various sources such as disposal from industries, domestic disposal etc which may be degradable or non-degradable.

3. Poison

Poison is a substance which when administered, inhaled or swallowed by living organism causes ill effects on the body. It is defined also as a medicine in a toxic dose. Toxic substance may be solid, liquid, gas or any environmental agent.

3.1. Classification of poison

Poisons can be classified in various categories depending upon their (A) mode of action and (B) physical state and (C) medicolegal classification (D) toxico-analytical as follow:

(A) On the basis of mode of action: On the basis of mode of action poison can be categorized into (i) Corrosive Poisons (ii) Irritant poisons, (iii) Neurotic Poisons, (iv) Cardiac Poisons and (v) Asphyxiants.

(i) Corrosive Poisons: Corrosive poisons are the poisons which cause inflammation at the site of contact. Both strong acids and alkalis are comes under this category.

(a) *Strong acids:* Concentrated sulphuric acid, nitric acid and hydrochloric acid

(b) *Strong bases:* Sodium hydroxide, potassium hydroxide and ammonium hydroxide.

[4] Mikko Nikinmaa, Aquatic Toxicology: An Introduction To Aquatic Toxicology, Chapter 1. (Elsevier, 2014).

(ii) **Irritant poisons:** Irritants are those substances which cause irritation, pain, excessive vomiting. These are further divided into (a) inorganic poisons, (b) organic poisons and (c) mechanical poisons.

(a) ***Inorganic poisons: Inorganic poisons are consisted of:***

Metallic – Lead, arsenic, mercury, antimony, copper and zinc etc.

Non Metallic - Chlorine, bromine and iodine etc.

(b) ***Organic Poisons***: Organic poisons consist of poisons of both vegetable origin and animal origin.

Animal poisons – Snakes venom, scorpion venom, spiders etc.

Vegetable poisons – Croton oil, castor oil etc.

(c. **Mechanical Poisons:** Mechanical poisons are the poisons which cause irritation, perforation obstruction in the gastrointestinal tract. For example, powder glass, diamond dust etc.

(iii) **Neurotic Poisons:** - Neurotic poisons are the poisons which affects the different part of central nervous system such as cerebral poisons, spinal poison, peripheral poisons etc. and these constitute of following poisons:

a. *Cerebral Poisons* –Alcohol, opium, barbiturates, benzodiazepines etc.

b. *Spinal Poison* – Strychnine.

c. *Peripheral* – Curare

(iv) **Cardiac Poisons** – Digitalis, tobacco.

(v) **Asphyxiants** – CO, CO_2 etc[5].

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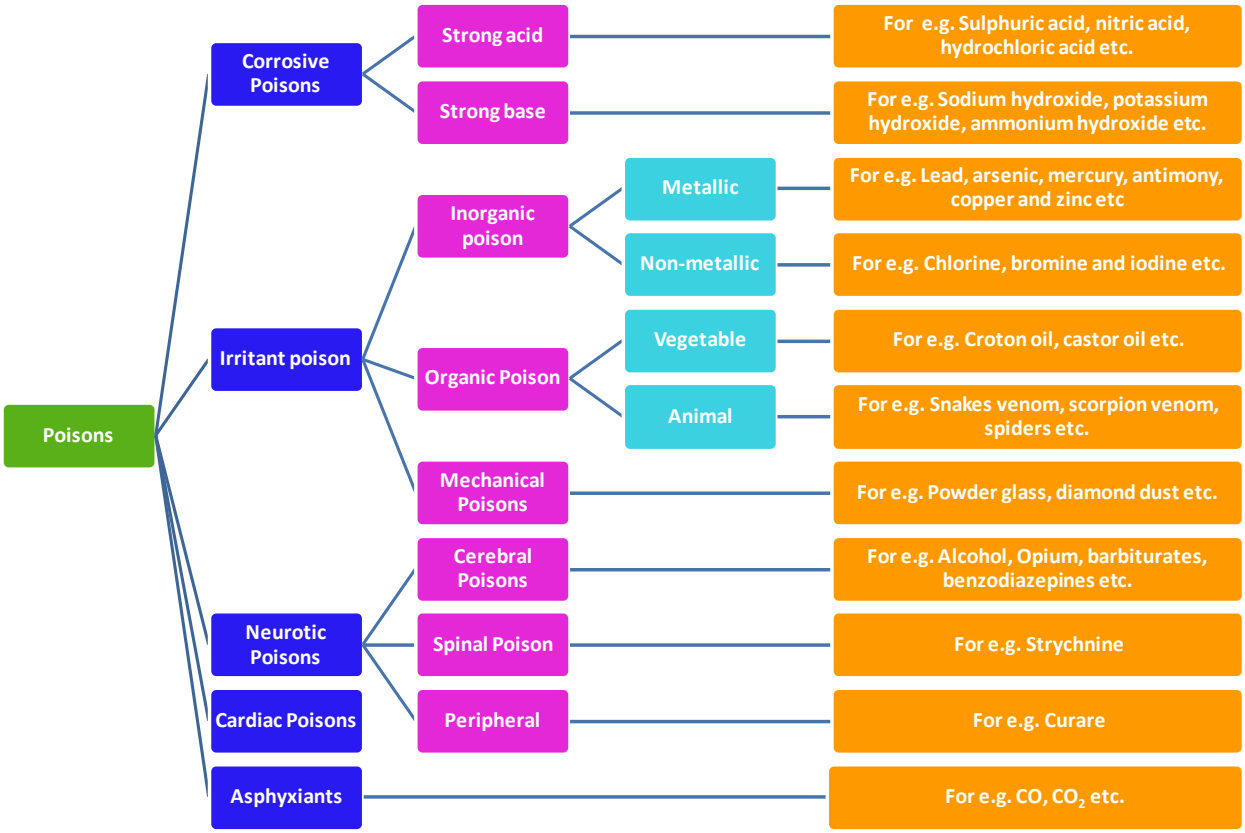
[5] K Vij , Textbook of Forensic Medicine and Toxicology: Principles and Practice, Chapter 30 p. 429, Basic Consideration in Drugs/Chemicals, 5th edn., (Elsevier, 2011).


Poisons
Corrosive Poisons
Strong acid
For e.g. Sulphuric acid, nitric acid, hydrochloric acid etc.
Strong base
For e.g. Sodium hydroxide, potassium hydroxide, ammonium hydroxide etc.
Irritant poison
Inorganic poison
Metallic
For e.g. Lead, arsenic, mercury, antimony, copper and zinc etc
Non-metallic
For e.g. Chlorine, bromine and iodine etc.
Organic Poison
Vegetable
For e.g. Croton oil, castor oil etc.
Animal
For e.g. Snakes venom, scorpion venom, spiders etc.
Mechanical Poisons
For e.g. Powder glass, diamond dust etc.
Neurotic Poisons
Cerebral Poisons
For e.g. Alcohol, Opium, barbiturates, benzodiazepines etc.
Spinal Poison
For e.g. Strychnine
Peripheral
For e.g. Curare
Cardiac Poisons
Asphyxiants
For e.g. CO, CO_2 etc.

(B) **On the basis of their physical state:** Based on physical state, poisons can be grouped into (i) solid poisons, (ii) liquid poisons and (iii) gaseous poisons.

(i) **Solid poisons:** Solid poisons don not get absorbed easily into the blood. These should be dissolved properly in liquid to get absorbed. For example- lead, arsenic, mercury etc.

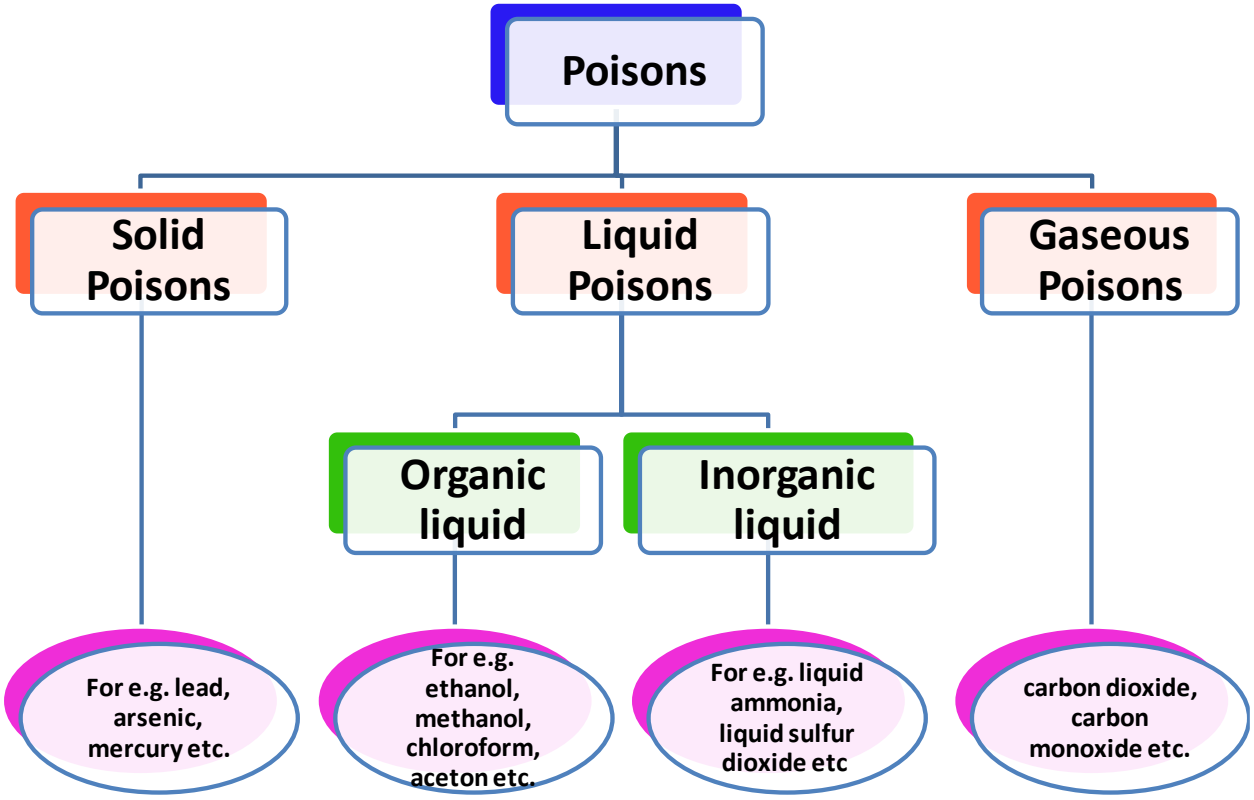
(ii) **Liquid poisons:** Liquid poisons contain both organic and inorganic liquid. Organic liquids are more volatile than inorganic liquids.

Liquid poison can be absorbed when administered orally or by inhalation or through skin. As organic liquids are vaporises and organic vapours are absorbed by lungs such as chloroform, acetone etc. and the organic vapours which are soluble in lipids get easily absorbed through skin for e.g. furfural.

(iii) **Gaseous poisons:** Gaseous poisons are absorbed by inhalation such as carbon dioxide, carbon monoxide etc.

In atmosphere, there are aerosols particles in air and these are either inhaled or deposited on the skin. They causes marked effect on lungs when inhaled during breathing and causes obstruction into the lungs (asbestos) in comparison to those absorbed through skin. Fibres and dust are also the examples of aerosols[6].

[6.] Toxicological Chemistry, LVIV–2009, Universitatis Medici Leopoliensis Sigillum. AD 1784.



(C) **Medicolegal classification of poison:** Based on intention behind the crime, poisons are classified into (i): Homicidal poisons, (ii) Suicidal poisons, (iii) Accidental poisons, (iv) Abortifacient poisons, (v) Stupefying agent/poisons, (vi) Agents used to cause bodily injury (vii) Cattle Poison (viii) Used for malingering.

(i) **Homicidal poisons:** The poisons which are used to kill the other person are known as homicidal poisons such as aconite, abrus precatorius, strychnos nux vomica etc.

(ii) **Suicidal poisons:** Suicidal poisons are those poisons which are used for self killing such as opium, barbiturate, organophosphorus, organochloro compounds.

(iii) **Accidental poisons:** Accidental poisons are those poisons which cause toxicity by accidents or used in mistaken of others**:** Snakes bite, CO, and child takes dhatura's seeds in mistaken of capsicum seeds as it resemble to capsicum seed.

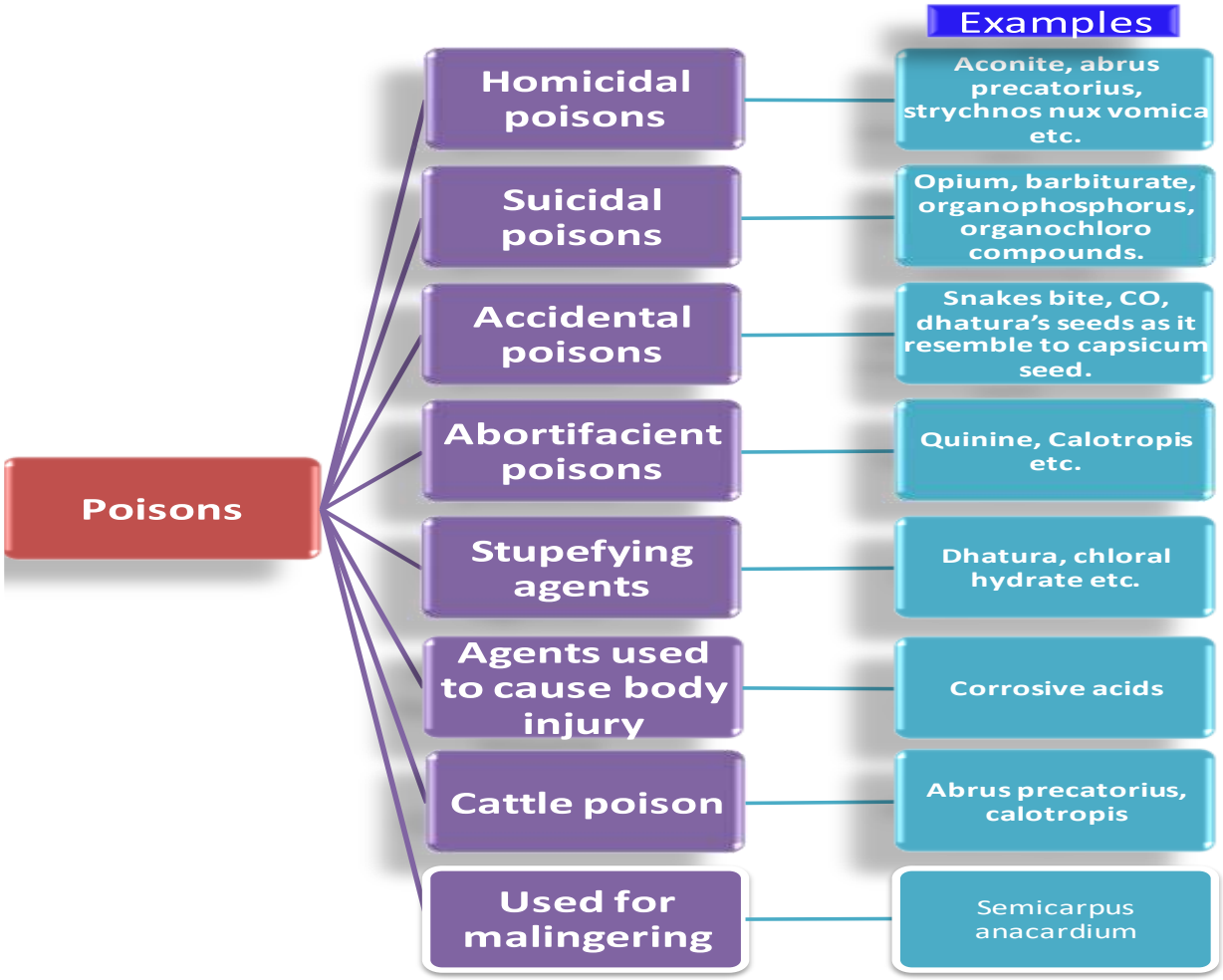
(iv) **Abortifacient poisons:** The poisons winch are used to procure abortion are know as abortifacient poisons for exemples Quinine (alkaloid), Calotropis etc.

(v) **Stupefying agent/poisons:** Stupefying agents are those poisons which are used to stupefy or fool the person for example Dhatura and chloral hydrate are used to rob the stranger or for the commitment of other crimes.

(vi) **Agents used to cause bodily injury:** Usually corrosive acids are used to cause injury on faces and known as vitriol throwing.

(vii) **Cattle Poison:** Agents which are used to kill livestocks are known as cattle poisons. Abrus precatorius, Calotropis are used to kill cattle.

(viii) **Used for malingering:** Some times semicarpus anacardium is used by malinger to escape from duties as these produces to produce an artificial bruise.


Examples
Poisons
Homicidal poisons
Aconite, abrus precatorius, strychnos nux vomica etc.
Suicidal poisons
Opium, barbiturate, organophosphorus, organochloro compounds.
Accidental poisons
Snakes bite, CO, dhatura's seeds as it resemble to capsicum seed.
Abortifacient poisons
Quinine, Calotropis etc.
Stupefying agents
Dhatura, chloral hydrate etc.
Agents used to cause body injury
Corrosive acids
Cattle poison
Abrus precatorius, calotropis
Used for malingering
Semicarpus anacardium

(D) **Toxico-analytical classification:** Poisons can also be classified on the bases of method used for extraction or analysis into (i) Gaseous and volatile substances, (ii) Organic non-volatile substances, (iii) Metallic poisons and (iv) Anion. Therefore, this classification is known as toxico-analytical classification.

(i) **Gaseous and volatile substances:** Poisons which are isolated by distillation or by headspace are categorised into this group. Volatile substances (methanol, ethanol, benzene, toluene, acetone etc.) can be separated from gaseous (ethane, butane etc.) poisons because they can be extracted with alternate methods.

(ii) **Organic non-volatile substances:** Compounds which are isolated by solvent extraction methods include in this group. For example drugs such as opiates and synthetic narcotics, sedatives and hypnotics, stimulants, antidepressants etc and pesticides which include insecticides, fungicides, herbicides, rodenticides, nematocides etc. In this group pesticides can be separated from drugs, though both are organic non-volatile substances which are isolated by solvent extraction method.

(iii) **Metallic poisons:** The substance which are isolated by dry ash method or by wet digestion method constituting this group. The commonest poisons are arsenic, lead, mercury, etc.

(iv) **Anions poisons:** Anions are isolated by dialysis. Most commonly encountered anions in poisoning cases are bromide, cyanide, fluoride, hypochlorite, nitrate, nitrite, phosphate, sulfide, sulfate etc[8].

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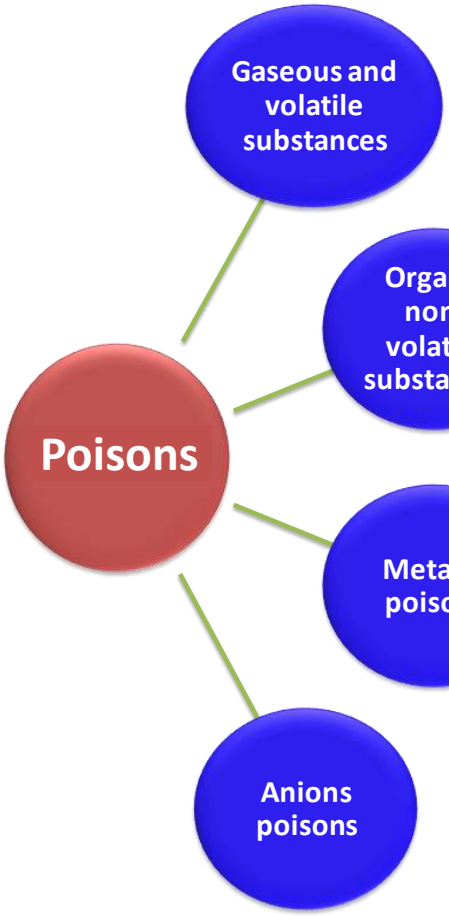
[8] A. C. Moffat, M. D. Osselton, B. Widdop, S. Jickells and A. Negrusz, Clarke's Analytical Forensic Toxicology, Introduction to Forensic Toxicology, Chapter 1, p. 1, 2nd edi., Editor: Adam negrusz, Gail A A Cooper, (Pharmaceutical Press, 2013).



Gaseous poisons: Methanol, ethanol, benzene, toluene, acetone etc.
Volatile substances: ethane, butane etc.

Drugs: Opiates and synthetic narcotics, sedatives and hypnotics, stimulants, antidepressants etc.
Pesticides: Insecticides, fungicides, herbicides, rodenticides, nematocides etc.

Arsenic, lead, mercury, antimony, zinc, copper etc.

Bromide, cyanide, fluoride, hypochlorite, nitrate, nitrite, phosphate, sulfide, sulfate etc.

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Collection and analysis of Non-Biological evidences: glass, soil, paint, fibres and tool marks.
Module Id	

Non biological evidence

Fiber

A fiber is the smallest unit of a textile material that has a length many times greater than its diameter. Fibers can occur naturally as plant and animal fibers, but they can also be man-made. A fiber can be spun with other fibers to form a yarn that can be woven or knitted to form a fabric.

The type and length of fiber used, the type of spinning method, and the type of fabric construction all affect the transfer of fibers and the significance of fiber associations.

Fiber Evidence

Fibers are gathered at a crime scene with tweezers, tape, or a vacuum. They generally come from clothing, drapery, wigs, carpeting, furniture, and blankets. For analysis, they are first determined to be natural, manufactured, or a mix of both.

Fiber Number

The number of fibers on the clothing of a victim identified as matching the clothing of a suspect is important in determining actual contact. The greater the number of fibers, the more likely that contact actually occurred between these individuals

Forensics of Fiber Analysis

Cross transfers of fiber often occur in cases in which there is person-to-person contact. Investigators hope that fiber traceable back to the offender can be found at the crime scene, as well as vice versa. Success in solving crimes often hinge on the ability to narrow the sources for the type of fiber found, as the prosecution did with their probability theory on the fibers

The world produced approximately 80 billion pounds of fabric in 1995, about half of which was cotton. The other approximately 44 billion pounds of fiber were manufactured or synthetic. It could be argued that the large volume of fibers produced reduces the significance of a fiber association discovered in a criminal case.Considering the volume of textiles produced worldwide each year, the number of textiles produced with any one fiber type and color is extremely small.

The likelihood of two or more manufacturers exactly duplicating all of the aspects of the textile is extremely remote

Fiber Evidence

The problem with fiber evidence is that fibers are not unique. Unlike fingerprints or DNA, they cannot pinpoint an offender in any definitive manner. There must be other factors involved, such as evidence that the fibers can corroborate or something unique to the fibers that set them apart.

Microscopic Examination

A compound microscope uses light reflected from the surface of a fiber and magnified through a series of lenses, The comparison microscope (two compound microscopes joined by an optical bridge) is used for more precise identification. The phase-contrast microscope, reveals some of the structure of a fiber.Electron microscopes either pass beams through samples to provide a highly magnified image, or reflect electrons off the sample's surface.

A scanning electron microscope converts the emitted electrons into a photographic image for display. This affords high resolution and depth of focus.

Spectrometer

The spectrometer, which separates light into component wavelengths. Every organic element has a uniqueness to its constituent parts. By passing light through something to produce a spectrum, the analyst can read the resulting lines, called "absorption lines."

That is, the specific wavelengths are characteristic of its component molecules of the substance.

Micro-spectrophotometer

This microscope locates minute traces or shows how light interacts with the material under analysis. Linking this to a computerized spectrophotometer increases the accuracy. The scientist can get both a magnified visual and an infrared pattern at the same time, which increases the number of identifying characteristics of any given material.

Natural Fibers vs Manufactured

Natural fibers come from plants (cotton) or animals (wool). Manufactured fibers are synthetics like rayon, acetate, and polyester, which are made from long chains of molecules called polymers. Many different natural fibers originating from plants and animals are used in the production of fabric. Cotton fibers are the plant fibers most commonly used in textile materials. The type of cotton, fiber length, and degree of twist contributing to the diversity of these fibers.

Other plant fibers :- Flax (linen), ramie, sisal, jute, hemp, kapok, and coir.

The identification of less common plant fibers at a crime scene or on the clothing of a suspect or victim would have increased significance.

Animal Fiber: Wool is the most frequently used in the production of textile materials and the most common wool fibers originate from sheep. Finer woolen fibers are used in the production of clothing coarser fibers are found in carpet. Fiber diameter and degree of scale protrusion of the fibers are other important characteristics.

Other Animal Fibers:- Although sheep's wool is most common, woolen fibers from other animals may also be found. These include camel, alpaca, cashmere, mohair, and others. The identification of less common animal fibers at a crime scene or on the clothing of a suspect or victim would have increased significance.

Man-Made Fibers:- More than half of all fibers used in the production of textile materials are man-made. Some man-made fibers originate from natural materials such as cotton or wood; others originate from synthetic materials. Polyester and nylon fibers are the most commonly encountered man-made fibers, followed by acrylics, rayons, and acetates. There are also many other less common man-made

fibers. The amount of production of a particular man-made fiber and its end use influence the degree of rarity of a given fiber.

The cross section of a man-made fiber can be manufacturer-specific. Some cross sections are more common than others, and some shapes may only be produced for a short period of time. Unusual cross sections encountered through examination can add increased significance to a fiber association. Generally, the analyst gets only a limited number of fibers to work with—sometimes only one. Whatever has been gathered from the crime scene is then compared against fibers from a suspect source, such as a car or home. Fibers are laid side by side for visual inspection through a microscope.

Important Considerations

An is the length of time between the actual physical contact and the collection of clothing items from the suspect or victim. If the victim is immobile, very little fiber loss will take place, whereas the suspect's clothing will lose transferred fibers quickly. The likelihood of finding transferred fibers on the clothing of the suspect a day after the alleged contact may be remote, depending on the subsequent use or handling of that clothing.

Steps of Fiber Analysis

The first step in fiber analysis is to compare color and diameter. Dyes can also be further analyzed with chromatography, which uses solvents to separate the dye's chemical constituents.

Fiber Color

Color influences the value given to a particular fiber identification. Often several dyes are used to give a fiber a desired color. Individual fibers can be colored prior to being spun into yarns. Yarns can be dyed, and fabrics made from them can be dyed. Color can also be applied to the surface of fabric, as found in printed fabrics. How color is applied and absorbed along the length of the fiber are important comparison characteristics. Color-fading and discoloration can also lend increased value to a fiber association.

Microscopy

Fibers should be first examined with a stereomicroscope. Physical features such as crimp, length, color, relative diameter, luster, apparent cross section, damage,

and adhering debris should be noted. Fibers are then tentatively classified into broad groups such as synthetic, natural, or inorganic. If the sample contains yarns, threads, or sections of fabric, construction should be recorded

Illumination and Magnification

Comparisons should be made under the same illumination conditions at the same magnifications. For comparison microscopes, this requires color balancing the light sources. This is best achieved with two fibers or fiber samples from the same source mounted on two microscope slides, which are then compared. A balanced neutral background color is optimal.

Side-by-Side Comparisons.

If all of the characteristics are the same under the stereoscope, the next step is to examine the fibers with a comparison microscope. This side-by-side and point-by-point examination is the best technique to discriminate between fibers, especially those that appear to be similar. The physical characteristics of the must be compared visually with the comparison microscope to determine if they are the same in the known and questioned samples. Photography is recommended to capture the salient features for later demonstration.

Glass

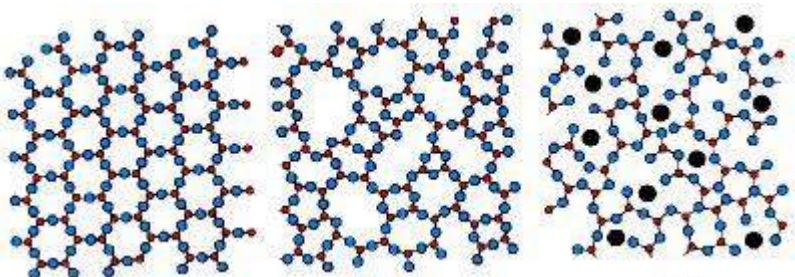
What is Glass?

It is a uniform amorphous solid. Glass have no specific melting point. It Softens over a temperature range. Because of this, glass breaks in a variety of fracture patterns.

What's in Glass?

Fusion of sand (SiO_2), soda (Na_2CO_3) & lime (CaO) produces a transparent solid when cooled called glass. It is a 3D network of atoms which lacks the repeated, orderly arrangement typical of crystalline materials.

Soil



Physical properties of glass: Glass is hard, elastic, brittle, non-conductor of electricity, density, refractive index, etc.

Chemical properties of glass: it is resistant to all but fluorine and very strong bases.

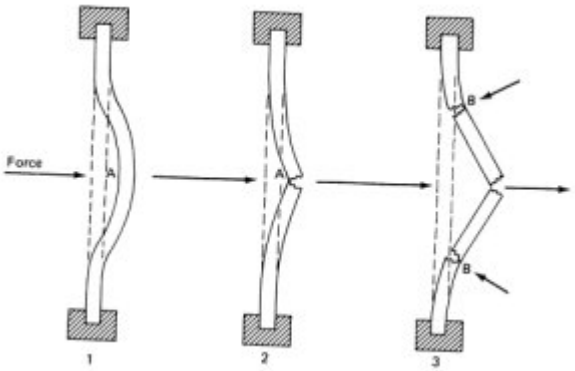
Forensic Examination of Glass

The primary uses for glass are in windows, containers, light bulbs and eyewear.

a) Borosilicate Glass (pyrex): 5% borax ($Na_2B_4O_7$) is added to resist breaking when heated or cooled.
b) Colored Glass: metal oxides or colloidal iron (Fe) & sulfur (S) are added to change its color.
c) Lead glass: Pb increases refractive index & density
d) Flat glass: made by a "float glass process"; molten glass is floated on a pool of tin while cooling. Commonly found in doors and windows.
e) Laminated glass: used in windshields, two sheets of glass with plastic between them.
f) Tempered safety glass: used in car side windows and designed to break into tiny pieces; potassium (K) replaces sodium (Na) on the surface.

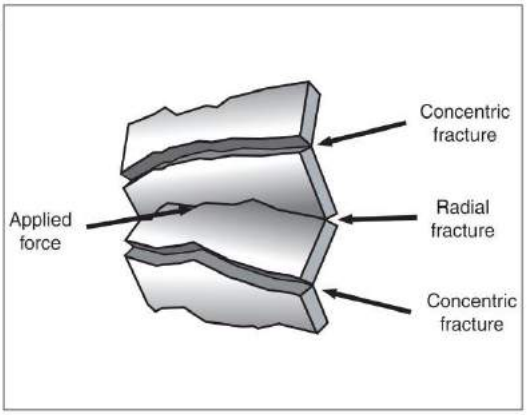
How Do Glass Windows Break?

Each force causes a deformation that may leave a visible mark or fracture the glass. This can be used to determine the direction and amount of force. Glass acts initially as an elastic surface and bends away when a force is applied. When the force increases beyond its tensile strength, it cracks.



Radial cracks form first and are propagated in short segments on the side opposite the force.

Concentric cracks come later from continued pressure on the same side as the force applied.



Edges of broken pieces of glass will show rib ("stress") marks. In a radial crack, the rib marks are perpendicular to unloaded side and parallel to loaded side. The arrow shows the side that received the impact.

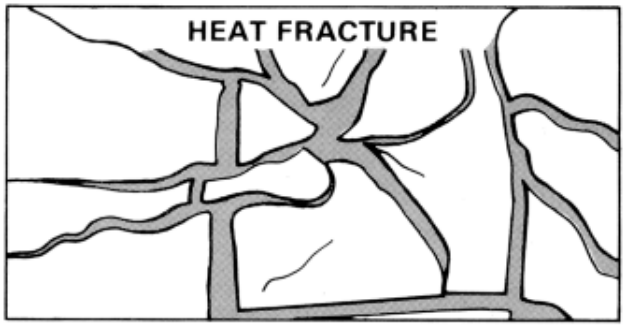
3R rule:

- Radial cracks give rib marks that make
- Right angles on the
- Reverse side from where the force was applied

Exceptions to the Three R Rule

a) Tempered glass "dices" without forming ridges, Very small windows held tightly in frame can't bend or bulge appreciably

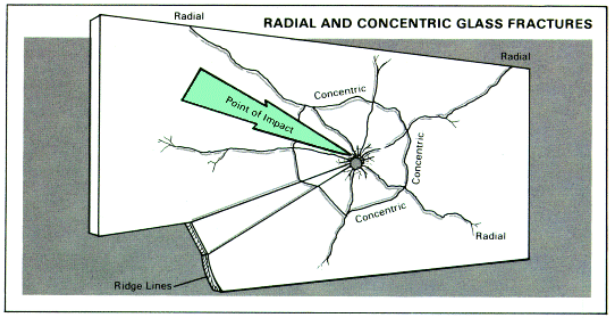
b) Windows broken by heat or explosion no “point of impact” curved, smooth edges at break point



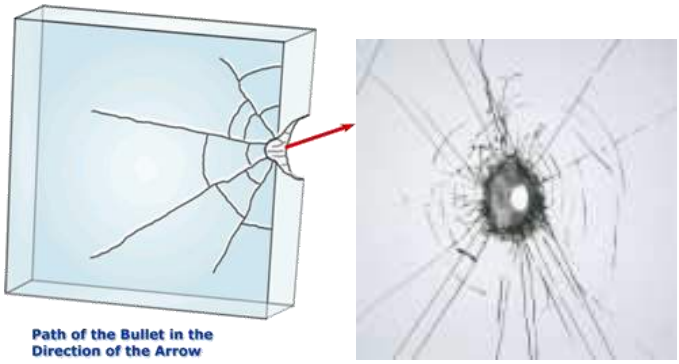
Types of Fractures by Projectiles

Bullets are a projectile force (load) that can pass through glass. Load side is the entrance side; unloaded side is the exit side. Low-speed projectiles: rib marks may indicate where breaking force was applied.

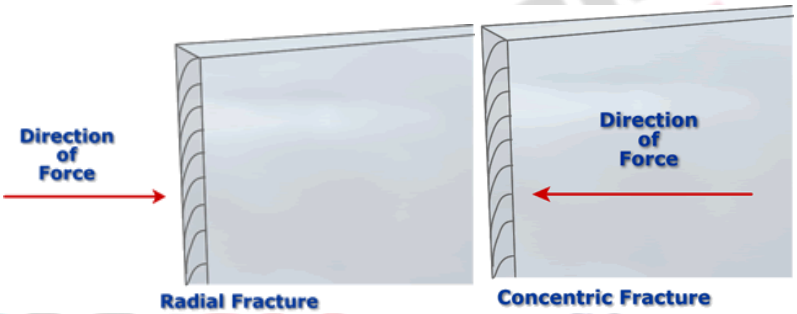
As the bullet’s velocity increases, the central hole becomes smaller, cracking patterns become simpler, and the exit hole becomes wider than the entrance hole.



Which side was the bullet fired from? Exit (unloaded) side is wider than entry (load) side.



Stress lines on the glass edge of radial cracks form a right angle on the reverse side from the force. Stress lines on the glass edge of concentric cracks form a right angle on the same side as the force.



Which Bullet Hole Was First?

The sequence of impacts can be determined since crack propagation is stopped by earlier cracks.

Examiners can fit together two or more pieces of glass that were broken from the same object. Because glass is amorphous, no two glass objects will break the same way.

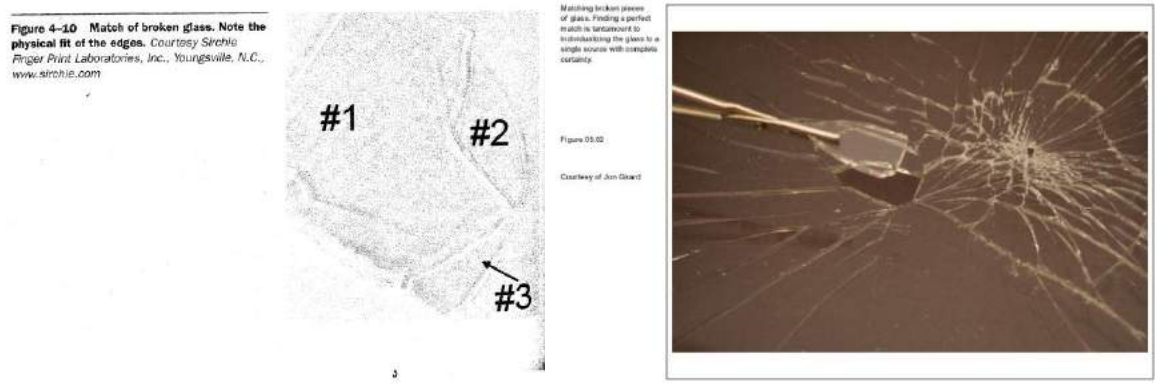


Figure 4–10 Match of broken glass. Note the physical fit of the edges. *Courtesy Sirchie Finger Print Laboratories, Inc., Youngsville, N.C., www.sirchie.com*

Glass Transfer Evidence

- When glass objects are broken, glass flies backward from all parts of the object where cracks appear not just from point of impact.

This creates a shower of minute glass particles and a transfer of evidence. Glass fragment comparison depends finding and measuring properties that will associate one glass fragment with another while eliminating other sources.

Collection of Glass Samples

a) The glass fragments should be packaged in boxes to avoid further breakage.

b) If evidence is to be examined for glass fragments, it should be taken whole and each item individually wrapped in paper and boxed.

c) If even the remotest possibility exists that glass fragments may be pieced together, every effort must be made to collect all glass fragments.

d) Submit glass evidence along with a representative sample of each type of glass from the crime scene.

Optical Properties of Glass

Make side-by-side comparisons using similar-sized fragments. Place samples on a white surface using natural light. Use both fluorescent and incandescent light to

determine the glass's color. Visual color analysis is very subjective. Dyes and pigments can be almost impossible to extract.

Non- optical Physical Properties of Glass

Surface striations and markings

  - Rollers leave parallel ream marks on sheet glass
  - Markings may indicate the glass's orientation when pieces are missing
  - Surface scratches, etchings, and other markings may also be used to individualize evidence
- Other Properties
  - Hardness=5-6 on Mohs scale; use a scratch test.
  - Determinations of curvature can distinguish flat glass from container, decorative, or ophthalmic.

Glass Density

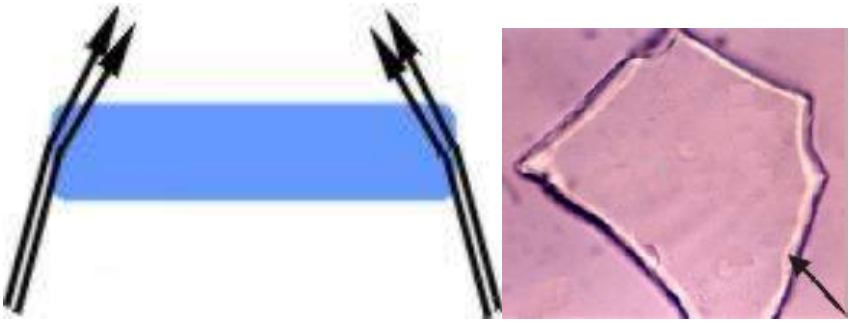
- Density can be measured by directly determining mass and volume (usually by displacement), by comparison by flotation and by comparison using a density gradient column
- Density gradient column method:
  - Fragments of different densities settle at different levels in the column of liquid of varying density.
  - Technique is not accurate for fragments that are cracked or contain an inclusion.

Refractive Index by Immersion

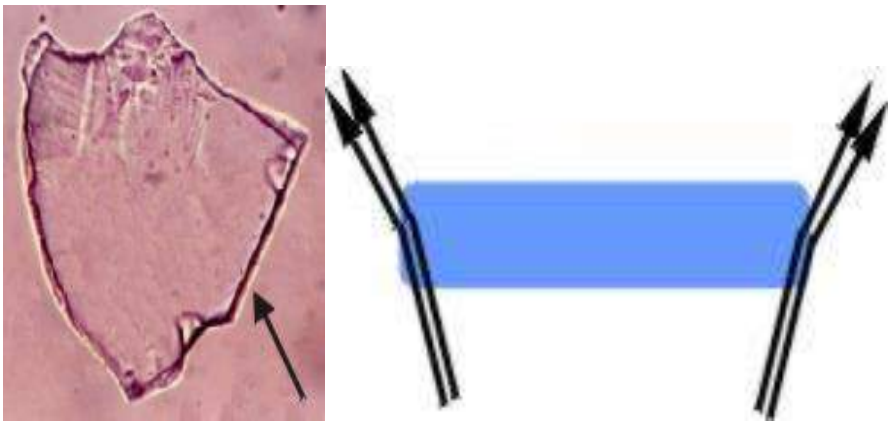
Immersing a glass particle in a liquid medium (silicone oil) whose refractive index can varied with temperature until it is equal to that of the glass particle. At this point, known as the match point, the Becke line disappears and minimum contrast between liquid and particle is observed: RI oil = RI glass. The Becke line is a bright halo near the boarder of a particle that is immersed in a liquid of a different refractive index.

Becke Lines

Glass has higher refractive index-note white line inside.



- Glass has lower refractive index-note white line outside



Chemical Analysis of Glass

- Fluorescence
  - Under UV radiation, many glasses exhibit fluorescence (glow)
  - Caused by heavy metals (including tin) from "float" process or organic coatings
  - Scanning Electron Microscopy Energy Dispersive X-ray Analysis
  - Can determine many elements simultaneously
  - Surfaces of samples (>50 mg) can be analyzed

Tool Marks

Tool marks are made when a harder object comes in contact with a softer object, leaving marks on it.A tool mark is considered to be any impression, cut, scratch, gouge, or abrasion caused by a tool coming into contact with another object. Tools often used in burglaries may leave a mark.

For example, if you attempted to pry open a locked window with a screwdriver, the screwdriver would leave a tool mark on the window and windowsill. Most often, tool marks are encountered at burglary scenes that involve forcible entry into a building or safe.

Typically, an indented impression is left on the frame of a door or window as a result of the prying action of a screwdriver or crowbar.

One of the first things an investigator looks for at a suspect's home is the suspect's toolbox. Any tools in the commission o f a crime leave unique scratch marks behind.

These striation marks can be used to match a tool to an object it came into contact with at the crime scene. A careful examination of these impressions can reveal important class characteristics. That is, the size and shape of the tool. However, they rarely reveal any significant individual characteristics that could permit the examiner to individualize the mark to a single tool. Such characteristics, when they do exist, usually take the form of discernible random nicks and breaks that the tool has acquired through wear and use.

Microscopic Irregularities

Just as the machined surfaces of a firearm are impressed with random striations during its manufacture, the edges of a pry bar, chisel, screwdriver, knife, and cutting tool will likewise display a series of microscopic irregularities having the appearance of ridges and valleys.

The Machining Process

Such markings are left as a result of the machining processes used to cut and finish tools.

These markings are called striation marks. The shape and pattern of such minute imperfections are further modified by damage and wear during the life of the tool. When a screwdriver is first made, the microscopic imperfections in the blade make it unique. As it is used, more imperfections are added and the blade becomes more unique.

Imperfections Cause Individuality

Considering the unending variety of patterns that the hills and valleys can assume, it is highly unlikely that any two tools will be identical. Hence, it is the presence of these minute imperfections that imparts individuality to each tool.

One of the major problems associated with tool mark comparisons is the difficulty in duplicating in the lab the tool mark left at the crime scene.

Striations

If the edge of a tool is scraped against a softer surface, it may cut a series of striated lines that reflect that pattern of the tool's edge. Markings left in this manner are compared in the lab through a comparison microscope with test tool marks made from the suspect tool.

Positive Comparisons

Once at the crime lab, a cast is made of the scratch marks left on the window lock from the forced entry. The result can be a positive comparison, and hence a definitive association of the tool with the evidence mark, when a sufficient quantity of striations match between the evidence and test markings.

Test Marks

A thorough comparison requires the preparation of a series of test marks obtained by applying the suspect tool at various angles and pressures to a soft metal surface (lead is commonly used). The cast and the lead brick with the scrapings are placed under a comparison microscope to see if the striation marks match. This approach gives the examiner ample opportunity to duplicate many of the details of the original evidence markings. Bring the entire object to the crime lab. Whenever practical, the entire object or part of the object bearing a tool mark should be submitted to the crime lab for examination.

When removal of the tool mark is impractical, the only recourse left, is to photograph the marked area to scale and make a cast of the mark.

Photograph the mark.

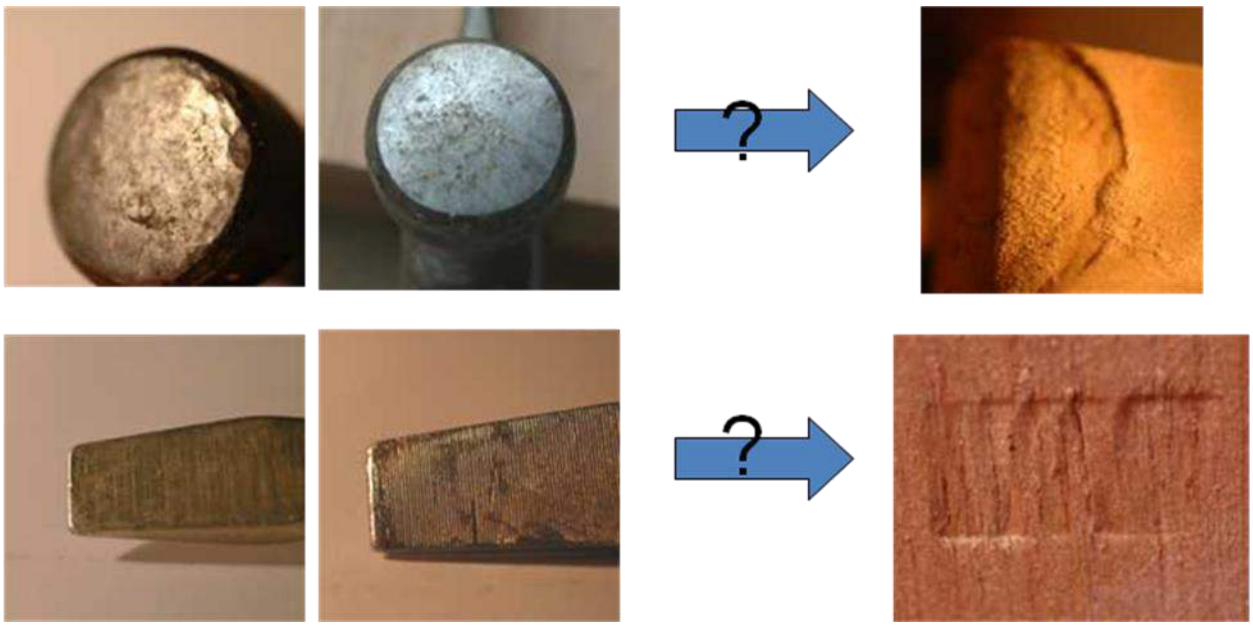
However, even under the most optimum conditions, the clarity of many of the tool mark's minute details will be lost or obscured in a photograph or cast.

Of course, this will reduce the possibility that the criminalist could individualize the mark to a single tool.

Use liquid silicone or dental stone for casting.

Under these circumstances, liquid silicone casting material or dental plaster has been found to be the most satisfactory for reproducing most of the fine details of the mark.

Matching Toolmarks



Photography and casting are important to match tool with mark.

Soil

What Is Soil?

Mixture of organic and inorganic material. It may range from 100% inorganic (sand) to nearly 100% organic (peat). Inorganic part is minerals. Organic part is decayed plant and animal material and is sometimes called *humas*

Forensic Significance of Soil

Soil is class evidence - cannot be individualized to a particular location. There is no classification system for soils. Soils can be easily transported. Soils within a few meters horizontally or vertically differ.

Forensic Soil Analysis is the use of soil sciences and other disciplines to aid in criminal investigation. Soils are like fingerprints because every type of soil that exists has unique properties that act as identification markers. This means that the origin of the soil sample can be identified. For example, clay embedded in the sneaker of a criminal can be traced back to a specific clay type found along a lake where a murder victim was discovered. The majority of soil cases involves footprints or tire marks that have been left in the soil.

The unique properties of soil are as follows:

Sediment– the original solid particles that were weathered and transported. This could be in the form of a grain of rock that breaks off of the larger parent material (larger version of rock). Soils can develop on these sediments due to physical and chemical alteration.

Color– indicates its history as well as the compounds present in the soil. For example, white or gray soil could mean that the soil contains lime or has been leeched((a chemical, a metal, etc.) from a substance by the action of a liquid passing through the substance. Gray soil can also mean that the organic material or moisture is present, black soil suggests the same. Soil that is red,brown or yellow generally suggests that there is iron present.

Structure-indicates whether a soil is composed of a single grain particle or not. This is determined by the presence of peds (clumps). These peds are formed due to cementing agents such as calcium carbonate attracting the soil particles so that they adhere to each other to form either bulky peds which are small conglomerates (masses) or platy peds which are flat and sheet like.

Soil samples can be collected in different ways depending on where the sample is being collected from. If samples are being collected indoors or from a vehicle vacuuming is generally used. If the sample is outdoors it's collected by placing a teaspoon of soil into a plastic vial. When found on a tool, it is wrapped in plastic and then sent to the lab for testing. Collecting soil samples off of a body isn't any harder than collecting a sample from anywhere else but it takes more work and care so that the evidence doesn't get contaminated. When collecting samples from a body, samples should be taken at regular intervals and a different spoon should be used each time.

Once the soil samples are collected they are sent to the laboratory. At the laboratory samples should be separated by samples from the victim and samples pertaining to the suspect. Also, each sample set should get its own examiner. This is to avoid contamination; if possible the samples should be kept in different rooms. To examine the samples the examiner will first want to use microscopic analysis to perform testing on the mineral content. Another test that can be done to help try to identify the origin of the soil is a density test. The density test is called the density gradient tube. This test consists of adding liquid to two glass tubes. The

liquid in both tubes is the same, but the rations are different. This represents two different densities. The soil sample is added to both liquid samples. After the soil samples become suspended in the liquid the separation of the bands can then be analyzed to reveal the profile of the soil. Heat tests can also be used to test the soils reaction and electron microscopes can be used to examine the structure of the minerals in the soil. During examination, an examiner might find that some soil samples may contain biological evidence such as saliva, semen or blood. If biological evidence is found in the sample the whole soil sample should be sent to the laboratory for testing.

Paint

One of the most commonly encountered types of physical evidence, most frequently in hit-and-run and burglary cases. Usually the forensic scientist will be asked to compare two or more paints for the purpose of determining common origin.

The paint from an automobile can be used to determine the color, make, and model of a car.

Paint is composed of pigments (to give color and hiding quality) and a binder which provides the support medium for the pigment and other additives. The binder is usually a polymer.

Automotive paint – there are four basic coatings for auto paint.

a. The ELECTROCOAT PRIMER is the first layer. It is electroplated onto the steel body to provide corrosion resistance. Usually grey or black in color.

b. The PRIMER SURFACER is applied over the electrocoat primer. Its function is to smooth out and hide seams or imperfections.

c. The BASECOAT is the layer that provides the color and appearance of the finish. Mica pigments, aluminum flakes, and other materials are added to give paint an individual and unique appearance.

d. The CLEARCOAT has no color and is used to provide gloss and add durability.

The microscope has traditionally been and remains the most important instrument for locating and comparing paint specimens. Color imparts paint with its most distinctive forensic characteristics. The importance of layer structure for evaluating the evidential significance of paint is very important. When paint specimens posses colored layers that match with respect to number and sequence of colors a common origin can is probable.

The diverse chemical composition of paint can provide for additional points of comparison between specimens. A thorough comparison of paint must include a chemical analysis of either the paint's pigment, binder, or both.

Pyrolysis gas chromatography is a valuable and accepted technique for distinguishing most paint formulations. In this process paint chips as small as 20 micrograms are decomposed by heat into numerous gas products. These products are sent through a gas chromatograph. What emerges and is recorded are the separated decomposition products of the polymer used in the paint.

It is the pattern of this chromatogen or "pyrogram" that distinguishes one polymer from another. What results is a pyrogram that is sufficiently detailed enough to reflect the chemical make-up of the binder.

Infrared spectrophotometry is another analytical technique used to provide information about the binder composition of paint. Binders will selectively absorb infrared radiation to yield a spectrum that is highly characteristic of a paint specimen.

The elements that comprise the inorganic pigments of paint can be identified by either emission spectroscopy, neutron activation analysis, X-ray diffraction, and X-ray spectroscopy. The emission spectrograph can simultaneously detect 15 to 20 elements in most automobile paint.

Crime labs are often asked to identify the make and model of a car from a very small amount of paint left behind at a crime scene.

Color charts for automobile finishes are available from paint manufacturers.

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Paper : **Forensic Science and Forensic Medicine**

Module : **Finger Prints: Definition, general characteristics: Patterns, delta, core, ridge count, ridge trace. Individual ridge characteristics**

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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Finger Prints: Definition, General Characteristics: Patterns, Delta, Core, Ridge count, Ridge Trace; Individual Characteristics.
Module Id	CRIMINOLOGY/FSFM/XVIII
Objectives	Learning Outcome: • To make the learners understand the basics of fingerprint science. • To inform learners regarding the brief history of the fingerprint science. • To acquaint learners with the identifying characteristics of fingerprints.
Prerequisites	General understanding of the fingerprint science and its importance in forensic science.
Key words	Fingerprints, core, delta, ridge count, ridge trace, individual characteristics.

1. Introduction:

Investigation of a crime, primarily mean to identify the person responsible for it, and fingerprints provides a scientific evidence which not only identifies that individual, but also excludes him from the rest of the world's population.

In a criminal trial, evidence has to be the proof beyond reasonable doubt and fingerprints provides a scientific, physical evidence which is accepted universally. The fundamental principles of the fingerprint science – firstly, the ridges are formed before birth and does not change until death, when decomposition occurs and secondly, that the two fingerprints are identical only and if only when they are produced by the same finger of the same individual.

Over the time, fingerprints have become the most well acclaimed panacea for personal identification and therefore an important branch of forensic science. Fingerprint evidence is the most assenting investigate means of identifying individuals due to the fact that every fingerprint is unsurpassed.

Sir Francis Galton, published his book "fingerprints" in 1892, establishing the individuality and permanence of fingerprints. He was able to scientifically prove what Herschel and Faulds suspected – fingerprints do not change over the course of an individual's lifetime, and that no two fingerprints are exactly the same. According to his calculations, the odds of two individual fingerprints being the same were 1 in 64 billion.

Figure 1.1 - Herschel's fingerprints recorded over a period of 57 years.

(Source: http://shawmst.org/biology/activity/fingerprinting)

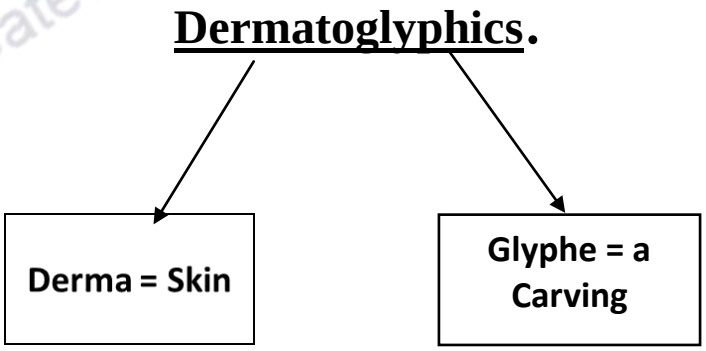
Galton identifies the characteristics by which fingerprints can be identified, these same characteristics (minutia) are basically still in use today, and are often referred to as Galton's Details.

The present module discusses the fingerprint science, a brief introduction, its biological origin, deals with the brief historical background, and explains fingerprints as an important aid in identification and individualization. Delineates the forensic importance of fingerprint evidence. Explains the various general and individual characteristics of fingerprints.

2. Fingerprints – Definition and its principles:

The skin covering the anterior surface (palm) of human hand and plantar surface (sole) of the human foot is different in texture and appearance than the one which covers the rest of the human body. The skin on the palmar and plantar surfaces is continuously wrinkled with narrow minute ridges (also known as frictional ridges) and is also completely free from hair and oil glands. However, there is a profusion of sweat glands and those are relatively large in size.

The study of the skin patterning on fingers, palm, soles and toes is termed as dermatoglyphics.



2.1 Definition of Fingerprints:

A study of ridge patterning is known as fingerprints, which is a reproduction of the friction ridges of the finger on a surface of contact.

In other words, a fingerprint is an impression of the friction ridges of all or any part of the finger. A friction ridge is a raised portion of the epidermis layer on the skin of palmar: palm and fingers or plantar: sole and toes, consisting of one or more connected ridge units on skin. These ridges are also known as dermal ridges or dermal papillae.

Fingerprints may be deposited in natural secretions from the exocrine glands present in the friction ridge skin (secretions consisting primarily of water) or they may be made by ink or other contaminants transferred from the peaks of friction skin ridges to a relatively smooth surface. The term fingerprint normally refers to impressions transferred from the pad on the last joint of the fingers and thumbs.

The science of fingerprint identification stands out among all other forensic science branches for the following reasons:

a) The fingerprint science has served almost all governments worldwide for nearly 120 years to provide accurate identification of criminals. No two fingerprints have yet been found alike in billions of fingerprints. Fingerprints are the very basis for criminal history foundation at every law enforcement agency.

b) It remains the most commonly used forensic evidence around the globe. In most jurisdictions fingerprints examination cases out number all other forensic examination casework combined.

c) It continues to expand as the premier method for personal identification, with tens of thousands of persons added to fingerprint records.

d) Fingerprints obtained from crime scenes lead to more suspects and generate more evidence in court than all other forensic techniques combined.

2.2 Properties of Fingerprints:

a) They are unique to an individual.
b) They are persistent and does not change with age.
c) They cannot be destroyed, even if damaged. The parameters considered in case of identification are so wide that it's nearly impossible to destroy all the details of one's fingerprint.
d) They can be lost only with the loss of limb/phalanges but still since all ten phalanges prints are recorded, in case of a criminal, so impersonation is not possible.

2.3 Fundamental Principles of Fingerprints:

Like any other science, fingerprint science lays its basis in its three fundamental principles:

a) Principle of individuality
b) Principle of persistency
c) Principle of variety.

2.3.1 Principle of Individuality:

It states that "No two fingers have yet been observed to possess identical ridge characteristics".

Explanation:

- According to Galton's calculation, the odds of two individual fingerprints being the same are 1 in 64 billion.
- Also, the general shape and pattern can be same but ridge characteristics – identity, number, relative position – imparts individuality to fingerprints.
- Fingerprints remain constant for the life and cannot be altered except by the destruction of skin.
- Fingerprints are present from birth both on epidermis and dermis layers of skin.
- Fingerprints form patterns that are absolutely individual and classifiable.

- Fingerprints are easily collectible.

2.3.2 Principle of Persistency:

It states that "A fingerprint will remain unchanged during an individual's lifetime".

Explanation:

- In the cross-section of the skin the boundary of cells is observed separating the epidermis and dermis (layers of skin). It is the shape of this boundary, made up of dermal papillae, that determines the form and pattern of the ridge on the surface of the skin. Once the dermal papillae develop in the human foetus during embryonic state, the ridge pattern will remain unchanged throughout the lifespan of an individual except for enlargement during growth of the limbs, i.e., the hands and feet.
- If an injury reaches deeply enough into the skin and damages the dermal papillae, a permanent scar will form. For this to happen, such a wound would have to penetrate up to 2mm beneath the skin's surface.
- The presence of permanent scars would serve as a new and additional characteristic for the purpose of identification.

2.3.3 Principle of Variety:

It states that "Fingerprints have general ridge patterns that permit them to be systematically classified".

Explanation:

- Fingerprints have general ridge patterns that permit them to be systematically classified.
- All fingerprints are divided into three major classes: Loops, Arches and Whorls.
- In general population, the percentage frequency of these patterns is
    - Loops - 60 – 65%
    - Whorls - 30 – 35%
    - Arches - 5 – 10%

- Based on these grounds, the fingerprints became a highly effective tool in establishing the identity of any individual.

3. Biological Origin of Fingerprints:

Fingerprints are formed during the second trimester of foetal development and when a child is born the fingerprints are already present on his palms, fingers, soles and toes. Once formed the fingerprints remain unaltered throughout the lifespan of an individual (except for the increase in size due to growth of the human body) until the skin decomposes or degenerates after death.

Fingerprints are the impressions produced by the papillary ridges present at the apex of the top phalanges (tips of the fingers) of one's hand. The ridges are the raised portions on the palm skin bearing numerous amounts of sweat glands. The arrangement of papillary ridges of every individual is unique to themselves and are permanent throughout in life. Their ability of being highly individual and permanent has made them an indispensable mode of identification for more than 100 years and still counting.

4. Historical Account:

The study of fingerprints dates back to the earlier civilizations. The exact person hence cannot be named who first time used the fingerprints for identification purpose. But the idea that fingerprints could be used for personal identification was first used by Sir William Herschel, district magistrate of Hooghly district, Bengal, 1858.

4.1 Ancient History:

- Earthenware estimated to be 6000yrs old, North-west China: has clear friction ridge impressions

- Thousands of years before BC, fingerprints were found on pottery as a mark and seal of the maker.
- Pre-historic cave wall etching found in Nova Scotia, Canda, showing a hand with ridge patterns sketched on it.
- Fingerprints were used as seals during Tong dynasty, China.
- The deeds were signed by means of fingerprints during Sung period.
- Persian physician Rashid-al-Din Hamadani or "Rashideddin" in his collections called Jami-al-Tawarikh, commented on the Chinese practice of identifying people through fingerprints.
- Fingerprints along with palm prints known as "PANJA" were used for identification. In India, fingerprints were embossed on clay tablets and seals during Indus Valley Civilization.
- Slabs of clay were found in King Tut-en-khamen's tomb in Egypt.
- In ancient China, thumb prints were found on clay seals.

4.2 From 17th Century to 20th Century:

- **Grew (1684):**
  - in his paper stated " Innumerable little ridges of equal size on the ends of the first joints of the fingers".
  - also mentioned about sweat pores, epidermal ridges and their arrangements.
  - Referred sweat pores as " Little Fountain".

- **Bidloo (1685):**
  - in his book human anatomy incorporated a diagram of friction ridges and pore structure but failed to mention about the individuality of the friction ridges.

- **Malpighi (1685 - 86):**
  - Referred about the function, form, and structure of the friction skin as a touchable organ

- Mentioned about spirals and loops in fingerprints but no reference to its importance
- 1.8 mm thick layer of the skin was named after him as "Malpighi layer".

- **Thomas Bewick (1753 - 1828):**
  - Used fingerprints in the form of stamp.

- **Purkinje (1823):**
  - Classified fingerprints into nine principal configuration groups and assigned name to each one of them. But he never mentioned anything regarding individuality of the ridge structure and their use in personal identification.

- **William Herschel (1858):**
  - Chief Magistrate of the Hooghly district, Jungipoor, India – First Person to use fingerprints on native contracts.

- **Henry Faulds (1880):**
  - Examined fingerprints in depth
  - Mentioned that fingerprints can be classified and also the ridge details are distinctive
  - Also, maintained that fingerprints are useful in medico-legal studies as the photographs of people may change but friction ridges never change
  - Also emphasized apprehending criminals by locating fingerprints at crime scene.

- **Kollmann (1883):**
  - First researcher who made a mention regarding formation of friction ridges in the embryos and the topographical physical stressors that may have been part of their growth.

- He identified the presence and location of volar pads on human hand and foot.

- **Thomas Taylor (1887):**
  - Made an effort to identify criminals, especially murderer, by comparing the marks of the hand left upon any object wit impressions in wax taken from the hands of suspected persons.

- **Sir Francis Galton (1822 – 1911):**
  - Published book entitled "Finger Prints" (1892), which included the first classification system for fingerprints
  - Scientifically proved that fingerprints do not change over the course of an individual's lifetime, and no two fingerprints are exactly the same.
  - According to his calculations, the odds of two individual fingerprints being the same were 1 in 64 billion.
  - Responsible for identifying the ridge characteristics (minutia) that are responsible for establishing the supremacy of fingerprints over Bertillon's anthropometric method of identification in 1901
  - Established it as the primary means of personal identification.

- **June Vucetich (1855 - 1925):**
  - In Argentina, set up his own equipment for taking criminal's prints.
  - In 1891, he independently worked out a fingerprint classification system and was filing criminal's fingerprints using his new system, which was practically used in solving the first ever murder case "The Rojas Murders" in 1892.
  - By 1896, Argentina, become the first country in the world to abolish anthropometry and file criminal records solely by fingerprint classification.

- **Sir Edward Henry (1850 – 1931):**
    - In 1891 added taking of the left thumb impression to each anthropometric file card.
    - In 1894 he instructed that all the ten fingers of each prisoner be printed and added to the anthropometric cards and assigned two Bengali officers, KHAN BHADUR AZIZUL HAQUE and RAI BHADUR HEM CHANDRA BOSE, to study the classification problem.
    - Eventually succeeded in setting up a classification system with 1024 primary positions and secondary breakdowns in each.
    - In 1897 fingerprints were adopted as the official method for the identification of criminals in British India.
    - In December, 1900, the Belper Committee, recommended that the fingerprints of criminals be taken and classified by the Indian System.
    - These recommendations were implemented in 1901 and the Indian system eventually replaced anthropometry.
    - Subsequently systems of Henry and Vucetich form the basis of most of the ten digit classification systems used at present.

- **Dr. Edmond Locard (1912):**
    - Established the Science of Poroscopy.

- **Salil K. Chatterjee (1962):**
    - Coined the term Edgeoscopy – to use ridge edges in concert with other friction ridge formations to establish individuality.
    - Observed different shapes on the friction ridge edges that tended to reappear frequently and named them.
    - Having an understanding of the relevance of edge shapes enhances comparison and improve the chances of establishing individuality.

5. Fingerprints – An Aid in Identification and Individualization.

Personal identification through fingerprint is regarded as the greatest contribution to law enforcement. The science of fingerprints provides unique service in the administration of justice and also in other areas where positive identification is of paramount importance. Identification is the comparing of the fingerprints of a suspect with the chance fingerprints obtained from a scene of crime to determine whether an identification can be made. An identification can be made by comparing a very small portion of ridges left at a scene of crime with those of a suspect and classification is not required for this comparison.

Fingerprint identification is the process of comparing questioned and suspected fingerprints, to check whether or not they are from the same finger of the same hand of the same individual. Identification otherwise referred to as individualization occurs when an expert or a computer based software determines that two fingerprint impressions are identified i.e., they are from the same finger of the same hand of the same individual.

Fingerprints have been in use as a mark of individual way back since they were legally adopted and possessed a proper classification. Fingerprints were used on the pottery to indicate the maker and the brand of the pottery.

With the development of the methods to identify the individual/suspect on the basis of the portrait parley, the method of individualization using fingerprints is now being used by many judicial organization all over the globe.

There are various reasons put forward for using the fingerprints for identification and individualization. Some of them are:

1. The fingerprint patterns are unique – no two individuals (including identical monozygotic twins) have not yet till date being reported to possess exactly same fingerprints.

2. Whatever surface /object we touch we leave impressions on everything we touch with pressure.

3. The fingerprints left can be visible or latent (invisible). Visible when the fingers are coated with dirt, ink, colored substances, etc. Latent (invisible), when they are made by sweat. In other words, finger impressions or fingerprints are always present.

4. Superficial injuries does not change the fingerprints and even when the new skin grows the same pattern/design appears as it was before.

5. Fingerprints has served governments all over the globe during the past 100 years providing accurate identification of criminals. They are the very basis for recording criminal history at every police agency all over the globe.

6. Fingerprints are the most commonly used forensic evidence out numbering the other evidences.

7. Fingerprints has also out performed DNA and all other human identification systems to identify more criminals.

5.1 Importance in Criminal Justice System:

Personal Identification through fingerprint is regarded as the greatest contribution to law enforcement. The science of fingerprints provides unique service in the administration of justice and also in other areas where positive identification is of paramount importance. Fingerprint science can help in:

- Identification of criminals where fingerprints are found at scene of crime
- Identification of fugitives
- Assistance to Prosecutors in presenting their cases in the light of defendant's previous records
- Exchange of criminal identifying information with identification bureaus of foreign countries in cases of mutual interest
- Assistance to probation or parole officers and to parole boards for their enlightenment in decision making
- Imposition of more equitable sentences by the courts
- Identification of persons and maintenance of identity records (service or criminal)
- Identification of unknown deceased persons
- Recognition by the government of honoured dead
- Identification of persons suffering from amnesia
- Identification of disaster victims
- Prevention of hospital mistakes in the identification of infants
- Identification of missing persons
- Identification of licensing procedures for automobiles, firearm, aircraft and other equipment.
- Identification of unconscious persons
- Problems of mistaken identity
- Establishing correct identity in cases of kidnapping
- Detection of bank forgeries.

6. General Characteristics of Fingerprints.

6.1 Introduction

The identification of fingerprints rely on matching their general and individual characteristics. The general characteristics are those characteristics based on which the fingerprints can be grouped into separate groups or in other words they are those characteristics which are common to a group of population. The various general characteristics are:

a. Delta
b. Core
c. Pattern types.
d. Ridge Counting
e. Ridge Tracing

6.2 Delta

Delta corresponds to the outer terminus of the fingerprint pattern or the outer boundary of the pattern. As the name suggest Delta is a triangular shaped structure which marks the boundary of the pattern area. For identification purposes, the Delta can be easily located in a fingerprint pattern as it resembles a 'horizontally lying "Y" shaped structure made by the ridges".

By definition, a Delta is a triangular plot which may be formed either by the bifurcation of a single ridge or by the divergence of two parallel ridges.

The delta is that point on a ridge at or in front of and nearest the center of the divergence of the ridges. It may be: (Figure 1.2)

a. A bifurcation
b. A dot
c. An abrupt ending ridge
d. A short ridge

e. A point on the first recurving ridge located nearest to the center and in front of the divergence of the ridges.

f. A meeting of two ridges

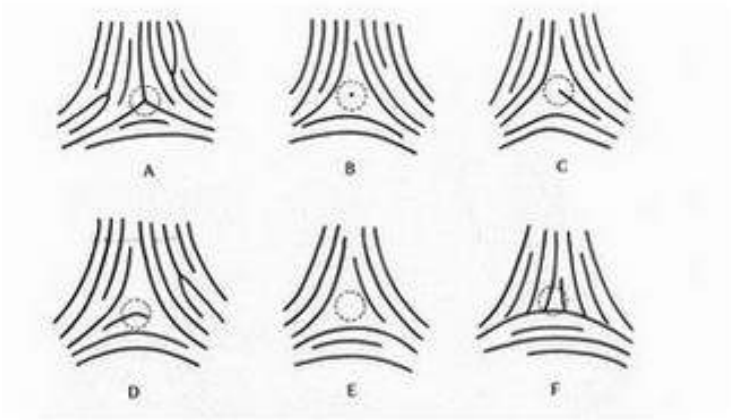


Figure 1.2 – Types of Delta

(Source: http://www.ireadhands.com/blog/dermatoglyphics/vestige)

6.3 Core.

The core as the name suggests is the centre of the fingerprint pattern, it is also known as inner terminus of the pattern. A core may consist either of an even or an uneven number of ridges not joined together at the top or may consist of two ridges joined at their summit. It may be the centre of the first ring in a whorl pattern or appoint from which the spiral begins to revolve.

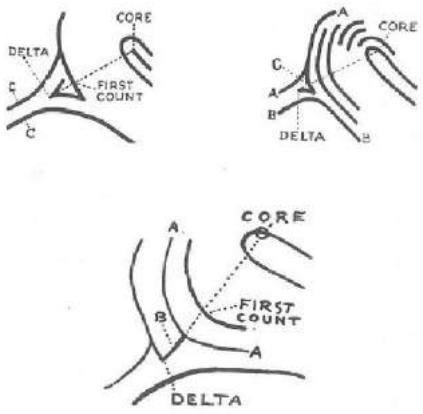


Figure 1.3 – Types of Core

(Source: The Science of Fingerprints Classification and Uses, United States Department of Justice, Federal Bureau of Investigation, John Edgar Hoover, Director)

6.4 Pattern types.

The classification of fingerprints has long been an important part of any fingerprinting system, which is, the partition of fingerprints into groups of broadly similar patterns. The most widely used system of fingerprint classification is the Henry system and its variants. In Henry Classification, fingerprint patterns are divided into four main types:

- Arches
- Loops
- Whorls
- Composites
- Accidentals

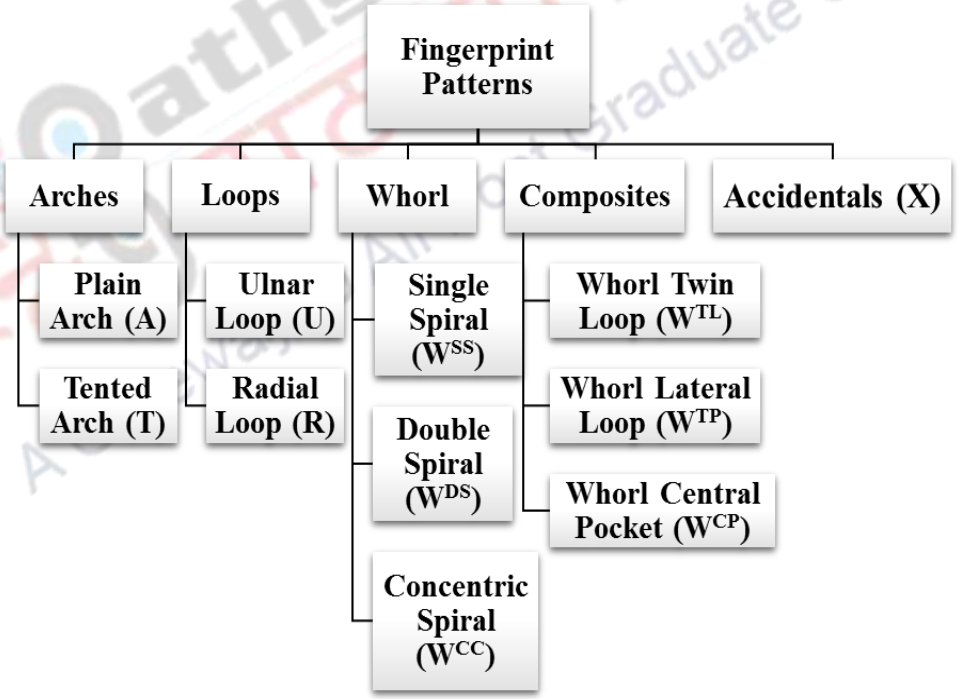


Table 1.1 – Types of Fingerprint Patterns

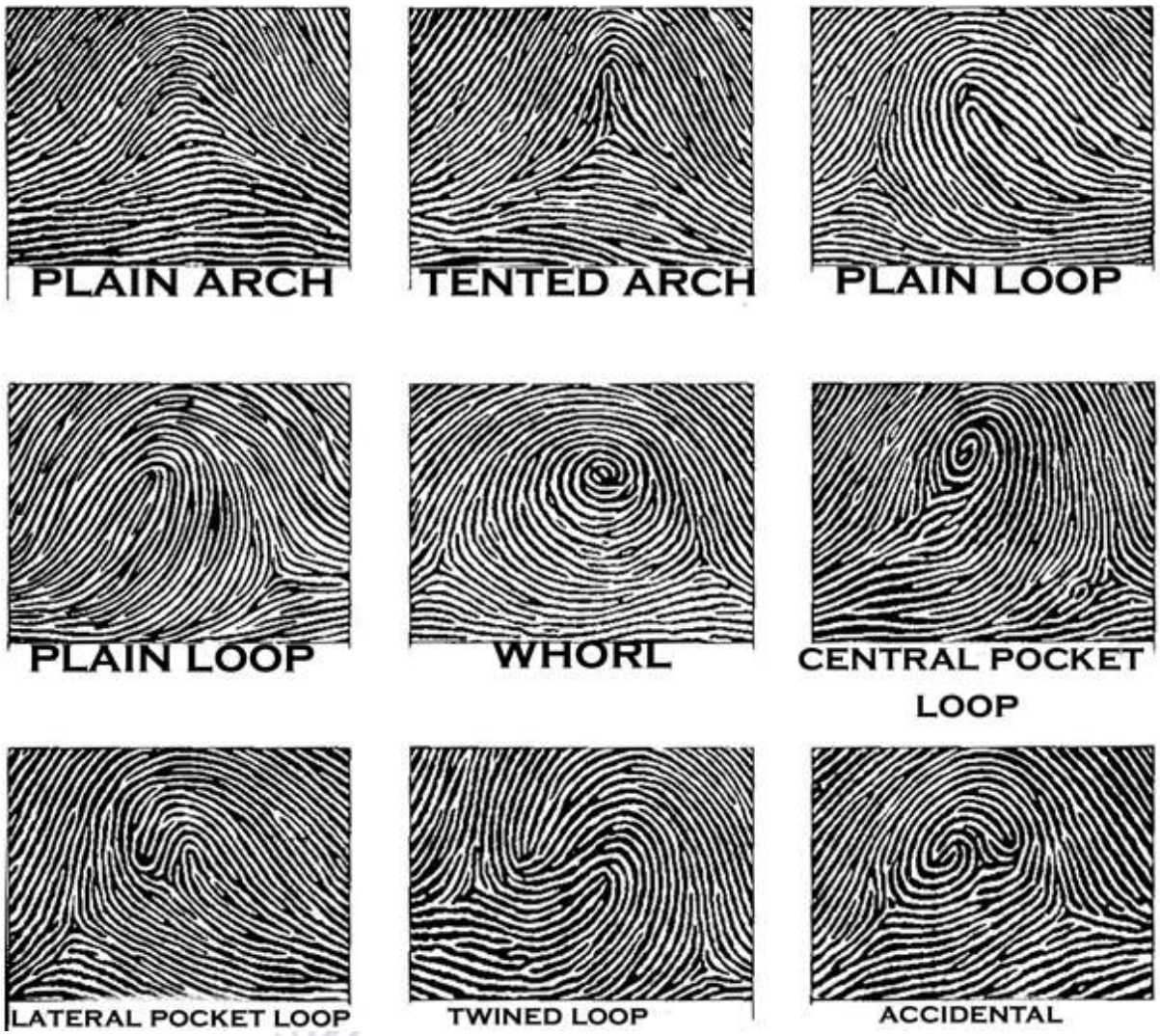


Figure 1.4 – Types of Fingerprint Patterns.

6.4.1 The Loop

A loop is that type of fingerprint pattern in which one or more of the ridges enter on either side of the impression, recurve, touch or pass an imaginary line drawn from the delta to the core, and terminate or tend to terminate on or toward the same side of the impression from whence such ridge or ridges entered.

Essentials of a loop

- A sufficient recurve.
- A delta.
- A ridge count across a looping ridge.

A sufficient recurve may be defined as that part of a recurving ridge between the shoulders of a loop. It must be free of any appendages abutting upon the outside of the recurve at a right angle.

Radial and Ulnar loops

The terms "radial" and "ulnar" are derived from the radius and ulna bones of the forearm. Loops which flow in the direction of the ulna bone (toward the little finger) are called ulnar loops and those which flow in the direction of the radius bone are called radial loops.

6.4.2 The Arch

The plain arch

In plain arches the ridges enter on one side of the impression and flow or tend to flow out the other with a rise or wave in the center.

The tented arch

In the tented arch, most of the ridges enter upon one side of the impression and flow or tend to flow out upon the other side, as in the plain arch type; however, the ridge or ridges at the center do not. There are two types of tented arches:

- The type in which ridges at the center form a definite angle; i.e., 90° or less.

● The type in which one or more ridges at the center form an upthrust. An upthrust is an ending ridge of any length rising at a sufficient degree from the horizontal plane; i.e., 45° or more.

● The type approaching the loop type, possessing two of the basic or essential characteristics of the loop, but lacking the third.

6.4.3 The Whorl

The whorl is that type of pattern in which at least two deltas are present with a recurve in front in each. The "plain whorl" consists of the simplest form of whorl construction and is the most common of the whorl subdivisions.

The plain whorl has two deltas and at least one ridge making a complete circuit, which may be spiral, oval, circular, or any variant of a circle. An imaginary line drawn between the two deltas must touch or cross at least one of the recurving ridges within the inner pattern area.

6.4.4 The Composites

Composites are compound patterns in which two or more designs are combined in one pattern area. Two o more triradii are present.

6.4.4.1 Central pocket loop

The central pocket loop type of whorl has two deltas and at least one ridge making a complete circuit, which may be spiral, oval, circular, or any variant of a circle.

In the central pocket loop, one or more of the simple recurves of the plain loop type usually recurve a second time to form a pocket within the loop. The second recurve, however, need not be a continuation of—or even connected with—the first. It may be an independent ridge.

6.4.4.2 Lateral pocket loop

This pattern type is characterized by the presence of two interlocked loops whose ridges when traced from the cores of the loops emerge on the same digital margin (radial or ulnar).

6.4.4.3 Twin loop

This pattern type is characterized by the presence of two interlocked loops whose ridges when traced from the cores of the loops emerge on the opposite digital margin.

6.4.5 Accidental

The accidental whorl is a pattern consisting of a combination of two different types of pattern, with the exception of the plain arch, with two or more deltas; or a pattern which possesses some of the requirements for two or more different types; or a pattern which conforms to none of the definitions. It may be a combination of loop and tented arch, loop and whorl, loop and central pocket loop, double loop and central pocket loop, or other such combinations.

6.5 Ridge Counting.

Ridge count is the number of ridges that intervene between the core and the delta, the points of core and delta are excluded while counting. A line which may be drawn to connect the core and delta is called a 'line of count'.

In counting the ridges in a loop pattern, it is first necessary to determine accurately the location of the delta and the core. The core and delta are not included in the actual count, and only those ridges, or portions thereof, that lie, exactly between the core and delta are considered.

The count is made by establishing an imaginary straight line from the delta to the core and all the ridges or ridge fragments touched by this line are enumerated. If the line of count cross a point where a ridge-forking occurs both sides of the fork ae counted, provided that the line of count falls at the point of bifurcation.

Since this imaginary line is one having no diameter, and only one dimension, namely that of length, it is extremely important that its establishment be determined with

exactitude, since a difference of even one ridge count may alter the classification formula and change the filing-place of a set of fingerprints.

Ridge counting in whorls is required for classification purposes where there is a larger database, in case of whorls in the right hand, the cunt is done from left delta to core and in case of whorls in left hand, the count is done from right delta to core.

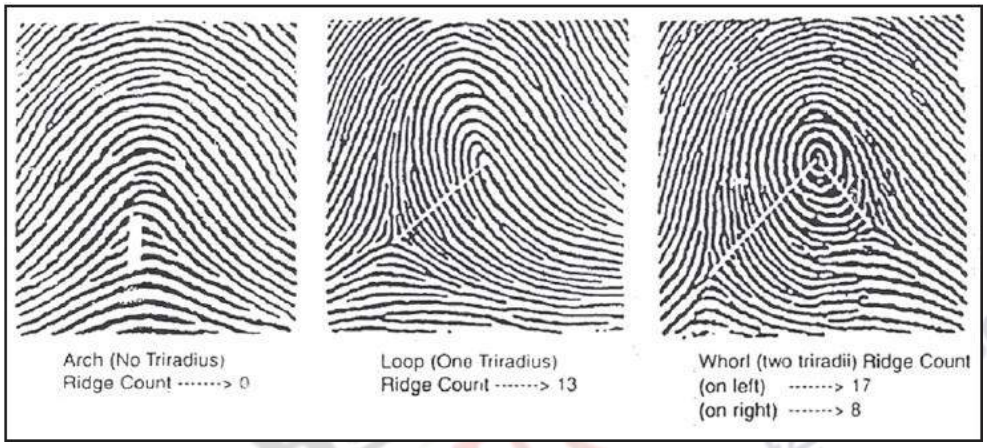


Figure 1.5 – Ridge Counting

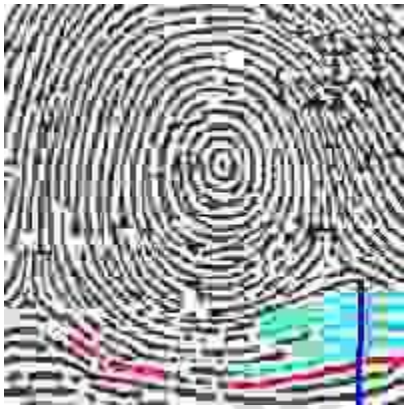
(Source: http://medind.nic.in/jao/t13/i4/jaot13i4p245.htm)

6.5 Ridge Tracing.

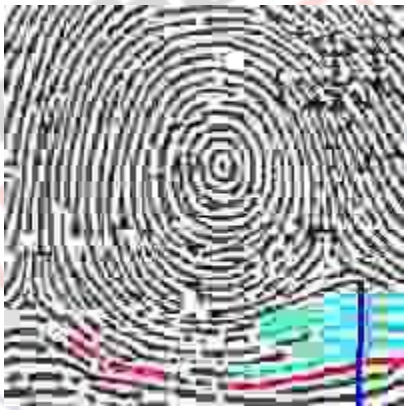
Valued patterns likes whorls and composites have two deltas. The lower arm of the left delta is followed, it may either meet the lower arm of the right delta or go inside or go outside

- If the lower arm of the left delta happens to meet the lower arm of the right delta then it is called “M” (meeting) tracing.
- If the lower arm of the left delta goes inside the lower arm of the right delta by three or more than three ridges, the it is called “I” (inner) tracing.
- If the lower arm of the left delta goes outside by the lower arm of the right delta by three or more than three ridges, then it is “O” (outer) tracing.

While traversing the path, if the lower arm of the left delta stops or breaks down abruptly, then the ridge next (beneath) to it should be followed and if it forks out, the ridge going down should be followed.



(a) M tracing



(b) O tracing

Figure 1.6 – Ridge Tracing

(Source: https://www.australianpolice.com.au/dactyloscopy/fingerprint-patterns/)

6. Individual Characteristics of Fingerprints.

Individual characteristics are those that are unique to a single person. They are also known as ridge characteristics.

Ridge characterize themselves in as many as 16 ways, thus giving rise to 16 types of ridge characteristics. These ridge characteristics are commonly occurring though with

varying frequencies and are free to occur independent of one another unbiased manner.

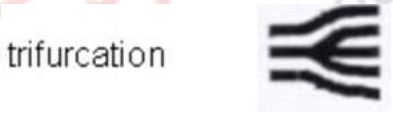
The various ridge characteristics are:

1. **Ridge Dot:** An isolated ridge whose length is also the same as its width.

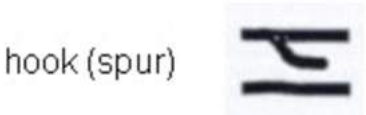
2. **Ridge Ending:** A single ridge that terminates within the ridge structure.

3. **Bifurcation:** The point at which one ridge divides into two ridges.

4. **Trifurcation:** The point at which one ridge divides into 3 ridges.



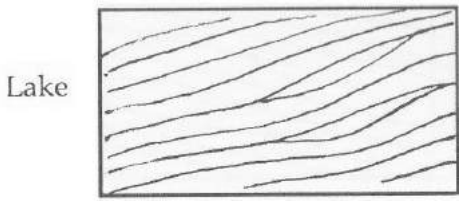
5. **Hook or Spur:** A bifurcation with one short ridge branching of a long ridge.



6. **Convergence:** It is the mirror image of bifurcation and is formulated when two or more or less parallel ridges emerging from the left side of the pattern fuse or converge to for a single ridge.

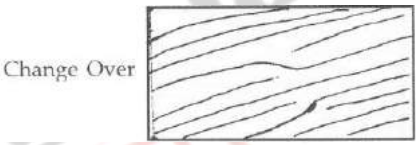
7. **Enclosure:** A single ridge bifurcates and re-joins after short while and continue as a single ridge.

8. **Lake:** an elongated enclosure.

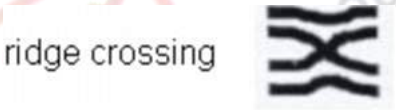


9. **Island or Short Ridge:** ridge of varying length.

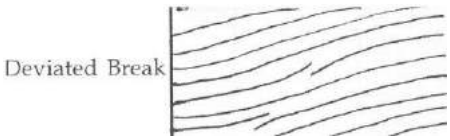
10. **Change over:** It is formed when two parallel ridges change their places. One ridge is interrupted while the other takes its place by passing through the break.



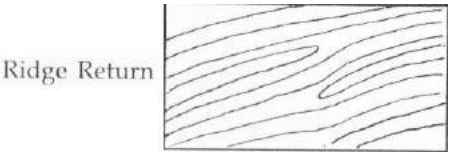
11. **Intersection or Ridge Crossing:** A point where two ridges intersects.



12. **Deviated break:** It is an interruption formed by two ridges which, instead of stopping just before they meet suddenly deviate, forming two ridge endings with a furrow between them.



13. **Ridge Return:** It is formed when a ridge starting from one margin of the print suddenly turns upon itself and returns its way it has come, forming a round loop without a core.



14. **Interjunction or Bridge:** A connecting ridge between parallel running ridges.

bridge 

15. **Ridge Fragment:** It is a ridge with ends which finishes abruptly. The fragment may be small or large in size and may appear between two parallel ridges.

Ridge Fragment 

16. **Natural Break:** It is formed by the interruption in the ridge. It is in its formation similar to two ridge endings facing each other.

Natural Break 

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DESCRIPTION OF MODULE

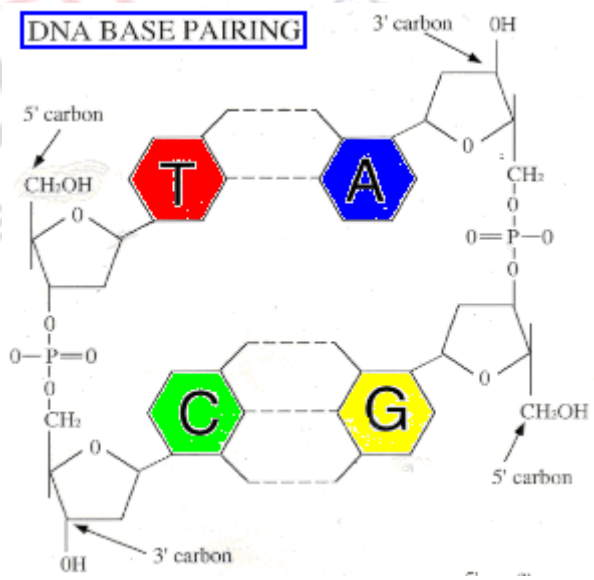
Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	DNA profiling: Technique and Forensic Application
Module Id	---------
Objectives	Learning Outcome: • To understand the genetic basis of DNA Fingerprinting. • To teach the learners different techniques of DNA fingerprinting. • To educate the learners the forensic importance of DNA Fingerprinting • To know the types of evidences those are collected for conducting DNA Fingerprinting.
Prerequisites	General understanding about genetic makeup of human being. Familiar with the basic biological instruments.
Key words	DNA fingerprinting, RFLP, VNTR, PCR. STR.

DNA fingerprinting

The chemical component of everyone's, either animal or human DNA is the same. The only difference between people and any animals DNA is the order of the base pairs or the numbers of repeat of a particular sequence. Due to the presence of millions of base pairs of DNA that every person has a different sequence.

Using these sequences, every person could be identified by the sequence of their base pairs.

These patterns do not, however, give an individual "fingerprint," but they are able to determine whether two DNA samples are from the same person or not. Scientists are now using a very small number of sequences of DNA that are known to vary among individuals a great deal. The process of DNA fingerprinting was invented by Alec Jeffreys at the University of Leicester in 1985.



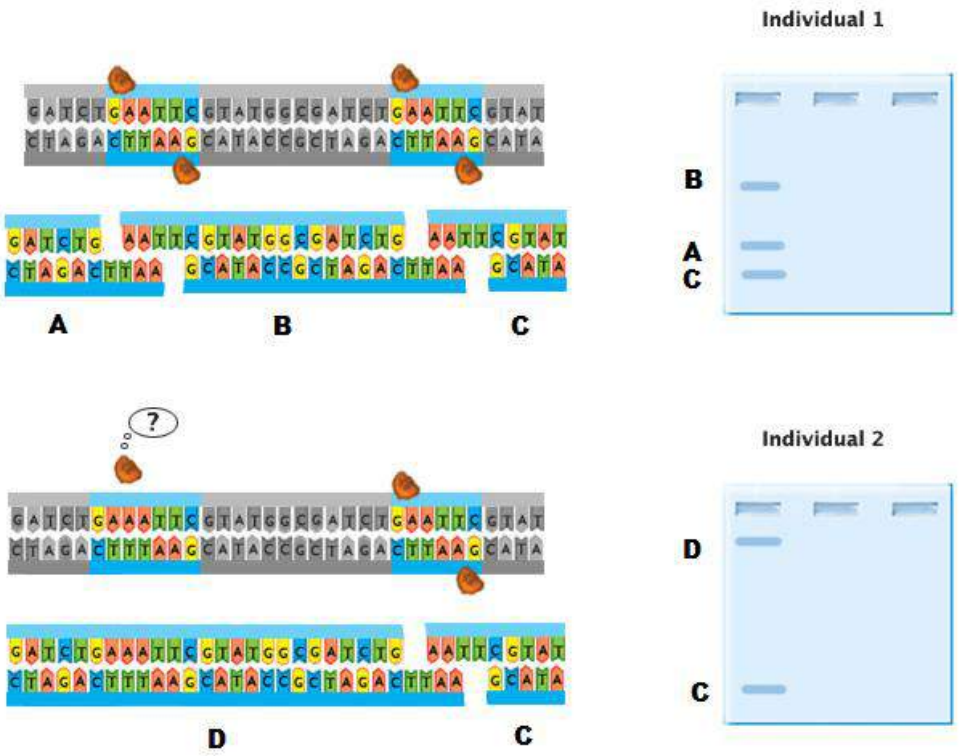
DNA fingerprinting: technique

1. RFLP technique

Restriction fragment length polymorphism (RFLP) is significant to find out variations in homologous DNA sequences. With the help of same restriction enzyme two different samples is digested and the length of that fragmented sequence can be revealed by electrophoresis. It was the first technique for DNA fingerprinting with widespread application. RFLP analysis is an important technique of molecular biology and useful in paternity dispute, gene mapping, localization of genes for genetic disorders and determination of risk for disease.

Nucleotide sequence variations in a region of DNA that generates fragment length differences according to the presence or absence of restriction enzyme recognition sites. The RFLP fragments can be separated by gel electrophoresis.

Fig:- Graphical representation of RFLP technique.



2.Southern Blot

Sir Edwin Mellor Southern (1938)

The Southern Blot is technique to analyze the genomic patterns which appear in a person's DNA. Southern blotting technique involve the following steps

1. Isolating the DNA in question. Isolation can be done either chemically or by applying a large amount of pressure in order to "squeeze out" the DNA.

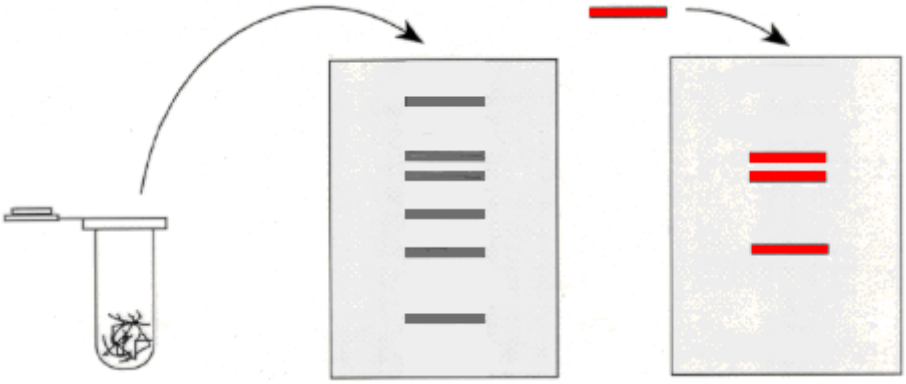
2. Cutting the DNA into pieces by restriction enzymes.

3. Sorting the DNA. The process by which the size separation, "size fractionation," is done. The DNA is poured into a gel and an electrical charge is applied to the gel. The different-sized of DNA will be separated by size, with the smaller pieces towards the bottom and the larger pieces towards the well.

4. Denaturing the DNA, so that it becomes single-stranded. Done either by heating or chemically treating the DNA in the gel.

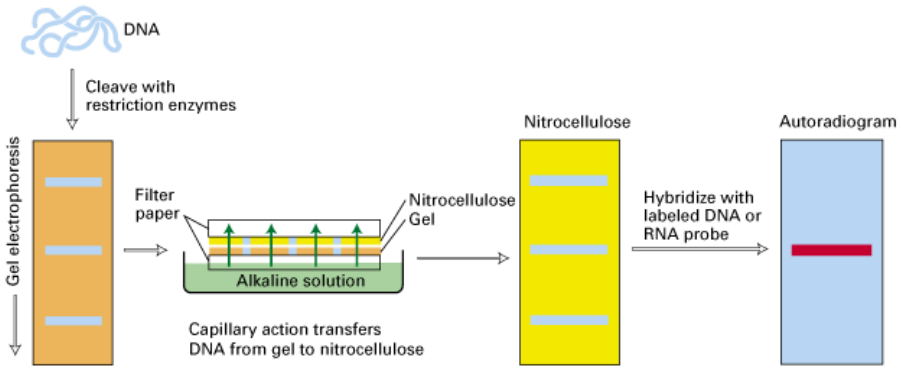
5. Blotting the DNA. The gel with the size-fractionated DNA is applied to a sheet of nitrocellulose paper, and then baked to permanently attach the DNA to the sheet. The Southern Blot is now ready to be analyzed.

In order to analyze a Southern Blot, a radioactive genetic probe is used in a hybridization reaction with the DNA in question. X-ray is also useful for Southern Blot after a radioactive probe has been allowed to bond with the denatured DNA on the paper, only the areas where the radioactive probe binds [red] will show up on the film. This allows researchers to identify, in a particular person's DNA, the occurrence and frequency of the particular genetic pattern contained in the probe.



Southern blotting

Southern blot hybridization: overview



-transfer of DNA from a gel to a membrane (e.g., nitrocellulose, nylon)
-developed by Edwin Southern

VNTRs

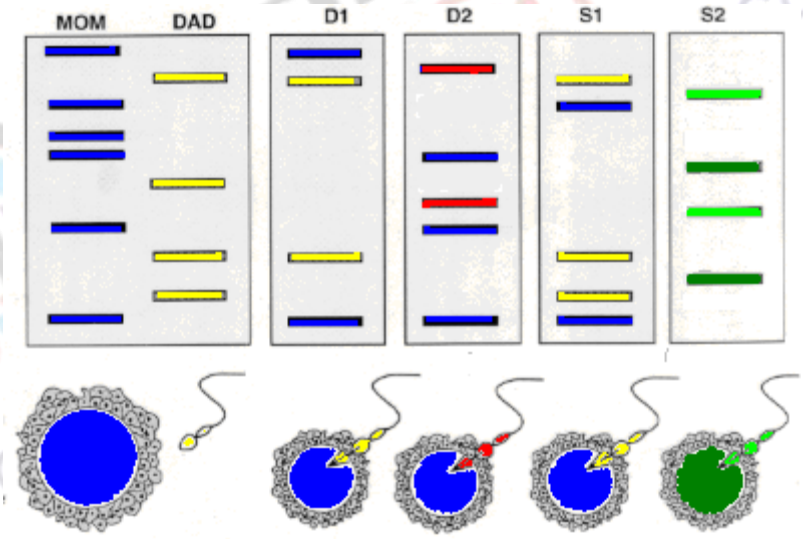
Every pieces of DNA contain genetic information called exons and pieces with no relevant genetic information called introns. Inspite introns seems useless, but it contain repeated sequences of base pairs. These sequences, called Variable Number Tandem Repeats (VNTRs), can contain anywhere from 20- 100 or more base pairs.

Every individual has some VNTRs. Southern Blot is performed to determine a particular VNTR, and then the Blot is probed, through a hybridization reaction, with a

radioactive version of the VNTR in question. The pattern which results from this process is what is often referred to as a **DNA fingerprint**.

An example of paternity dispute:-

A given person's VNTRs come from the genetic information donated by his or her parents; he or she could have VNTRs inherited from his or her mother or father, or a combination, but never a VNTR either of his or her parents do not have. Shown below are the VNTR patterns for Mrs. Nguyen [blue], Mr. Nguyen [yellow], and their four children: D1 (the Nguyens' biological daughter), D2 (Mr. Nguyen's step-daughter, child of Mrs. Nguyen and her former husband [red]), S1 (the Nguyens' biological son), and S2 (the Nguyens' adopted son, not biologically related [his parents are light and dark green]).



Because VNTR patterns are inherited genetically, a given person's VNTR pattern is unique. The more VNTR probes used to analyze a person's VNTR pattern, the more distinctive and individualized that pattern, or DNA fingerprint.

STR Typing

Short Tandem Repeats (STRs)

Currently the most used technique of all forensic markers for personal identification.

People differ in length at these loci

Locus or Loci:

Refers to the location on the chromosome.

Allele:

Refers to the type of DNA.

For STRs, the allele will be the number of repeats.

CCAGATAGATAGATAGATAGATAGATAGATAGATAGATCC

Example

Locus: D5S818

Alleles: 7,9

Paternal chromosome 5

CCAGATAGATAGATAGATAGATAGATAGATCC

Maternal chromosome 5

CCAGATAGATAGATAGATAGATAGATAGATAGATAGATCC

Regions of DNA can be repeated a different number of times

```
Person 1  ..GCCAGCTAGCTAGCTAGCTAGCTAGCTTTCAT..
               1       2       3       4       5         6

Person 2  ..GCCAGCTAGCTAGCTAGCTAGCTTTCAT..
               1       2       3       4       5

Person 3  ..GCCAGCTAGCTAGCTAGCTAGCTAGCTAGCTT..
               1       2       3       4       5         6          7
```

13 loci used in CODIS

STR Marker	Chromosome	Repeat Sequence	Repeat units	Other Alleles
TPOX	2	AATG	6 - 14	
CSF1PO	5	AGAT	6 - 15	10.3
D5S818	5	AGAT	7 -15	
D7S820	7	GATA	6 - 14	
D8S1179	8	TATC	8 - 19	
D13S317	13	TATC	7 - 15	
D16S539	16	GATA	5, 8 - 15	
D3S1358	3	TCTA*	9, 11- 20	15.2, 16.2
FGA	4	CTTT*	15 - 30	16.2 -30.2
				22.3, 34.2, 46.2
TH01	11	AATG*	3, 5 - 12	8.3, 9.3, 10.3, 13.3
VWA	12	TCTA*	11 - 22	15.2
D18S51	18	AGAA*	8 - 27	13.2, 14.2, 15.2
				17.2, 19.2
D21S11	21	TCTA*	24 - 38	24.2 - 35.2

Practical Applications of DNA Fingerprinting

1. Paternity and Maternity

A person inherits his/her VNTRs from his/her parents only, thus the VNTR patterns establish paternity & maternity. The patterns are so unique that a parental VNTR pattern can be reconstructed with the known children's VNTR patterns. Parent-child VNTR pattern analysis used to solve paternity dispute as well as legal nationality and, in instances of adoption, biological parenthood.

2. Criminal Identification and Forensics

DNA isolated from different biological samples like blood, hair, skin cells, semen, veginal secretion left at the scene of a crime can be compared, through VNTR patterns, with the DNA of suspect. VNTR patterns can establish the identity of a homicide victim, either from DNA found as evidence or from the body itself.

3. Personal Identification

The concept of DNA fingerprints as a sort of genetic bar code to identify individuals. The technology required to isolate, keep on file, and then analyze millions of very specified VNTR and STR patterns.

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Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Crime scene investigation and management of crime scene: Searching Methods, documentation and Types of physical Evidence, Importance of evidence
Module Id	

TABLE OF CONTENTS

1. Learning Outcomes

At the completion of this module, you shall be able to attain the insights of physical evidence, its role in forensic science, steps to process physical evidence and various types thereof, in depth, which can be encountered at the crime scene.

2. Physical Evidence

2.1 Definition

Physical evidence is any tangible material or object that plays some vital role in the matter that gave rise to the litigation, introduced in a trial, intended to prove a fact in issue based on its demonstrable physical characteristics.

2.2 Physical Evidence in Forensic Science- Role

There is a vital role of physical evidence in the investigation of a crime scene more or less it all depends on different factors, namely, number of physical evidence recovered and how much potential it is. Evidences recovered from the crime spot are very crucial in reconstruction of events. The physical evidence alone does not describe everything that happened but it can support or contradict accounts given by witnesses and/or suspects. The information obtained from physical evidences recovered can also generates leads to the information and also confirms the reconstruction of a crime to a jury.

2.3 How to process Physical Evidence

There are myriads of steps involved and to be followed while processing physical evidences. These are stated under:

1. Discovering physical evidence
2. Recognizing physical evidence
3. Examining physical evidence
4. Collecting physical evidence
5. Recording physical evidence
6. Identifying physical evidence
7. Packaging, conveying and storing physical evidence
8. Exhibiting physical evidence in court
9. Disposing of physical evidence when the case is closed.

3. Types of Physical Evidences

Different types of physical evidences recovered at the crime scene. A few of them have been discussed in depth below:

1. Blood
2. Semen
3. Saliva
4. Documents
5. Explosives
6. Firearms and ammunition

Other vital physical evidences are:-

7. Fingerprints
8. DNA Evidence
9. Skeletal Evidence
10. Petroleum products
11. Plastic bags
12. Plastic, rubber, and other polymers
13. Vehicle lights
14. Wood and other vegetative matter

Now, let us throw light on a few crucial physical evidences:-

3.1 Blood

Blood is a bodily fluid in animals that delivers essential substances, namely, nutrients and oxygen to the cells and transports metabolic waste products away from those same cells.

Blood is often encountered at many crime scenes specifically in heinous crimes, for example murder, rape, suicide, hit and run and many more. Many potential details can be discovered from blood evidence regarding the crime scene which can further be used in the investigation. DNA, proteins & cells are the vital components of blood allowing the laboratory to perform examination. Plenitude of useful information can be ascertained from blood.

The examinations can be performed to ascertain:

1. Source of Origin- If the source of origin of blood is human or non human.

2. Specific Animal Family- The specific animal family can be determined for non-human blood.

3. Exclusion and Inclusion of Possible suspects- If blood belongs to Human origin, then it can be compared with the specimen blood for exclusion or inclusion of possible suspects.

3.2 Semen

Semen (seminal fluid) is an organic fluid that may contain spermatozoa. It is secreted from the sexual glands and other sexual organs of male or hermaphroditic animals and can fertilize female ova.

In case of sexual offenses and when the perpetrator is a male, then semen stains are common to encounter from the crime scene. The stains may be found on the body of victim, clothings, rags, upholstery, beddings and multitude of sources as well.

The below-mentioned are a few steps involved in the collection of Semen Stains from the crime scene:

1. All the stained material under suspicion should be recovered carefully.
2. In order to avoid cross contamination of evidences and to prevent their loss, each item should be separately packaged.
3. All damp stains should be air-dried.
4. The location of moist stain on the evidences itself must be marked. On Air dry, it may not be visible.
5. Use clean paper, spread it under the item to catch any kind of debris which may be dislodged during the drying process, and between items hanging next to each other to prevent cross contamination.
6. Avail assistance of forensic staff to recover the stains in case when semen stains are on object that cannot be easily submitted to the laboratory.

3.3 Saliva

Saliva is a watery substance located in the mouths of animals. It is secreted by the salivary glands. Human saliva contains

99.5% - Water and
0.5% consists of electrolytes, mucus, glycoproteins, enzymes, and antibacterial compounds.

Saliva stains are not usually evident from a visual examination. Certain types of evidences frequently contain traces of saliva, namely, cigarette butts, gummed surfaces of envelopes, chewing gum, bite marks, ski and/or nylon masks, and many more.

3.3.1 A few points must be kept in consideration while collecting Saliva Evidence

If the saliva stained object is transportable, then it is advisable to submit the object intact. And in case it is not possible to transport the stained object, e.g. bite mark on a body, then following points might be kept in mind while collecting the saliva stain:

1) Moisten a sterile cotton swab with distilled or tap water.
2) Shake the swab to remove excess water.
3) Gently swab the suspected saliva stain.
4) Allow the swab to thoroughly air-dry prior to packaging in a paper envelope and seal.

In order to collect the negative control, select an unstained area and collect a sample in the same manner as described before. This swab will serve as a negative control.

3.4 Documents

Section 3 of Indian Evidence Act describes Document as below:

Document means any matter expressed or described upon any substance by means of letters, figures or marks, or by more than one of those means, intended to be used, or which may be used, for the purpose of recording that matter.

A document examiner is often asked to determine whether a questioned item is originated from the same source as that of known item(s) followed by presenting their opinion on the matter in court as an expert witness. A document examiner also determine what has happened to a document, its absolute/relative date of production, decipher information on the document that has been obscured, obliterated or erased.

3.4.1 Types of document examined

Documents play a vital role in our daily lives including our business and personal affairs. Authenticity of almost any kind of document can be questioned.

In broadest sense, a document is anything bearing marks, signs or symbols which conveys message or meaning to someone. It includes traditional paper documents, things like graffiti on a wall, stamp impressions, or covert markings hidden in a written letter, among other things etc.

A questioned document may be a sheet of paper bearing handwriting or mechanically-produced text such as a ransom note, a forged cheque or a business contract. That is to say, it may be some material which is not normally thought of as a 'document'.

A forensic document examiner conduct examinations and comparisons which can be quite diverse. The following examinations are usually performed by a forensic document examiner:-

- Handwriting (cursive / printing) and Signatures
- Typewriters, Photocopiers, Laser printers, Ink Jet Printers, Fax machines
- Chequewriters, Rubber stamps, Price markers, Label makers

- Printing Processes
- Ink, Pencil, Paper
- Alterations, additions, erasures, obliterations
- Indentation detection and/or decipherment
- Sequence Determination
- Physical Matching

3.4.2 Handwriting examinations

Generally, there are three stages in the process of handwriting examination. In brief, they are:

1. Analysis
2. Comparison (questioned item against the known standard)
3. Evaluation
4. Optionally, the fourth step consisting of verification/validation or peer review may also be there

3.4.3 Tools for document examination

- Excellent eyesight
- Handlens
- Stereomicroscope
- Electrostatic detection device (EDD)
- Video Spectral Comparator (VSC)
- Docubox Dragon
- Docucenter
- Raman Spectrophotmeter

3.5 Explosives

An explosive material, also called an explosive, is a reactive substance that contains humongous of potential energy that can result into an explosion if released suddenly, usually accompanied by the production of light, heat, sound, and pressure. That is to say, an explosive is a substance, may be an element, a compound or mixture, which is capable of exerting pressure on its surroundings on explosion/transformation. Forensic Science plays a role vis-a-vis explosives. Explosives are studied by forensic personnel mainly related to mass destruction episodes where bombs are used for illicit activities. The explosive residues discovered from the crime scene are examined for

many causes especially so as to identify the explosive material, the source and intention of explosion. An explosive has myriads of applications which are legitimate and do not cause harm to any animal or human being.

Legitimate Uses: An explosive might be used in blasting rocks for Mining, Oil Explorations, in Satellite and space craft propulsions, in constructing roads railway line etc., in fireworks displays, and may also be used as Military Explosives which we will discuss in forthcoming slides.

Illegitimate Uses: The criminals are using the explosives for causing havoc to individuals or a nation by blasting bombs. The illegitimate use of explosive causes high destruction to the integrity of any nation and is severely punitive under Indian Penal Code, Explosive Act and The Explosives Substance Act.

Some common examples of explosives are RDX, TNT, TETN, ANFO, Dynamite etc.

Forensics plays a vital role in the investigation of explosions where explosive substances/materials are the prime ingredients. Explosives can be detected prior to explosions (during trafficking) and also in the wake of the explosion by forensic spot tests and also by hi-tech forensic analytical tools. In simplest term, we can define an explosion as rapid increase in volume and release of energy along with the generation of high temperature and release of gases.

Due to the presence of organic compounds containing $-NO_2$, $-ONO_2$ and $-NHNO_2$ groups and others, an explosion is a spontaneous chemical reaction which is driven by humongous release of heat and energy. This type of explosion is called Chemical Explosion. The chemical explosion is of three types, namely, Decomposition, Deflagration and Detonation.

The chemical decomposition of an explosive is a slower process which takes place in storage. This may take years, days, hours, or a fraction of a second. Deflagration and Detonation are two rapid forms of Chemical decomposition.

Deflagration of the explosive material is propagated by a flame front which moves slowly through the explosive material. Low explosive undergoes the process of Deflagration.

Detonation of an explosive is propagated by an explosive shock wave traversing the explosive material. The shock front is capable of passing through the high explosive material at great speeds, typically thousands of metres per second. Detonation takes place in High Explosives.

The Explosives can be classified on the basis of composition, velocity, sensitivity and physical forms. But broadly explosives are of three types. Low explosives, High Explosives and Miscellaneous which we can further divide into Homemade Explosives, Nuclear Explosives and others.

Availability and cost, Sensitivity, Sensitivity to initiation, Velocity of detonation, Stability, Power, performance, and strength, Brisance, Density, Volatility, Toxicity, Explosive train, Oxygen balance and Chemical composition are some of the important characteristics of an explosive which are very important to ascertain whether the explosive is suitable for a particular use.

There are some important rules which an investigating officer must keep in mind for Evidence Collection. A few of them are mentioned below

a) Make Sure That There Are No Suspected Devices
b) Use Aerial Photography
c) Use Wire Mesh Screens to collect post blast residues
d) Do not- Handle potential explosives yourself
e) Clear and secure the area from unauthorized persons
f) Call the Bomb Squad
g) Use Bomb Disposal Suit
h) Always photograph the item "as found”
i) Always note the Evidence and its location
j) Do not restrict to a limited area of blast scene.
k) Always wear latex gloves to collect evidence.
l) Search far and wide from Epicentre

m) Always use clean, suitable, and unused containers.

n) Always label properly.

o) Always change gloves between collecting different items.

p) Always clean tools between collecting different items.

q) Always keep evidence in a secure location on the scene.

r) Always maintain the chain of custody.

s) Size of explosive does Not Matter

t) Collect soot deposits

u) Interview the Witness

v) Search for explosive device/bomb fragments.

3.6 Ballistics Evidence such as Firearms and ammunition

The range of evidence in firearms-related cases can be as small as a piece of a bullet fragment having rifling marks or as large as hundreds of bullets and cartridge cases and numerous firearms.

A firearm is a portable gun, being a barreled weapon that launches one or more projectiles often driven by the action of an explosive force, whereas ammunition may be defined as a propellant and projectile, or anything that can be used in combat including bombs, missiles, landmines and anti-personnel mines.

A ballistics expert is a forensic specialist who is responsible for accumulating and analyzing ballistics-related evidence, which includes firearms and ammunition.

The Ballistics evidence which may encounter at the crime scene may include:

- Firearms
- Spent cartridges
- Spent shell casings/bullets
- Shot shell wadding
- Live ammunition
- Clothing

3.6.1 Firearm Evidence Collection

Firearms evidence can be recovered in plenitude of ways and areas.

Firearms themselves can be recovered at shooting scenes by crime scene investigators and sent to the laboratory.

Bullets, bullet fragments, cartridge cases, shotshell wadding, etc., are normally collected individually after proper documentation/photography and sent to the laboratory.

Bullet evidence can also be obtained at autopsy or in an emergency room setting. In these cases, the sample should be marked as a biohazard and then sent to the laboratory. Each laboratory has written procedures for packaging and submitting evidence.

Bullets/slugs that do not strike a person are often imbedded into a nearby surface such as wood/drywall. This evidence is best gathered by cutting out a section of the material and submitting it to the laboratory to allow a firearms examiner to carefully extract it. This prevents adding or destroying any markings that could be crucial to identifying or matching the suspected firearm.

3.6.2 Analysis of firearm Evidence

A well-trained firearms examiner should perform the evaluation and comparison of this evidence.

a) The marks left on ammunition may help in determining which firearm was used to fire the bullet.

b) From the bullets fired to calibers and rifling patterns it is possible to identify the characteristics of firearms.

c) Cartridges and cases are analyzed to search for signs of firing pin impression, ejector marks, extractor marks, and other tool marks.

d) Even from small samples, information can be developed to indicate the type of firearm used and possibly identify the actual firearm that was used.

e) Other firearms evidence that could be found at a shooting scene includes shotshell wads and shot pellets; these can indicate the gauge of the shotgun.

f) Wads and pellets can be gathered and preserved in the same manner as bullets and cartridge cases.

g) By examining wadding materials, the examiner may be able to determine the gauge of the shotgun, the manufacturer or marketer, a range of possible shot sizes based on impressions in the shotshell wad, individual characteristics (in some cases).

4. Summary

1. Discovering, recognizing, examining, collecting, recording, identifying, packaging, conveying & storing, exhibiting and disposing of physical evidence are a few steps involved in processing of physical evidence discovered from the crime scene.

2. Various types of Physical evidences encountered from the crime scene such as blood, Semen, Saliva, Documents, Explosives, Firearms and ammunition, Fingerprints, DNA, Skeletal Evidence, Petroleum products, Plastic bags, Plastic, rubber & other polymers, Vehicle lights, Wood and other vegetative matter etc.

3. Blood is a bodily fluid in animals that delivers nutrients and oxygen to the cells and transports metabolic waste products away from those same cells.

4. Blood is usually encountered in heinous crimes, namely, murder, rape, suicide, hit and run etc.

5. Potential details regarding the crime scene can be discovered from blood evidence which can drive the investigation.

6. DNA, proteins & cells are the vital components of blood allowing the laboratory to perform examination.

7. Source of Origin (whether human or non human), Specific Animal Family (in case of non-human blood), Exclusion and Inclusion of Possible suspects (in case of Human origin) can be find out from blood.

8. Semen is an organic fluid that may contain spermatozoa.

9. Semen is secreted by the sexual glands and other sexual organs of male or hermaphroditic animals and can fertilize female ova.

10. Seminal stains are usually encountered in sexual offenses and when the perpetrator is a male.

11. The seminal stains may be found on the body of victim, clothing's, rags, upholstery, beddings and on other sources also.

12. All the stained material under suspicion should be recovered cautiously.

13. In order to banish cross contamination of evidences and to thwart their loss, each item should be separately packaged.

14. All damp seminal stains should be air-dried.

15. The location of moist seminal stain on the evidences itself must be marked. On Air dry, it may not be visible.

16. Use clean paper, spread it under the item to catch any kind of debris which may be dislodged during the drying process, and between items hanging next to each other to thwart cross contamination.

17. Avail assistance of forensic staff to recover the stains in case when semen stains are on object that cannot be easily submitted to the laboratory.

18. Saliva is a watery substance located in the mouths of animals and secreted by the salivary glands.

19. Human saliva contains 99.5% water and 0.5% consists of electrolytes, mucus, glycoproteins, enzymes and antibacterial compounds.

20. Saliva stains evidences are usually found at cigarette butts, gummed surfaces of envelopes, chewing gum, bite marks, ski and/or nylon masks, etc.

21. Submit the object intact if the saliva stained object is transportable.

22. If it is not possible to transport the stained object such as bite mark on a body, then moisten a sterile cotton swab with distilled or tap water, shake the swab to banish excess water, gently swab the suspected saliva stain and allow the swab to thoroughly air-dry prior to packaging in a paper envelope and seal.

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25. Document can also be described as “Anything bearing marks, signs or symbols which conveys message or meaning to someone including traditional paper documents, things like graffiti on a wall, stamp impressions, or covert markings hidden in a written letter, among other things etc.”

26. A questioned document may be a sheet of paper bearing handwriting or mechanically-produced text, namely, a ransom note, a forged cheque or a business contract.
27. A forensic document examiner conducts examinations and comparisons usually for Handwriting (cursive / printing) and Signatures, Typewriters, Photocopiers, Laser printers, Ink Jet Printers, Fax machines, Cheque writers, Rubber stamps, Price markers, Label makers, Printing Processes, Ink, Pencil, Paper, Alterations, additions, erasures, obliterations, Indentation detection and/or decipherment, Sequence Determination and Physical Matching.

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44. A firearm is a portable gun, being a barreled weapon, that launches one or more projectiles often driven by the action of an explosive force.

45. Ammunition is a propellant and projectile, or anything that can be used in combat including bombs, missiles, landmines and anti-personnel mines.

46. A ballistics expert is a forensic specialist who is responsible for collecting and analyzing ballistics-related evidence.

47. Firearms, Spent cartridges, Spent shell casings/bullets, Shot shell wadding, Live ammunition and Clothing are the ballistics evidence which may encounter at the crime scene.

48. Firearms evidence can be recovered at shooting scenes by crime scene investigators and sent to the laboratory.

49. Bullets, bullet fragments, cartridge cases, shotshell wadding, etc., are normally accumulated individually in the wake of proper documentation/photography and sent to the laboratory.

50. Bullet evidence can also be obtained at autopsy or in an emergency room setting. In these cases, the sample should be marked as a biohazard and then sent to the laboratory.

51. The marks left on ammunition may help in determining which firearm was used to fire the bullet.

52. From the bullets fired to calibers and rifling patterns, it is possible to detect the characteristics of firearms.

53. Cartridges and cases are analyzed to search for signs of firing pin impression, ejector marks, extractor marks, and other tool marks.

54. Wads and pellets can be gathered and preserved in the same manner as bullets and cartridge cases.

Tiremarks ;- Tiremarks are the class evidence means that may not be enough to convict individually/

Shoeprints:- they ar also lie in the category of class evidence the shoeprint of a relatively new shoe ,me rely suggest the make, style and size of the shoe. although no shoe wears down in the same way. every person has their own individualistic gait pattern. people takes a unique path when they walk.

A Gateway to all Post Graduate Courses

An MHRD Project under its National Mission on Education through ICT (NME-ICT)

Subject: **Criminology**

Production of Courseware

- Content for Post Graduate Courses

Paper : **Forensic Science and Forensic Medicine**

Module : **Examination of currency, passport, computer printouts and e-documents**

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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Examination of currency, passport, computer printouts and e-documents
Module Id	CRIMINOLOGY/FSFM/XXV
Objectives	Learning Outcome: • To make the learners understand the need for having security documents. • To acquaint learners with the security features of currency notes. • To acquaint learners with the examination of passports. • To make learners understand about e-documents • To make learners understand about computer printouts.
Prerequisites	General understanding of the currency notes, passports, e-documents and computer printouts.
Key words	Currency notes, passports, e-documents, computer printouts

1. Introduction:

The word document implies anything which is written on any surface using alphabets, numerical, symbols, signs or pictures which has some meaning or which delivers some message. The term questioned document stands for those documents on which doubt is being raised about their authorship, authenticity and genuineness.

The branch of forensic science which deals with the examination of documents and questioned documents is the questioned document division.

The general perception is that the questioned document division deals with the cases related to handwriting and signatures examination only but as the name suggest the division handles the cases which involves documents. The cases include the examination of currency notes, passports, stamp papers, credit cards, e-documents etc. The present module discuss in the detail the examination of currency notes, passports, computer printouts and e-documents.

2. Examination of currency notes:

Use of currency notes in India was started in the year of 1770 when Bank of hindostan introduced its own currency note in the denomination of Rs. 16/- . later on following the footsteps of Bank of Hindostan others banks also introduced their own notes in the denominations they wanted like Bank of Bengal introduced a note of Rs. 250/- . This process of having own notes by different banks continued for about 100 years till the year of 1861 when government of India passed the currency regulation act and took over all the control of currency in its own hands at that time the notes were printed and made in England and were imported from there only. In the year 1934 on 1st Jan RBI – Reserve Bank of India was established and it started its functioning from 1st April 1935 and took over the full control of currency. From this time on the printing, design denomination, size and colour scheme was the responsibility of RBI with the approval of Ministry of Finance, Government of India. The RBI was also responsible for the destruction of solid notes also. In the year of 1928 first currency note printing press was established in India in Nasik, Maharashtra under the name of Currency Note Press (CNP). Later on three other printing presses were established namely:

1. Bank Note Press (BNP), Dewas, Madhya Pradesh.

2. New Note Press, Mysore, Karnataka.
3. New Note Press, Salbony, West Bengal.

Security Features in Indian Currency Notes:

There are lot many security features in Indian currency starting from raw material which is made up of 100% cotton pulp to water marks, security thread, optical fibers etc. these are discussed in detail below one after the other.

1. **PAPER:** It is made from 100% cotton pulp. The forge notes are made from wood pulp paper which can be identified by the perception of touch and its crackle sound. Also the forge notes made from the cotton paper are identifiable as their grammage is more and they are thicker in feel.

2. **WATERMARKS:** These are the marks made on the paper at the pulp stage with the removal of water under pressure applied which also carry with some fibers making a design on paper. This design made cannot be destroyed nor can it be made or altered in fully made paper hence it act as a good security feature. In Indian currency three water marks are made. These are
   (a) Portrait of Mahatma Gandhi – in the window
   (b) RBI – in vertical
   (c) Denomination (10,20,50,100,500,2000) on the right corner.

In addition to these one more water mark is added in the note of Rs. 2000/- which 2K on the right hand side of the note. 1K means one thousand hence found only in Rs.2000/- notes. These are either absent in forge notes but even if present they show difference in the fine details of design and spacing of watermarks.

3. **OPTICAL FIBRES:** These are added as a special pulp in the cotton pulp when it is almost ready to make paper. In original notes there are three coloured optical fibres are present :
   $ yellow
   $ blue
   $ green

These are tiny fibres that can be seen on both the sides of the note under ultraviolet light. In forged notes these are absent.

4. **SECURITY THREAD:** It is an OVI coated synthetic filament introduced in notes at the stage of pulp. The following features of it should be noted:
(a) there is micro printing on it of original notes. Under transmitted light, the words 'RBI' and 'BHARAT' (in Hindi) can be read. Throughout the length of the thread (alternatively). In forge notes no such printing is found.

(b) In original notes, it can be seen as a regular and complete line under transmitted light. Whereas in forged notes, this line is visible as a broken or segmented line.

(c) In original notes, the segmented security thread gives deep blue fluorescence under ultraviolet light, whereas in the forged notes, it gives violet or dark or no fluorescence.

(d) Shinning segments in the original notes are six in number, whereas in some of the forge notes, the number of segments is more than this.

5. **INTAGLIO PRINTING:** On the obverse side of the original note, the signatures of Governor, Promissory note, Mahatma Gandhi emblem, Braille Mark and portion of design is printed in Intaglio style with a raised printing. This type of printing can be felt by rubbing the obverse side of the note with finger. In forge notes, the intaglio printing is absent.

6. **UV FLUORESCENE:** Paper of original currency notes does not give any fluorescence under UV light, whereas the paper of forged currency note (other than made by cotton pulp) gives blue fluorescence under UV light. Also the features like optical threads, series number and portion of printing is also fluorescence under UV light.

7. **BRAILLE OR IDENTIFICATION MARK:** In the notes a special design called identification or Braille mark is created for visually impaired persons. In new notes this feature is replaced by Bleed Lines, these lines are four in number in 100/-, five in number in 500/- and seven in number in 2000/- note. This feature printed in Intaglio is present at the left side of watermarked window.

8. **SEE-THROUGH REGISTER:** Since the front and backside of the original notes are printed simultaneously as such, it gives perfect alignment of front and back printing. In forge notes perfect alignment is absent.

9. **MICROPRINTING:** Micro printing is been created at the backside of the head and ear of Mahatma Gandhi in original notes. This area is filled with the letters RBI and denomination of note, which can be read with the help of 6 x-illuminated magnifying glasses. In forged notes, the micro printing is absent or shows only dots or dashes at this area instead of micro printing.

10. **LATENT IMAGE:** On the right side of the original note, there is a green coloured vertical band. In this area, a hidden design the denomination of note called Latent image has been created by a special technology. These figures can only be seen when the note is held on the palm and seen against light parallel to the eye and note. In forged notes, this latent image is absent.

11. **OVI FEATURE:** The value of note, is printed at the middle of the note with shinning green OVI (optically variable ink) in Intaglio printing. These figures change their colour from green to dark blue when the note is titled or its angle is changed. This feature is absent in forged notes.

12. **FONT SIZE:** A careful examination and comparison of the numbers and series show difference in the font size. In forged notes, the font size is normally smaller in comparison with the font size of the original currency notes.

3. Examination of passports:

The passport is an official document of identification which is issued by the Government of India to the Indian citizen. In our country, three types of passports are issued by the government, Red, white and blue. Red passport is issued to the diplomats it is known as diplomatic passport. White passport is known as the official passport and is issued to the citizens who are visiting the foreign countries on official work as asked by government of India. Blues passport is known as the citizen passport, it is issued to all the citizens of our country. At one particular time an individual can possess only on of either three of the passport, possession of more than one type of passport is an offence.

Passport carries the information of an individual certifying the holder's identity, nationality, citizenship, residential address, age, date of birth, date of issue, date of expiry, parents and spouse name and address, travelling details, etc. The passport issued by Government of India is either of 36 pages or 60 pages not more or less.

The passport being an important document contains various security features, such as

1. Paper
2. Optical fibres
3. Watermark
4. Chemical sensitization
5. Micro printing
6. Embossing
7. Photograph and signature security
8. Punched numbers
9. Florescent features

PAPER: paper is the key component in the security of a passport as it gives excellent protection against the counterfeiting and in conjunction with other compatible components, it protects them against fraudulent alterations. For the passport, high quality paper is used which is prepared by cylinder mould process due to which watermarks are produced during paper manufacture process.

OPTICAL FIBRES: tiny fibres of blue are mixed in pulp at the paper manufacturing stage which are invisible to the naked eye but become visible on both the sides of the paper of passport under ultraviolet light.

WATERMARK: at the middle of each page of the passport there are watermark in the form of Ashoka Pillar in upright and downward design. When the pages of the passport are held against transmitted light, watermark can be seen distributed over the surface.

CHEMICAL SENSITISATION: the base printing of the passport is done with water-soluble fugitive ink of light blue colour and on application of a few drops of water or alcohol, this base printing gets dissolved forming smear of ink which gives look of tempering or erasing. This feature is created to avoid the chemical erasures in the passport.

MICRO PRINTING: all the vertical and horizontal black printed lines on the visa pages of the passport are printed with a special technology. These lines during visual inspection look like normal lack lines but if the lines are magnified with magnifying lens, one can observe evidence of micro printing in these lines which when deciphered can be read as "VISA PAGE (respective page number figure like 5, 12, 13 etc.). This feature has been created to avoid scanning and photocopying of visa pages as scanners do not read micro printing while preparing same size papers.

EMBOSING: design of ashoka pillar is embossed on laminated sheet while heating and affixing it on the first page of passport paper above photograph etc. This can be seen at an angle in the form of diagonal horizontal and vertical lines with the words "SATYA MAV JAYATE" below the ashoka pillar.

PHOTOGRAPH AND SIGNATURE SECURITY: in each and every passport of the world, the photograph and the signature of the holder are affixed on the first page of the passport. To avoid the problem of substitution of photograph and signature as

on the passport, both of them are scanned and printed at the relevant page and the laminated sheet is affixed above the scanned photograph and signature.

PUNCHED NUMBER: on the second half portion of the passport i.e., pages 19 to 36 and back cover page, punched passport numbers are present by laser technique and the pages are smooth from both the sides.

FLORESCENT FEATURES:

- A special laminated sheet with invisible printed security feature is affixed on the left inner cover page of the passport. This sheet is affixed by heating it at the temperature of 160 degree Celsius to 180 degree Celsius. On the laminated sheet invisible printing, which gives fluorescent in yellow and red colour and hidden text i.e. “Bharat Sarkar” (in Hindi) in yellow and Government of India in Red colour becomes visible when the passport is placed in UV light. Discontinuity in this printing proves tampering.
- On each page of the passport beside visible printed number, the page number is also printed with special invisible inks which gives deep blue fluorescence under UV light.
- At the centre of each page of the passport, there is secret invisible circular printed design around the upper portion of printed ashokas pillar, which also give deep blue florescence under UV light.
- The thread used for stitching passport gives deep yellow florescence under UV light. Lately this thread is replaced by red type of thread which gives multicolour fluorescence under UV light.
- Most of visas shows various florescent features in the design under UV light. The absence of these fluorescent designs indicates forgery of visas.

4. Examination of computer printouts:

Printers are hardware devices that help to create a hard copy of the e-document. The printers can be classified into two categories impact and non-impact printers. Impact printers – dot-matrix printers and non-impact printers – inkjet and laser printers. For

examination of printed documents, wee study general and individual characteristics. General characteristics includes category of printers whether impact or non-impact. The individual characteristics included defects of the printers due to wear and tear or defects due to the use of non-standard usable parts of printers viz., ribbon, cartridge, toner, etc.

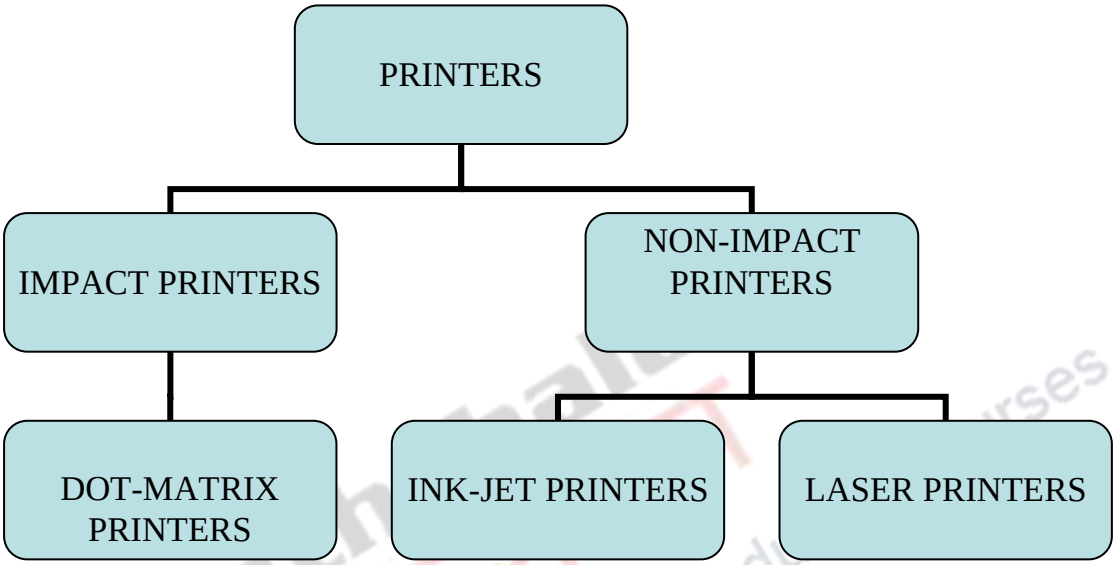

FIGURE: Types of Printers

DOT-MATRIX PRINTERS:

Dot-Matrix is a kind of impact matrix printer with a print head that runs back and forth on the page and prints by impact, striking an ink soaked cloth ribbon against a paper.

Each dot is produced by a tiny metal rod also called as wire or pin which is driven forward by the power of a tiny electromagnet or solenoid. As the printer head moves in horizontal direction, the print head controller sends electrical signals which forces the appropriate wires to stroke against the inked ribbon making dots on the paper and forming the desired character.

After magnification of print out, the dot-matrix will show bigger circles compared to inkjet as dot matrix works on impact principles containing matrix of pins whereas inkjet printer works on non-impact principle which contains nozzles through which ink comes out.

Print impressions appears at the back of the print out document in case of dot matrix printers where as it is absent in in inkjet or laser printers.

In case of laser printers print is fine as there is neither pins as in dot matrix printers nor nozzles as in ink-jet printers but it works on scanning principles with the help of lasers.

General Characteristics of Dot-Matrix:

1. Low resolution.
2. Being an impact printer, depth of dots can be seen under magnification.
3. A standard ribbon of dot matrix printer contains carbon-wax based ink which is non-soluble in water.

Individual characteristics of Dot-Matrix:

1. Problems due to print-head.
    a. Print head data ribbon cable are missing dots.
    b. Uneven or intermittent printing.
    c. Black or white horizontal line along each line.
2. Defect in motor may cause misalignment of printed text.
3. Problems due to old ribbon, head's print pin is worn-out, maladjustment of plates and print head are non-uniform printing density/faint printing, absence of the printed portion of the dot at the location from where print head is worn out.

General Characteristics of Ink-Jet Printers:

1. High-resolution printing.
2. Being a non-impact printer, depth of dots cannot be seen under magnification but distortion of image can be observed.
3. Overspray of in in te form of red and green dots can be seen under magnification.
4. Two cartridges of inkjet printers contain colour ink in the form of secondary colours, i.e., cyan, yellow, magenta and other is black ink cartridge. These inks are soluble in water.

Individual Characteristics of Ink-Jet Printers:

1. Vertical horizontal lines in the graphics printout are due to software problem.
2. Vertically shaky image is due to cartridge problem, images being misaligned.
3. Disappearing characters are due to faulty buffers, excess data or protocol mismatch.
4. Change in font style or design is due to computer software problem.

Laser Printer:

When we print something, our computer sends a vast stream of electronic data (typically a few megabytes or million characters) to laser printer. An electronic circuit in the printer figures out what all this data means and what it needs to look like on the page. It makes a laser beam scan back and forth across a drum inside the printer, building up a pattern of static electricity. The static electricity attracts onto the page a kind of powdered ink called toner. Finally, as in a photocopier, a fuser unit bonds the toner to the paper. Millions of bytes (characters) of **data** stream into the printer from your computer.

1. An **electronic circuit** in the printer (effectively, a small computer in its own right) figures out how to print this data so it looks correct on the page.
2. The electronic circuit activates the **corona wire**. This is a high-voltage wire that gives a static electric charge to anything nearby.
3. The corona wire charges up the **photoreceptor drum** so the drum gains a positive charge spread uniformly across its surface.
4. At the same time, the circuit activates the **laser** to make it draw
5. The image of the page onto the drum. The laser beam doesn't actually move: it bounces off a moving mirror that scans it over the drum. Where the laser beam hits the drum, it erases the positive charge that was there and creates an area of negative charge instead. Gradually, an image of the entire page builds up on the drum: where the page should be white, there are areas with a positive charge; where the page should be black, there are areas of negative charge.

6. An **ink roller** touching the photoreceptor drum coats it with tiny particles of powdered ink (toner). The toner has been given a positive electrical charge, so it sticks to the parts of the photoreceptor drum that have a negative charge (remember that opposite electrical charges attract in the same way that opposite poles of a magnet attract). No ink is attracted to the parts of the drum that have a positive charge. An inked image of the page builds up on the drum.
7. A sheet of **paper** from a hopper on the other side of the printer feeds up toward the drum. As it moves along, the paper is given a strong positive electrical charge by another corona wire.
8. When the paper moves near the drum, its positive charge attracts the negatively charged toner particles away from the drum. The image is transferred from the drum onto the paper but, for the moment, the toner particles are just resting lightly on the paper's surface.

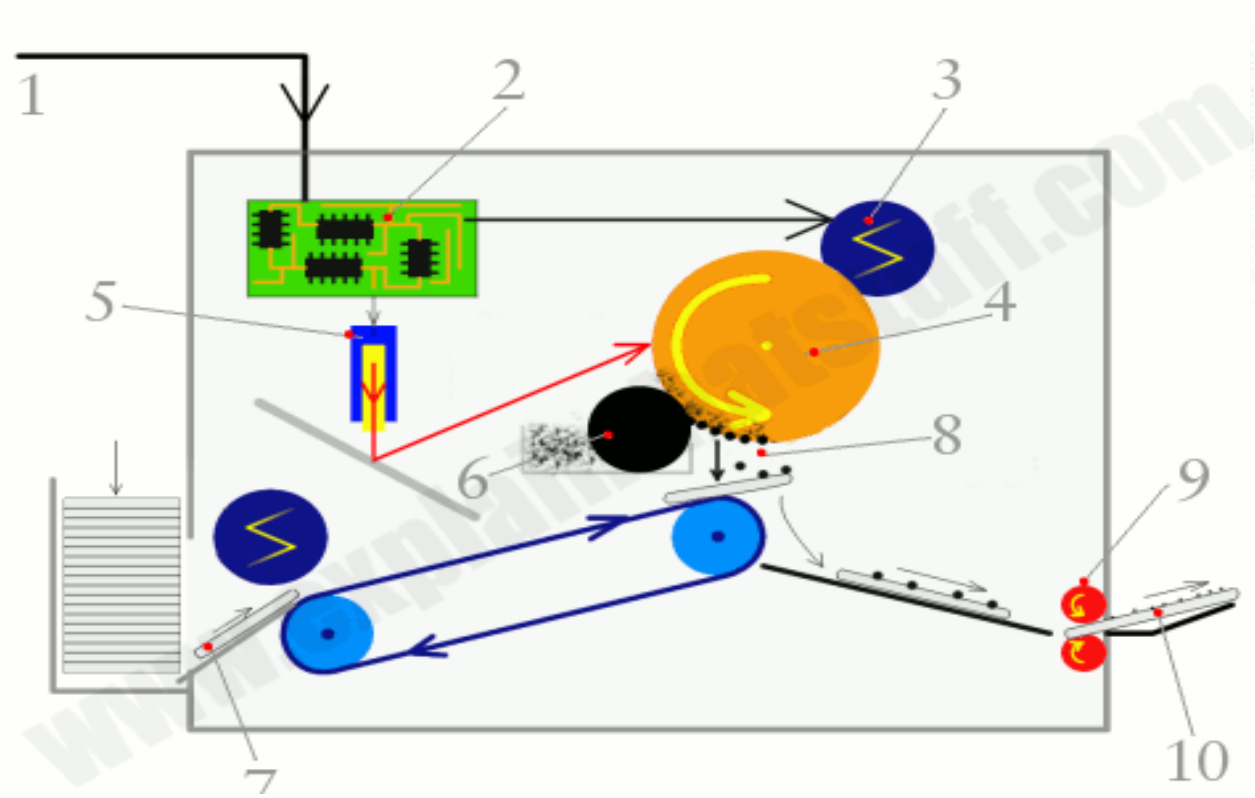

FIGURE: Working of Laser Printer

(Source: Scientific Examination of Questioned Documents by Kelly)

General Characteristics of Laser Printer:

1. High resolution printing
2. Distortion of image can be seen at a very high magnification depending up on the resolution i.e. dpi of the printer
3. Toner is used as ink in the cartridges of secondary colours and black cartridge. The toner is non-soluble in water and also gives glossy effects in printing.

Individual characteristics of Laser Printer:

1. Image defects due to toner cartridge sealing tape not completely removed, toner not available, drum is not rotating, high voltage circuit or DC controller assembly is defective.
2. Faint printout or character void problem is due to print density is not set correctly, toner cartridge is nearly empty or transfer roller is defective.

5. Examination of e-documents:

An electronic document is any electronic media content (other than computer programs or system files) that are intended to be used in either an electronic form or as printed output. Originally, any computer data were considered as something internal — the final data output was always on paper. However, the development of computer networks has made it so that in most cases it is much more convenient to distribute electronic documents than printed ones. And the improvements in electronic display technologies mean that in most cases it is possible to view documents on screen instead of printing them (thus saving paper and the space required to store the printed copies).

However, using electronic documents for final presentation instead of paper has created the problem of multiple incompatible file formats. Even plain text computer

files are not free from this problem — e.g. under MS-DOS, most programs could not work correctly with UNIX-style text files (see newline), and for non-English speakers, the different code pages always have been a source of trouble.

Even more problems are connected with complex file formats of various word processors, spreadsheets and graphics software. To alleviate the problem, many software companies distribute free file viewers for their proprietary file formats (one example is Adobe's Acrobat Reader). The other solution is the development of standardized non-proprietary file formats (such as HTML and OpenDocument), and electronic documents for specialized uses have specialized formats.

6. Summary:

The questioned document division in a forensic science laboratory deals with all types of cases related with doubts about document raised in the court of law. These days the job of the expert is to not only check these forgeries but also to make people aware of the security features of the security documents so as to avoid the cases of cheating.

After reading through this module you are been informed about the security features of Indian currency notes, passports, and are also made informed about the examination of computer print outs and e-documents.

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Paper : **Forensic Science & Forensic Medicine**

Module : **Insecticides: organochlorines, organophosphates and carbamates.**

Role	Name	Affiliation
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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Forensic Toxicology
Paper Name	Forensic Medicine & Toxicology
Module Name/Title	Insecticides: organochlorines, organophosphates and carbamates.
Module Id	LAW/CJA/VIII /12
Objectives	Learning Outcome: • To make the learners understand about various types of insecticides. • To make the learners understand about action mechanism i.e. how different insecticides affect different biological system. • To acquaint the learners about the type of insecticidal poisoning on the basis of the pattern of toxicity caused.
Prerequisites	To aware about different type of synthetic insecticides which are responsible for their toxic effects.
Key words	Insecticides, agricultural poisons, organophosphorus, organochloro, carbamates etc.

1. Introduction:

Insecticides are used in agriculture to control the growth of insects which could harm the crop or vegetation. Most of them are synthetics. These are also known as agriculture poison. Exposure to insecticides comes from food or vegetables and consumption of water. Besides, workers who are engaged in their manufacturing and spreading are at high risk.

Synthetic organic insecticides can be classified into three categories: (1) Organophosphorus insecticides (2) Carbamates and (3) Organochloro insecticides. These have been described as follow.

2.1. Organophosphorus insecticides

These are the esters of phosphoric acid and can be classified in two different classes i.e. (A) alkyl phosphate and (B) aryl phosphate. HETP (Hexaethyl tetraphosphate), TEPP (Tetraethyl pyrophosphate), OMPA (Octamethyl pyrophosphoramide), Demifox, Melathion etc. are the example of alkyl group while, Parathion, Paraoxon, Methyl parathion, Chlorthion, Diazinon etc. are belong to aryl phosphate group.

Action Mechanism: Poisoning can occur from inhalation, ingestion and absorption through skin. These compounds are powerful **inhibitors of cholinesterase** at the myoneural junctions and synapses of the ganglions. Acetylcholine (neurotransmitter) therefore accumulates and results in hyper-excitation of the voluntary and involuntary muscles[1].

Sign and symptoms	**Toxic effects are as follow:** a) Muscarine-like effects b) Nicotine-like effects c) On the central nervous system **a) Muscarine-like effects (acts on smooth muscles) :** • It affects the bronchial tree and results in tightness of the chest

with prolonged wheezing expiration. Therefore, there is discomfort or pain in chest, difficulty respiration, froth at the mouth and nose with cynosis. The effects simulate bronchial asthma.

- It causes gastrointestinal disturbances which include anorexia, nausea, vomiting, abdominal cramps, epigastric tightness wih diarrhoea, tenesmus and involuntary defaecation.
- It also affects sweat glands (increases sweating), salivary glands (increases salivation), lacrimal glands (increases lacrimation). Pupils are slightly become miosis, Ciliary body may blurred and results in dimness of vision. It also acts on urinary bladder which may result in frequent and involuntary micturition.

b) Signs and symptoms of nicotine-like effects:

- It affects striated muscle which results in early fatigue, muscular twitching, cramps, difficulty in respiration with dyspnoea and cynosis.
- Sympathetic ganglia is also affected which causes high blood pressure.

b) Signs and symptoms of action on the CNS

- It causes irritability, restlessness and muscular weakness (with tremors in hands, eye lids, face or tongue with convulsions.
- It also results in mental confusion. Coma with depression of respiratory and circulatory centers.

Fatal Dose :

Compound	i.m.	orally
• TEPP	50 mg	100 mg
• Parathion	80 mg	175 mg
• HETP	60 mg	350 mg

	• OMPA 80 mg 175 mg • Malathion & Diazinone 1 g orally **Fatal Period :** usually 1 hour to 10 days.
Postmortem Appearances	• There are sign of asphyxia. Externally, the face is cyanosed. There is froth with blood stained at nose and mouth. A kerosene-like smell may also be perceived. • Internally, the stomach contains greenish oily substance with kerosene-like smell. The mucous of stomach is congested and petechial hemorrhages are also seen. • There is pulmonary edema and hyperaemia of lungs, brain and other organs. • Delayed paralysis of the extremities may found in case of parathion, malathion and there is degeneration of motor horn cells. • It resist putrefaction hence poisoning can be detected in buried bodies.
Medicolegal aspects	• These are used commonly agriculturally as insecticides. • They are used for suicide as these are easily available. • They have been used for homicide by mixing with alcohol to mask their smell. • A number of accidental deaths have also been recorded through contamination and leakage of these compounds to edibles[2].

[1]https://www.epa.gov/sites/production/files/documents/rmpp_6thed_ch5_organophosphates.pdf

[2.] K. S. N. Reddy and O.P. Murty, The Essential of Forensic Science and Toxicology, Chapter 25 p. 448, 25th edi. (2006).

2.2. Organochlorines insecticides

Organochloro compounds are the chlorinated hydrocarbons and are also used in agriculture like organophosphorus insecticide. DDT (dichlorodiphenyltrichloroethane), BHC (benzene hexachloride) are used as a general garden insecticide, Gamma-benzene hexachloride (GBH), Dieldrin, etc. are the other example of this class[3]. Besides, Endrin is most toxic among the cholrinated insecticides and is mainly applied to control the growth of insect pests of cotton, sugarcane and tobacco, paddy. As endrin it shows wide spectrum of activity against variety of plant pests, it is therefore, known as plant *penicillin*[4].

Action Mechanism

These affect the sodium conductance across the neuronal membrane, central nervous system and also affect metabolism of neurotransmitters.

Sign and symptoms	• Organochloro poisoning results in salivation, nausea vomiting, pain in abdomen. • Froth are seen at the respiratory airways, giddiness, ataxia, tremors, convulsions, coma and death is ensues due to respiratory failure.
Fatal Dose : About5 to 6 gm **Fatal Period** : An hour to several hours	
Postmortem Appearances	• There are signs of asphyxia. • Smell of kerosene is perceived from mouth and stomach content. • Endrine can be detected in viscera as it resists putrefaction.
Medicolegal aspects	• As these are easily available it is therefore, used for suicidal purposes. • It is used for homicidal purposes by mixing it with alcohol. It

	may also be mixed with other foods. • Accidental poisoning also occurs due to contamination and leakage[2].

3. http://dhss.delaware.gov/dhss/dph/files/organochlorpestfaq.pdf

4. R. N. Karmakar, Forensic Science and Toxicology, p. 471, 3rd edi., (Academic Publisher, 2010).

2.3. Carbamates

Carbamate insecticides are the derivatives of carbonic acid. Carbamates are commonly used as surface sprays or baits to control of household pests. Carbamates have wide spectrum of activity. For example, Propoxur is very effective against cockroaches. Bendiocarb is mostly used as turf and ornamental insecticide while, Methomyl is applied as adult fly bait. Apocarb (Baygon), carbyl (Sevin), carbofuran (Fuaxdan) etc. are the other carbamates available in market.

Action Mechanism: The mode of action of carbamate insecticides is very similar to that of the organophosphate insecticides as they inhibit cholinesterase enzymes[5].

Sign and symptoms	• Like organophosphates, carbamates are also inhibitors of acetylcholinesterase as organophosporus insecticides but they differ from carbamates as they itself hydrolyse from cholinesterase enzymatic site. • Carbamates do not penetrate the CNS effectively. Therefore, toxicity to CNS is very limited. • Other manifestations are similar to the organophosphorus poisoning[6].
Fatal Dose : **Fatal Period :**	For carbamates it ranges between 25 mg to 350 mg orally 30 min to three weeks[7].
Postmortem Appearances	• Sign of asphyxia are common as in case of organochloro and organophosphorus insecticides.
Medicolegal aspects	• It is used for suicidal purposes.

	• Commonly used as surface sprays or baits to control of household pests. • Accidental poisoning may also occurs[2].

[5] K Vij , Textbook of Forensic Medicine and Toxicology: Principles and Practice, Chapter 43 p. 531, Agro-chemical Poisoning, 5th edn., (Elsevier, 2011).

[6] L. D. Schulze, C. L. Ogg, E. F. Vitzthum, University of Nebraska Cooperative Extension EC97-2505 - A Signs and Symptoms of Pesticide Poisoning, http://www.rst2.edu/ties/ddts/university/docs/toxic.pdf.

[7] Lecture on Insecticide Poisoning, DOU, University of Health Sciences, D.U.H.S., http://www.duhs.edu.pk/curriculum/downloads/lec10-sem6-ENO2WK3-20130826.pdf.

MODULE 21

Component-I (A) - Personal Detail

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Language Editor (LE)		

Component-I (B) Description of Module:

Items	Description of Module
Subject Name	Criminology
Paper Name	History of the Questioned document examination and classification of Documents

Module 21 - History of the Questioned document examination and classification of Documents:

1. Introduction

In recent times, although digital world had taken advantage over all the areas, still documentation is important and necessary part of any legal, official or personal issue. Abundance of vital information can be extracted from documents which are related to a civil or criminal case. The will of a rich guy- was it altered or changed so a relative could be benefitted? Is the suicide note found written by the victim or someone else? Does the bank robbers left any invisible expression on hold up note which can probably give his address to locate?

The questioned document is discipline, often referred as forensic document examination, which is associated with the white collar crimes such as fraudulent cheques; while it can be used in any cases involving forgeries through writing. Before understanding questioned documents in detail, let us understand what define "*document"*.

Ordway Hilton gave the following definition for the word "document"(1)

"In a broadest sense a document is any material containing marks, symbols, or signs that convey meaning or message to someone; may be in the form of pencil, ink writing, typewriting or printing on paper"

It means almost everything we touch, manipulate and share is a form of document. We go through many documents in our day to day life, such as tickets, ID cards, bank notes, cheques, credit cards, letters, and any contracts and so on. When a child take birth, a document is generated called birth certificate and after death, called death certificate.

With reference to all contexts, Questioned Documents can be defined as (2),

"One in which the facts appearing therein are not true, and are contests either in whole or in part with respect to its authenticity identity, or origin. It may be deed, contract, will, election ballots, marriage contracts, cheque, visa, application forms, cheque writers, certificates, etc."

Now we understand the term questioned documents, now we need to understand what forensic document examination implies. The terms forensic document examination or questioned document examiners would indicate the analysis of questioned documents to answer the court's query by using various scientific tools and methods.

The query's or questions would vary from document to document which need to be addressed such as Does the writing belongs to A or B? Is document is original? Age of documents or is there is any alterations in documents? All sorts of examinations are conducted to answer all possible questions.

The Basic QD Examinations include:-

- Comparisons of signatures or handwritings
- Detection of any changes in documents such as alterations, deletions or insertions or substitutions.
- Decipherment of erased or obliterated matter
- Identification of counterfeits
- Analysis of charred, torn, water soaked, stained documents
- Ink and paper analysis

- Age of documents
- Sequencing of entry made
- Examination of indented or accidental or secret writings
- Examination of matters wriiten by machines like typewriters, photocopier or printer

For questioned document examination, combinations of examination techniques are employed to address the questions particular to type of documents. There are few common examples of documents submitted for the examination such as wills, cheques, contracts, birth certificates, suicide notes, deeds, financial records, legal files, personal diaries etc (3).

Learning Objectives

At the end of this chapter, students will be able to:

- This module will provide definition of the Questioned Documents and Forensic Document Examination and what are the basic components of the forensic question document examination.
- History and development of forensic document examination are described in chrological ways around the world and India in this module.
- Module also gives basic principles of questioned document examination and work of forensic document examiner for the civil and criminal cases.

2. Historical overview of questioned documents

Before we consider, detailed knowledge about how questioned documents are examined, let us know about history and types of document, we may encounter for forensic document examination.

Figure 1 Third Century- Roman Empire

The documents are ancient methods for communication or recording various activities, with documents of importance, there will be a question on its originality to prove. There is crucial face where forensic document analysis is required to check the genuineness of documents. Since the beginning of civilization, forgers tend to deceive people by simulating the writings of others. In the Egyptian rule, pharaoh used the seal for first time to identify royalty, but forger would alter it by melting and reseal it (4). Forensic document examination was first time used in third century in Rome where it becomes common to make fraudulent official documents. In the third century in the time of Titus and Anthony, protocols for the identification of the any forgery and way of forgeries detected were established by jurists under Roman law (5, 6). These protocols and procedures were not developed as it is today but fairly effective to prevent forgery.

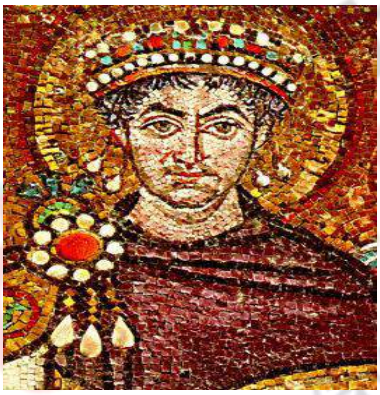

Figure 2 Roman Emperor - Justinian

In the sixth century (539 AD), Justinian Code on handwriting comparison was conducted for the guidelines for the handwriting examination in Roman courts. The Roman emperor, Justinian established further in the court of roman law guidelines for the using of handwriting comparisons. The judges may use power of discretion if required to examine the written documents by the person who had special skills for writing and provide testimony as the originality of the contested text. Although, the handwriting examination was purely based on likeness and similarities in two subsets without any science application. These guidelines improved the detection of forgery. Years after, the Justinian Code on handwriting comparison was accepted and practiced in European countries (7). These handwriting comparison methods were practiced in Spain where public servants were appointed to detect any forgery in official documents by sage Alfonso X. In France, “Master writers” were those experts who do handwriting comparisons.

In 1887, with reference to case of Brewster vs Bell, The Supreme court of Ohio realized the importance of handwriting to identify the person. On the basis of standards of comparison, handwriting experts may provide testimony that the writing belongs to specific writer or not (8). This led to use of scientific approaches to strongly opine on the handwriting comparison.

2.1 Document Examination in Scientific World

The field of handwriting comparison was given support to the invention of photography in 1890s as the photographs could be enlarged and could provide a better visualization to study even a minute detail in the documents consisted of extended handwritings and signatures.

In one of famous case of public document forgery, Alphonse Bertillon, a Frenchman who invented anthropometry and a photographer accused an army officer of altering documents which was challenged later by the forensic document experts from US and England and finally charges were exonerated from that army officer.

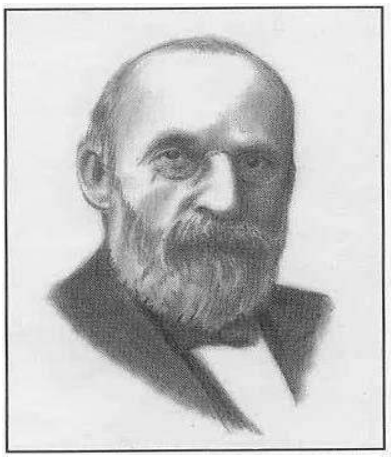

Figure 3 Daniel T Ames

In the 1890s, handwriting examination was started establishing in US, when there is introduction of scientific tools and methods in this area. Forensic examiners started using microscopes, chemical reactions, photography etc in their daily document examinations (9). During 1890-1900s, handwriting examination was common enough in Eastern courts and two of the examiners; W.E. Hagan and P. Frazer, published a books entitled "*Disputed Handwritings*" (10) and "*A manual for the study of Documents*" by Frazer. Just after these issues, few year later in 1900, Daniel T Ames published a book "Ames on Forgery" was the one of the earliest treatises by the founder of the Penman' Art Journal (11). These three books had given some insights to the examination of the handwriting and provided some sort of base. Frazer revised his book in 1901 and retitled as "*Bibliotics: A Manual of the study of Documents"* and also provided French version of the same book (12).

Figure 4 Albert S Osborn

During 1900s, a pioneer in the field of document examination, Albert Sherman Osborn published several articles including the most cited one on typewriting identification in 1901 (13). In this era of 1900s, Osborn articles had been dominated the field and 1901, he published the first edition of one of the greatest book entitled "*Questioned Documents*" and with some modification second edition of the book was published in 1929 (14). Although the book was written in 1910 but it application is still found in modern world as well. The principles stated in the book are still very true for the cases involving handwriting and signature detection. This book is the cornerstone for the questioned document examination and Osborn is also recognized as the father of science of document examination.

3. Brief History in India and World – Questioned Documents

In India in start of 1900's, The British Government of Bengal required identification of the secret handwritings on the documents recovered 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 (15). This setup 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 Brewester, 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.

The comprehensive textbook "*Questioned Documents"* which covered almost all the aspects of handwriting and signature identification in detail and also explained other types of evidences on documents including pen, paper, ink, typewriting and alterations etc. Osborn was one of the legal document examiners in major cases and was concerned for any document work such as examination methods, new techniques employed, court presentation and legal matters related to documents. During his career lifetime, he had published many articles on legal issues and document examinations (2).

In 1923, one of the landmark case of Frye vs United States (293 F, 1013; DC Cir. 1923) provided standard known as Frye Standard or Frye test or general acceptance test. The District court of Colombia had rejected the validity of polygraph test as it did not had significant acceptance in scientific community and court provided guideline for admissibility of scientific evidences (16). These guidelines for the acceptance for document examinations expert testimony were also applicable. Another landmark case in Virginia (Adams vs Ristine), court raises questions on scope of cross examination of expert testimony, qualification of expert to give testimony and use of photograph as evidence. It provided certain rules and guidelines before testimony is accepted in court of law (17).

In lieu of all the examinations testimony, the first organization forensic science laboratory, "the Scientific Crime Detection Laboratory in Chicago, IL, was established in 1929. Initially, the lab was under private firm, but with the continuous efforts of Professor John H Wigmore, the laboratory was affiliated by School of Law of Northwestern University.

Osborn had long discussion meetings with other experts in the field to constitute an organization which can formally related questioned document examination. In 1942, American Society of Questioned Document Examiners was formally founded under Albert S Osborn was established. The ASQDE focused on educational fulfillment and annual gathering for the full participation in the program and the organization was considered primarily as a professional institution giving support to research in the field of document examination.

Another organization, The American Academy of Forensic Sciences was founded in 1950 (18) and the forensic document examination to be considered as a discipline to be included. In 1952, two examiners were included as a member and Ordway Hilton was designated as chairman and he took forward to make a active section. After second revision of Osborn's book, Hilton tried to update through his writings "Scientific examination of Questioned Documents" in 1956 and after few years another book followed "Evidential Documents" by James V.P. Convay in 1959 (1).

Later in 1969, as revised version of Charles Scott's "Photographic evidences" was published which mentioned the importance and suitability of photographic documentation in examinations in detail. Various important articles were published in *Journal of Forensic Sciences* and the *Journal of Criminal Law*. With the help of these and other foreign journals, common consensus would have made on the examinations of questioned documents.

For the certification of the document examiners and to improve quality of questioned document work, a national certification program was developed. Officially, The American Board of Forensic Document Examiners, Inc was organized for the first time in 1977 under the chairmanship of John J Harris for certifying questioned document examiners. The ABFDE stated two clear objectives of the board; first to maintain, establish and improve standards of qualification for those who are forensic document examiners and certifying applicants who match with guidelines and requirements by ABFDE (3).

Historically questioned document examination is a comprehensive profession, but so-called pseudo-experts (in palmistry and fortune-telling) were sometimes encouraged to call so, and even today, it suffers from a bit of identity crisis in that at least eight different, or related, areas can be identified:

Questioned Document Examiners - Analyzes questioned document of any source and is capable of more than just questions of authorship limited only by their access to laboratory equipment

Historical Dating - These is work involving the verification of age and worth of a document or object, sometimes done by a document examiner, and can get as complicated as Carbon-14 dating

Fraud Investigators - This is work that often overlaps with that of the document examiner and focuses on the money trail and criminal intent

Paper & Ink Specialists - These are public or private experts who date, type, source, and/or catalogue various types of paper, watermarks, ink, printing/copy/fax machines, computer cartridges, etc., using chemical methods

Forgery Specialists - These are public or private experts who analyze altered, obliterated, changed, or doctored documents and photos using infrared lighting, expensive spectrography equipment, or digital enhancement techniques

Handwriting Analysts - These are usually psychology experts who assess personality traits from handwriting samples, also called graphologists or graphoanalysts;

Forensic stylistics- Refers to the same purpose, but by looking at semantics, spelling, word choice, syntax, and phraseology.

Typewriting Analysts - These are experts on the origin, make, and model used in typewritten material

Computer Crime Investigators - This is an emerging group that relates to QDE through some common investigative and testimonial procedures.

4. Types of Questioned Documents Evidences

Questioned Document forgery is very common among the most reported crime in civil and criminal cases. The type of evidences varies from case to case and can be characterized into two major categories; Patent and Latent. Latent document evidences are those which are not visible to the naked eye and need external aid to detect or identified the things and patent are those which have individual characteristics and visibly identified.

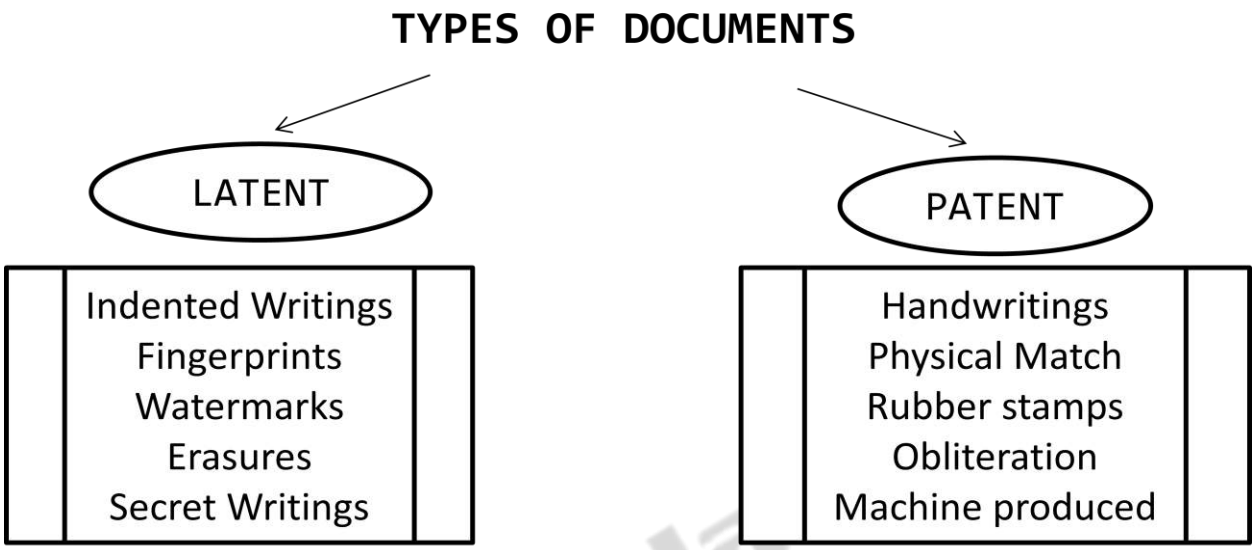

Fig 5. Types of documents which are encountered in forensic departments.

In the Fig 5, we can see the types of documents encountered by the experts like a fingerprints on the paper or secret writings employed to convey messages or watermarks etc. The patent documents are majorly found in a forensic scenario such forgery found in bank cheques, forged signatures on wills, deeds or official documents, fabricated documents using computer applications etc. All such documents are deposited by the investigating agencies to examine for its authenticity.

5. Principles and Guidelines for the Questioned Documents

For the better understanding of the handwriting or signature identification, some major principles were constructed by the pioneers of the experts to address the problem. These principles are universally applied to all sorts of the writings in any languages. These principles are followed all over the world by most of questioned documents experts in legal cases to assist the court of law. We have discussed here principles in different categories to understand.

5.1 Principles of Identification

The basic principle behind the identification of handwriting is based on the idea that "people are all alike; people are all different". To be able to make a positive identification of a person, a document examiner must be able to observe the distinguishing individual features which separate one person from all others.

All handwritings are alike. If this were not so, we would not be able to read another person's handwriting. All handwriting is different. If this were not so, we would not be able to identify the handwriting of close relatives and friends with whom we correspond (19).

5.2 Similarities and Differences

Any two writings in the same language and especially those based on the same writing system, naturally, have similarities and when closely examined, two writings by the same person show some natural and inevitable variation in letter form, which must be weighed, measured, noted and accounted for by the expert.

In the identification of handwriting all characteristics of both the questioned and specimen writings must be considered. Basic handwriting habits common to both must agree if all are the work of the same writer. Any single fundamental dissimilarity between two samples of writing is a strong indication of two writers, unless this divergence can be logically accounted for.

Several repeated fundamental dissimilarities establish that two writings are not the work of a single person. Under no circumstances, however, can identity be established by one, two or even several unusual characteristics. Rather, if two writings have been produced by one individual, there will be a combination of a sufficient number of similarities without any fundamental dissimilarity so that all chance of accidental co-incidence is excluded (1).

6. Class and Individual Characteristics

All the factors which identify handwriting fall into two general and somewhat overlapping groups - class and individual characteristics.

1. *Class characteristics* are those common to a number of writers and may result from such influences as the writing system studied, family associations, trade training, or foreign education as well as carelessness and haste in execution.

2. *Individual characteristics* are those which are highly personal or peculiar and unlikely to occur in combination in other instances (2).

All these individual characteristics are explained in the next chapters.

The Questioned document examination is now well established and demanding field in forensic science as it requires skills and extensive evaluation. As the rate of crime related to documents is far more than any other crime, need of document experts are much more required than any other forensic field. With the help of forensic document expert opinion on disputed documents, the court takes decisions on various criminal and civil cases.

Summary

Questioned document examination is very primitive science, used in pre-medieval periods and also one of the most demanding science around the world. The forensic document examiners examine all the questioned documents whose authenticity are challenged. Starting from the Egyptian rule and till date, history had been extensively filled with documents, presentations and their examination prove its authenticity. This module brief discusses about all the major historical development in the field of forensic questioned document and its examination. Documents are also categorized into different types on the basis of their use. Some of the important involved in the identification of handwriting hab been briefly discussed with reference to the class and individual characteristics. Handwriting and its genuinity had been put in question many time in past history and people have tried to put efforts in identifying genuine among forged documents.

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Subject: Criminology

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Component-I (A) - Personal Detail

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Items	Description of Module
Subject Name	Criminology
Paper Name	Forgery in Documents
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Pre-requisites	
Objectives	
Keywords	

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Module 22: Forgery in Documents

1. Introduction

Every individual at one time or another was asked to sign a document rather than merely putting a fingerprint to the paper as a method of identification. But why signature had replaced fingerprints? It would be simple to just place a our fingerprint on a cheque instead of a payer's signature? It may also prevent forgery. Yes or No? The answer behind the use of signature is that it is easier to read is illogical, as lots of signatures have evolved until, they are symbolic illustrations of ancient handwriting and are now illegible.

The answer to this question lies in the word "intent." By signing a document, the signatory are entailing intent on his/her part to consent with consequences provided by that cheque, postscript, agreement, contract, etc. One could intentionally and easily put the fingerprints of somebody recently dead or unconscious upon a document, if the fingerprint was only required for authentication. This does not assume, though, that the placing an inked thumbprint next to a payer's signature on a cheque, about to be consulted at a cheque cashing counter in a bank, would not be a help out. The fingerprint's universal implication would certainly, at the very least, be a prevention to the individual intent upon passing a forged instrument.

Handwriting and signatures are prone to be forged, over the years, many ways of forgeries had been employed to defy the concern person by the forger. Signatures are very common means of authentication in terms of banks transactions, cheques are vulnerable to be forged by imitating or copying signature of victim. These forgeries are needed to be addressed and what are the ways to identify these forgeries need to be discussed.

Learning Outcome

In this module, we are going to learn several points which are mentioned below:

- What is a forgery? Types of forgeries which are classified as per execution.
- Different characteristics of forged signature or handwriting, which identify the forge documents.
- Who should examine these forged documents on the basis of qualification and expertise.

2. Forgery: Defnition and characteristics

What do we understand with the term ‘forgery’? When the documents are called forged in the law of forgery? To understand forgery, we should well versed with the definition of forgery of documents in the legal term. “Forgery” in a stringent way is a legal term and its use as a result should most likely be avoided by the questioned document examiner. There have been proposed four characteristics for making a false document which need a attention:-
Making a false document by
(1) Signing a fictitious name;
(2) Passing off an otherwise true document by false representations dehors the instruments
(3) Signing one's own name;
(4) Writing a false address or description to a true signature (1).
Legally forgery is well defined in our criminal justice system. An underlying intent to defraud, based on knowledge of the false nature of the instrument, must accompany the act. Forgery is defined in our Indian Penal Code (IPC) under section 464 which states that;
Making a false document. — [A person is said to make a false document or false electronic record— First —Who dishonestly or fradulently—(a) makes, signs, seals or executes a document or part of a document; (b) makes or transmits any electronic record or part of any electronic record; (c) affixes any 342 [electronic signature] on any electronic record; (d) makes any mark denoting the execution of a document or the authenticity of the electronic signature.(2)
Tools of forgery may include bills of exchange, bills of lending, any notes of promise, bank cheques, legal bonds, cash or payment receipts, money order or order of goods, mortgages, discharges of mortgages, deeds, public records, account books, and certain kinds of tickets or passes for transportation or events. The compositions of forgery are Making false documents, liability to legal systems, forger identification and defraud intention.
An apt fraud requires superior to anything normal dexterity and a lot of practice. Creative ability helps, as well. Penmanship is an exceedingly complex neuromuscular action that requires coordination between the hand, arm, and fingers, and also the eyes. When realistic development has been come to – at the end of the day, once a kid has figured out how to compose – composing turns into a characteristic demonstration, obtained after some time. It is no more important to stop and consider every stroke and how to take care of business.Unless there is a physiological or psychological problem, genuine handwriting is usually smooth, spontaneous, and free-flowing, with less focus on the movement and more on the content (3).
The counterfeiter, then again, is compelled to keep up steady control over the pen, focusing eagerly on every moment point of interest. Under the magnifying instrument, the written work line will demonstrate successive stops and falterings, and the tight hold the counterfeiter must keep up on the pen, thusly, creates heavier weight on the paper. When he achieves the end of the mark, the counterfeiter has typically neglected to adhere to the casualty's

style and his own particular characteristic style creeps in. Subsequently, the penmanship inspector gives careful consideration to the finishes of letters, words, and lines, as opposed to the beginnings.

3. Types of forgeries in Questioned Documents

3.1 Simulation

With regards to falsification, one size does not fit all. There are different types, the most common type of which is the **simulation**. Simulation is a type of forgery that involves the perpetrator's use of a model of the victim's handwriting. The falsifier deliberately watches the genuine, and after that makes duplicates of the individual's mark to work on imitating it. As indicated by penmanship master Sheila Lowe, the falsifier pays consideration on the way capital letters look, drawing instead of composing the signature. His slip-up, in any case, is neglecting to notice such attributes as the spaces amongst words and letters, and the upper and lower lengths and the arrangement of the letters that makes an individual's penmanship novel. Counterfeiter endeavors to duplicate the pictorial attributes – the way the composition looks – with a specific end goal to make it as near the bonafide signature as could be expected under the circumstances. This is a significantly more burdensome assignment than it may sound. Attempting to duplicate another's writings or signature is likened to emulating the way somebody strolls or talks (any individual who supposes this is simple ought to attempt it!). Counterfeiter neglects to go to, yet what the report inspector takes a gander at, is the measure of space left amongst words and letters, the extents of the upper and lower lengths, the arrangement, and other unwittingly rendered qualities (4).

Various techniques are accessible for a counterfeiter to use in the development of a signature that may appear to the laypersons as real. These incorporate free-hand reenactment, following, and propagation by an electrostatic copier or PC. Free-hand recreation with a model accessible starts with the falsifier putting the original signature close to the paper on which the forged signature will be set. At that point, utilizing pen or pencil, the counterfeiter draws a photo of the authentic signature. Under amplification, such reproductions may uncover various pen stops and lifts or indications of rectification, alongside signs of a moderate, tremulous line quality. Less aesthetic counterfeiters regularly utilize tracings by different intends to deliver recreated marks (5).

3.2 Tracing

Another type of forgery is the tracing. Tracing is very crude method of forging the signature or handwriting. At the end of the day, the counterfeiter has a model of the honest to goodness genuine signature, which he may hold against a window, or use carbon paper or a light box, and place another sheet of paper over the top, and actually follow the line. Under the process of act, numerous begins and stops the counterfeiter gains as he checks his ground – called resting dots – which are promptly seen. Likewise, the forged written work is slower, and once in a while there is a indentation in the paper, which can be seen close by the ink line (6).

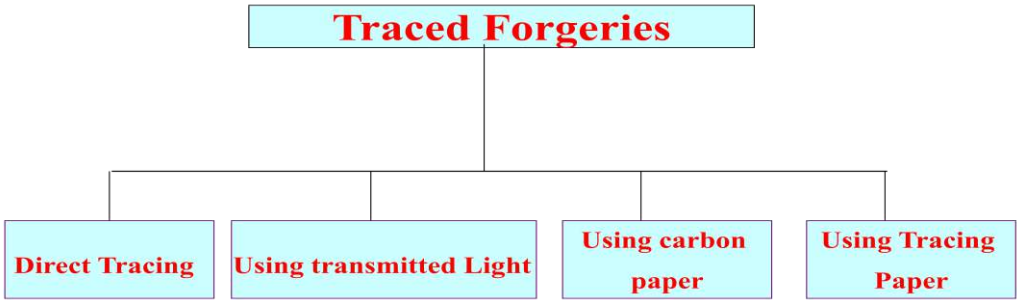

Fig 1. Classification of different types of tracing forgery

Tracing forgery is classified on the basis of the method of execution (Fig 1). Traced Forgeries display the rules which are present underneath the signatures. These rules might be as indentations or carbon outlines and ink strokes will be discovered holding fast to the rules. Direct tracing is the method where the forger uses direct original to trace in signature in forged documents without using any aid, whereas when a transmitted light is used beneath the document for the tracing are classified as transmitted forgery. Another way is to use carbon paper, carbon print is taken to forge document from original and carbon is covered up by ink using pine. By using tracing paper or butter paper, original signatures are traced by indentation and then writing it with an ink pen to cover the indented part made to document. These classifications of tracing forgeries provided the execution style, which is necessary to understand the nature of forgery. Knowledge of these methods of forgery are very important to identify these forgeries (7).

3.3 Cut and Paste Forgery

The cut-and-paste forgery is closely as the term suggests. A real signature is cut from one report and set on the spurious record, then photocopied. In the event that the lighting and determination is legitimately balanced, the record will seem genuine. Since one of the principle on which penmanship examination rests is that it is difficult to compose a signature 100% the same way twice, the simplest approach to demonstrate a cut and paste falsification is to find the report from which the name was copied. They will be indistinguishable, or to a great degree close if the counterfeiter is sufficiently astute to change some minor points of interest, for example, the last strokes. Indictment depends on the law implementation criminologist's capacity to locate the original signed document from where it had been copied, and analyze the suspect's penmanship on the false to that of the first. Since no two parts of penmanship are indistinguishable, the counterfeiter abandons himself open to conviction by overlooking a couple of minor points of interest, for example, the way his casualty works out her numbers (7, 8).

3.4 Electronic Forgery

Electronic forgery is also closely related to the cut-and-paste forgery. In the advanced computer era, the scan and-drop strategy has developed. The PC gives the counterfeiter a strong weapon. The falsifier basically digitizes a genuine signature by high resolution scanning, then embeds it into the spurious archive and prints it. Under the magnifying lens, in any case, the pixelation uncovers that it has been digitized (9).

3.5 Freehand Forgery

This is another kind of fabrication where the falsifier essentially composes the another's name without making any effort to duplicate. He basically signs a structure in his own particular penmanship, now and again picking wording or stating of his own. The Fraud and Forgery Division of the forensic science labs is said to have many illustrations where the counterfeiter has kept in touch with some made-up expression, camouflaged as a signature. As per Lowe, this is the most effortless kind of signature for a falsifier to attempt. It will diminish his odds of arraignment, since it is more troublesome for analysts to peruse the two penmanship tests with a specific end goal to make a positive correlation (3, 10).

4. General indications of non-genuineness may include the following:

4.1 Blunt beginings and endings: The falsifier puts the pen point in contact with the paper, and afterward begins composing. When he is done with the name or some bit thereof, he stops the pen and lifts it from the surface (Fig 2). This may bring about an underscored blunt start or completion where the pen was set in contact with the surface. Now this contact is held so long that if the pen contains a liquid ink it will wet the paper and relocate outward from the contact indicate or even through the back of the paper.

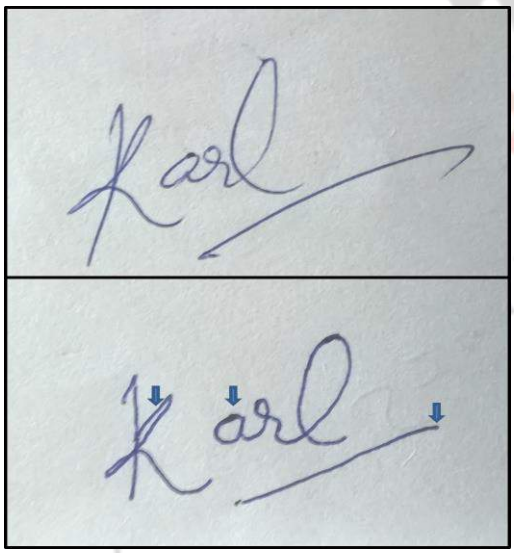

Figure 2 Signs of Forgery shown with the arrow marks.

There might be pointless and incidental imprints brought on by pen begins and stops. The author may choose subsequent to put his pen in contact with the paper, that it is in the wrong spot, lifts it up and moves it to a position considered more right. Regularly a mark's begins and stops are a great deal more dynamic. The pen is moving on a level plane before it contacts the paper and is lifted toward the end while still in flight. This leaves a decreased appearance at the beginnings and endings of names or letters. There are, obviously, special cases for this (11).

4.2 Unnatural Pen lifts and unusual hesitation: Sometimes, when the pen stops at an uncommon point in the composition of matter; maybe where a radical alter in the course is going to happen or another letter development is going to be begun. This may look like presence of little gap in the composed line where one is not expected, or a covering of two ink lines where there

ought to be one and only consistent line. The pen lifts and hesitation point out the signs of forgery in the document (7).

4.3 Forger's Tremor: Tremors may occur in writing or signature due to old age, or some illness or poor skill in writing (12), it may look similar to forgery, either by tracing or simulated. Since the formation of most types of n fake signatures is more similar to the drawings, the pen moves so gradually that little, now and then microscopic variations in course occur in what ought to be a liquid-looking line. The resultant line is not smooth, but rather look like the "shaking" pen.

For the identifying forger's tremor two ways are basically employed. First is by elimination, elimination of any other doubts by analyzing the samples from the original writer or admitted writings during that time of forgery (2, 13).

4.4 Speed and pressure: Ordinary penmanship is uninhibitedly and quickly executed and in this way typically described, particularly, when a nib-pen is utilized, by light and hairline upstrokes and shaded or substantial down strokes. Although ball point or felt tip pens have a tendency to minimize this difference between strokes, it is still a big element in composing. Again in forged writings, in light of the fact that the pen is moving gradually instead of with the dynamic movement connected with most authentic compositions, the ink line stays steady in thickness because of the same consistent pressure applied to a gradually moving pen. There will be less, assuming any, decreasing of inner lines (14).

4.5 Patching: Occasionally, however, at some time, a most of us have made a mistake while composing our own signature. A few people may allow the signature to sign unbothered, thinking minimal about the oversight or flaw, while others will essentially "alter" the signature by adjusting the culpable part. This might be done keeping in mind the end goal to make the signature more discernable, or in light of the fact that an imperfection in the pen or paper has influenced what we see to be our "ordinary" signature, or for some other reason that may even be intuitive. These "fixes" are generally patent, with no endeavor made with respect to the author to veil or generally shroud the redress (7).

These signature amendments are not exactly the same as the settling that is frequently found in non-authentic signatures. On these occasions, the creator is not attempting to make the signature more clear, but instead to appear satisfactory. He is changing an obvious blemish that he sees as discernible, and might uncover his forged thing and foil his arrangement. These generally show up as a change in accordance with a blemish in the structure line rather than as a letter. Enlargements to section or terminal strokes, or to cut down jumping bits of letters, nearby amendments to embellishments, are ordinary of non-true blue settling (15).

4.6 Carbon Outlines and Indentations

As showed before, traced signatures may hold evidence of their technique for generation, for example, carbon or graphite follows or out-of-line indentations. Forger tries to eradicate carbon-paper or graphite imprints may yet leave hints of those substances: if not, confirmation of the deletion itself might be

distinguished by different means. As well, demonstration of erasing may harm or dull the signature or other traced composing, and this might be seen by microscopic perception. Infrared photography will infiltrate numerous overlying inks and along these lines uncover the carbon following (carbon being dark to infrared). Diagonal or oblique lighting may improve the indents visualization and show that they don't precisely relate with the inked line of composing (16).

There are times when some of these same forgery indicators will be displayed in genuine signatures. Aged or informed writers will frequently display similar patterns. The mere presence of these indicators does not mean that the signature under scrutiny is non-genuine, but should contribute to the overall determination as to genuineness. Alternately, the signature devoid of these indications may not be assumed to be genuine. The signature of an elderly individual may, for instance, be expected to contain tremor and hesitation. If, however, the questioned signature appears to be written in a fluid manner and/or on a higher skill level than what is expected, the red warning flag should be waving. This occurrence may itself be indicative of non-genuineness. Often, a forger, because of an inherent high skill level in his writing, may produce a product that contains fewer indications of forgery than a counterpart with a lower skill-level (3).

5. Selecting a Handwriting Expert

At the point when the help of a penmanship master is required to reveal reality about the realness a signature (or other penmanship), the legitimate consultants or legal advisors is all around encouraged to choose the experts with consideration, as there is no proper licensing in the field of penmanship examination except for the government document examiners. In this field, as in others, there are the individuals who have earned themselves the notoriety of an enlisted firearm.

To maintain a strategic distance from potential issues, the experts ought to be a present part on favorable terms of a legitimate penmanship examination association (not only an extortion analysts association, for example, the National Association of Document Examiners or Association of Forensic Document Examiners, for instance or working with presumed scientific science research facility with great scholastic and useful foundation.

Summary

Forgery of documents is common now a days, signature and handwriting forgery are need to be tackled in more technical and scientific ways. Any deliberate attempt to alter or modify the documents by adding or editing the marks, symbol or other written material is termed as a forgery. Forgery is categorized in different ways on the basis of the method used for the forgery. From crude to technical forgery are considered for the examination by the document forensic examiners. Tracing and simulation are the common form forgeries identified and examined. There are well known characteristics of these forgeries which are found in the cases. These features of non-genuiness should be analyzed by the document specialist to address the problems. Slow speed, blunt starts and stops, unusual tremors, evenness in

pressure, carbon outline or indentation in terms of tracing forgeries are some of the major identification features for the forged signatures or handwritings. For identification of these forgeries, a document experts are needed. The document expert should be specialist and known with the facts and procedure for the conduction of examination. Forensic document examiners had gained their knowledge and expertise through proper channel and licensed to practice.

MODULE 23

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Component-I (B) Description of Module:

Items	Description of Module
Subject Name	Criminology
Paper Name	Handwriting examination: General and individual characteristics and rules for handwriting examination

Module - 23

Handwriting examination: General and individual characteristics and rules for handwriting examination

1. Introduction

Handwriting or Penmanship is a procured aptitude and unmistakably one that is a complex perceptual-engine undertaking, now and then alluded to as a neuromuscular errand (Hilton, 1992). Talented writing movements are so common nowadays that person may ignore their multifaceted nature. Without distortion, be that as it may, writing is a standout amongst the most progressive accomplishments of the human hand. Handwriting is a yield of adjusted coordination between hand muscles and mind. Three districts regions of mind plays vital parts in writing; a first primary motor area which controls over fine developments; second pre-motor region which offers control to our visual direction and third is supplementary region which manages muscle and sequencing of terminating. The hand is a to a great degree intricate and sensitive component, containing approximately 27 bones controlled by more than 40 muscles (Marquardt and Mai, 1994; Wing, 2000). The majority of the muscles are arranged in the lower arm and interface with the fingers by an unpredictable arrangement of ligaments. Their capacity in controlling a written work instrument is exactly organized by a planning framework under a neural control of developments of the arm, the hand, and the fingers. The exact requesting and timing of the developments decides the structure of the example that is recorded by the pen or pencil (Osborn, 1946).

The development of writing is complex because it is, in part, culture dependent, and cultures differ with locales and undergo constant change. The evidence of this dependence is manifest in class, system, or national characteristics. Writing is a continuous or flowing task, not one of discrete or separated actions. There are apparent interruptions at word boundaries, but in many cases the pen movement may be continuous and uninterrupted, although not recorded as an inked line (Luria, 1977).

Learning Outcome

From this module a student will learn:-

- Definition of handwriting and handwriting examination. Importance of handwriting in forensics
- Examination of handwritings and signatures.
- Priniciples involved in handwriting identification
- General and class characteristics of handwriting identification.
- Characteristics of forged handwriting or signatures

2. Why handwriting is important?

Writing has a very long history. It began as simple pictographs drawn on a rock, which were then combined to represent ideas and developed into more abstract symbols. Just like our writing today, early symbols were used to store information and communicate it to others. In recent years, modern technology has dramatically changed the way we communicate through writing. However, despite the increased use of computers for writing, the skill of handwriting remains important in education, employment and in everyday life.

Time devoted to the teaching and learning of letter formation in the early years will pay off. Legible writing that can be produced comfortably, at speed and with little conscious effort allows a child to attend to the higher-level aspects of writing composition and content. This is important when assessments are based on written work, particularly in time-limited written examinations, which remain as a major form of assessment for many formal qualifications. Without fast and legible handwriting, students may miss out on learning opportunities and under-achieve academically (Feder and Majnemer, 2007).

3. Principles involved in handwriting identification

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 time frame in which it was created, identify the materials used in its preparation or uncover modifications to the original text.

I. All other things being equal, the significance of any combination of characteristics, qualities, and features as evidence to establish the identity of a writer is (Koppenhaver, 2007):

A. Directly proportional to the speed, spontaneity, and naturalness with which the writing is written, and

B. The frequency of occurrence in random writings of the combination of those particular characteristics, qualities, and features of the writing that when considered collectively making it identifiable.

II. Given a sufficient amount of handwriting, no two skilled writers exhibit identical handwriting features. The examined writing, questioned and known, must be suitable and sufficient in quantity and quality to conduct a meaningful examination and comparison. In some instances, either the questioned or known writing is so limited or lacks sufficient individuality that a meaningful examination and comparison to determine authorship is not possible. Some letters and letter combinations, written singularly or in a limited combination, such as “eo,” “ee,” “ion,” a name like “Lee,” consists of repetitive garland or arcade movements that are supposed to represent letters and letter combinations, or numerals, such as a “1,” may not contain sufficient individuality for a meaningful examination and comparison and determine their authorship. Initials are frequently unidentifiable because by themselves, they may not be sufficient to identify their writer. When any of these factors are present, either singularly or in some combination (Huber and Headrick, 1999):

A. It may not be possible to reach any conclusion concerning the identity of the writer of the writing. In other words, the examiner begins the examination and comparison process from a position of neutrality and the observable evidence in the writing is not sufficient or significant enough to move him from that starting position.

B. In some situations there may be sufficient observable evidence within the examined writing to reach a very qualified conclusion, such as evidence was noted to indicate or suggest that…, and no higher. As in every case, the conclusion reached by the examiner must be based only on the examination and comparison of the examined writings.

III. The comparison process can become more difficult because of the adverse influence of one or more factors on either or both the questioned and known writing. Two examples are:

A. Unnatural writing resulting from a transitory or permanent factor affecting the writer at the time he is writing, i.e., stroke, drugs, alcohol, a cold writing hand, writing surface imperfections, etc.

B. When the writer attempts to conceal his normal handwriting habits by deliberately disguising his writing, he may write more than one style of writing, etc.

When examining writing affected by one or more of these factors, it may not be possible to accurately determine the significance that should be attached to the combination of characteristics, qualities, and features of the writing necessary to unequivocally identify or eliminate a writer. In such cases, it may be possible to reach a qualified conclusion.

IV. Based on the collective experiences and writings of Forensic Document Examiners over the years, no two writers have been found to write exactly the same way, nor do they incorporate in their writing exactly the same combination of characteristics, qualities, and features. Some writers have been found to have more than one style of writing that they can write with equal proficiency. These variations are called natural variations. Natural variations in handwriting are marks of genuiness and also considered as consistency in handwriting. By Definition “Natural Variations is the imprecision with which the habits of the writer are executed on repeated occasions”. Natural variations are expected attribute of the standards, for which allowance must be made in the study of any apparent disparity between standards and the unknown or questioned writing. Individuality of handwriting also comes with the natural variations in one’s writing (Arora et al., 2002).

A. There is the possibility that two limited writings may be so close in characteristics, qualities, and features, that the individual writers of each cannot be determined.

B. In like manner, no single writer has been found who can write exactly the same way each and every time. Some normal range of variation in writing is expected in everyone’s writing. The extent of that range of variation is dependent upon that individual writer’s level of graphic maturity, as demonstrated by his relative speed of writing, pressure habits, and a multitude of additional factors outside the scope of this paper.

V. In simulating or tracing another person’s writing, the imitator’s goal is to copy or draw those characteristics, qualities, and features of the model writing that strike his eye most forcibly. Typically, in a simulation, the simulator many times disregards those characteristics, qualities, and features of the model writing that are less conspicuous, or that he knows he cannot write. There may also be numerous other characteristics, qualities, and features of the model writing that he may never notice. Are there writers who can simulate writing so successfully that what they write cannot be distinguished from the model writing they used? Yes, but thankfully the number of writers having this skill and ability are rare (Morris and Morris, 2000).

4. Class Characteristics of handwriting

The class characteristics of handwriting are defined by number of times by different experts. Ordway Hilton defines it as “Not all characteristics encountered in document examination are peculiar to a single person or thing, and one that is common to a group may be described as class characteristics (Osborn, 1929). In a paper entitled, “Handwriting Identification for the Investigator”, the definition is, “Class characteristics belong to the system or style of writing the person learned. They may also be forms or features added to the letters by environmental or cultural influences (Morris and Morris, 2000).

Everyone’s writing consists of combination of “class” and “individual” characteristics. To what extent and in what combination is dependent upon the individual. This is one of the basic reasons why handwriting is identifiable.

Experts usually examine the following characteristics when examining handwriting samples:

1. Line quality: Do the letters flow or are they written with very intent strokes?

2. Spacing of words and letters: What is the average space between words and letters?

3. Ratio of height, width, and size of letters: Are the letters consistent in height, width, and size?

4. Lifting pen: Does the author lift his or her pen to stop writing a word and start a new word?

5. Connecting strokes: How are capital letters connected to lower-case letters?

6. Strokes to begin and end: Where does the letter begin and end on a page?

7. Unusual letter formation: Are any letters written with unusual slants or angles? Are some letters printed rather than in cursive?

8. Pen pressure: How much pen pressure is applied on upward and downward strokes?

9. Slant: Do letters slant to the left or right? If slant is pronounced, a protractor may be used to determine the degree.

10. Baseline habits: Does the author write on the line or does the writing go above or below the line?

11. Fancy writing habits; Are there any unusual curls or loops or unique styles?

12. Placement of diacritics: How does the author cross the t's or dot the i's?

It is virtually impossible to find any writer who can imitate exactly all of the characteristics, qualities, and features of another person’s handwriting while simultaneously suppressing his own. This does not mean the simulator can be identified as the writer of the simulation based on the presence of their handwriting characteristics in the simulation (Turnbull et al., 2010).

5. Individual Characteristics of handwriting

Handwritng is unique to each individual. Although some peoples’ handwriting may have similar styles and characteristics in common, acquired when these people learned to write by copying letters and words, they tend to take on individual styles with age. Also, as a person ages, their handwriting will show additional changes (Hilton, 1983).

Depending upon his success at simulating the model writing, he may incorporate some of his writing characteristics, qualities, and features in the attempted simulation. When this occurs, it may or may not be possible to reach some qualified conclusion concerning the probability of his writing the simulation. By definition, if the writing is a simulation, the writer is copying a model that is either in front of him at the time he is writing, or he is writing the simulation from memory. It is virtually impossible to find sufficient evidence in a simulation to identify the writer of the simulation (Morris and Morris, 2000).

The following is a universally accepted truth or axiom of handwriting and hand printing identification. The result or opinion rendered in all examinations and comparisons performed by any Forensic Document Examiner is based only on the evidence present in the actual document or documents examined, giving consideration to any factor(s) affecting the writer at the time of that writing.

All conclusions concerning authorship of writing on documents is based on the examination and consideration of the evidence on a specific, examined document. A conclusion reached based on the examination and comparison of a copy, photocopy, fax, microfilm, carbonless paper, etc., purportedly of an original document of whatever type and generation cannot be extrapolated back to the original the copy purports to represent.

It is not prudent, nor can it be justified to make the assumption that the examined copy is an accurate representation of an original document without comparing the copy to the original it purports to be a copy of. Rather than an original, the copied document may actually be a copy of a copy or even a fabricated document and no truly original document exist. There will always be evidence on the original document that will not be present on the copy. The examiner has an ethical obligation to advise the submitter of this fact.

There are several reasons why this is a universal truth or axiom. First, the process of photocopying and/or faxing documents introduces into the copies defects and distortion. Therefore, the writing on the copy cannot be exactly the same as the original document that is being copied. The most recent and accurate work in this area was done by Mr. Robert Gervais.1 His work demonstrates the introduction of defects and distortion in photocopies when the controlled original is written with blue and black ink, for both slow and rapid writing, and at different degrees of copy darkness, and different generations of the copy.

In some situations, the examined copy may actually be a first, second, third, or greater generation copy, all of which were produced on different photocopiers. In some instances, a photocopy and not an original was placed in the fax machine for transmission. In this situation, the problematic nature of the received fax is compounded. If the copy submitted for examination is a fax of a fax, the submitted document is even more problematic for a meaningful examination and comparison. In every case, the original document is the best evidence. A first generation photocopy of an original is second best (Hilton, 1988).

6. Handwriting & Signature Examination

When there's a suspect in a crime and the evidence includes a handwritten note, investigators may call in handwriting experts to see if there's a match. In some cases, it might be the one piece of evidence that gets a suspect charged and eventually convicted. But what if it's a false match? How exactly do experts go about analyzing someone's handwriting?

In handwriting analysis, Original documents must be maintained for evidence. Handle original documents as little as possible. Keep them protected in archival sleeves or folders. Never work with original documents. Always make copies to work with (Osborn, 1946).

First of all, examine the class characteristics of handwriting as discussed in previous topic. Like examine the spacing between letters and words. Use a ruler to measure typical spacing, examine the relative height, width, and size of letters. Use a ruler to measure these for comparison, examine pen lifts and separations, some letters and combinations will be continued while others may not be connected, look at the beginning and ending strokes of words and letters and any connecting strokes, are there any unusual letter formations such as loops and curls or a mixture of cursive and printing of letters?, Is there any shading of letters due to uneven pressure applied in writing? Examine the slant of the letters. Do they slant left, right, or not at all? Are the slants consistent throughout the writing sample? Measure the angles of slant using a protractor. Examine the baseline habits. Are the words and letters on the baseline or are they above and below. A ruler will be helpful in determining this. Look for flourishes and embellishments. Using small circles to dot i's or for periods, loops of capital letters or ending letters, etc. Are there any unusual letter formations? Look at the placement of diacritics. Are the i's dotted and t's crossed? Individuals tend to dot i's and cross t's in unique fashions.

Class characteristics as mentioned, thorough examination may rule out various important factors, before examination of individual characteristics and signs of forgery.

7. Signatures and their examination

Signatures serves as mean of identification and are typically used in the course of business to authorize financial transactions or even establish the legality of important documents. Sometimes, the addition of a signature can increase the value of an item, such is the case of celebrity memorabilia. As such, the high value items attached to such signatures make them likely targets of forgery as compared to handwriting.

In a typical signature case, detailed microscopic comparative examinations are made of a set of known ("specimen") signatures and one or more questioned signatures, the writer of which is in doubt. Signature forgery can occur in many ways, including freehand simulation, tracing and image transfer. Alternatively, a signature may be written with some disguise with a view to disavow it at a later time. Chance coincidence in the signatures of two persons is rare but may be possible if the signature is particularly simple. It must be noted that a finding that a signature is genuine does not establish the genuineness of the document as a whole as it may be the product of some form of document manipulation (Fielding et al., 2001).

Signatures can be disputed on all kinds of documents including Wills, financial documents, contracts, agreements, cheques, application forms and receipts. Signature verification may be applied to cases involving alleged cases. The authenticity of signatures on business documents such as contracts or agreements often forms the point of contention between two parties in a civil dispute. In such cases, a forensic handwriting expert will compare the signatures on the questioned documents with specimens to determine if the said person could have signed those documents.

Attempts to forge signatures usually occur in three ways:

- Freehand simulation
- Tracing and
- Cut-and-paste: either physically or by electronic means using digital software.

FDS is also aware of the emerging use of electronic (biometric) signatures. We are familiar with certain technologies used to capture electronic signatures and the forensic analysis software required to interrogate them.

At times, there may also be deliberate acts of disguise by the writer, with the intention of denying the authorship of the signature afterwards. For examination of signatures, a forensic document examiner would have to consider the above possibilities and more. Our experienced document examiners are able to provide advice on the relevance of signature examination to your case and answer your queries.

8. Characteristics of Forged handwriting and signatures

Writing in forged documents tends to be slowly written and will show a lack of individuality. Letters tend to have an unnatural appearance as if the forger was drawing the letters. This makes letters inconsistent in the document, shows unnatural starts and stops and a general lack of rhythm to the writing. Any mistakes will show a careful correction. Signatures will be identical.

8.1 Disguised Writing

If a suspect attempts to disguise their writing, they will generally exhibit inconsistent slant and letter formations with a major change in the size of their letters. Capital letters will be different and they often will use block lettering. As they write, there will be a lack of rhythm, irregular spacing, and unnatural starts and stops. Occasionally they will add excessive ornamentation. Some individuals will try to write with the wrong hand. Signatures are the most frequent type of questioned writing encountered, although a person's handwriting also frequently attracts attention in litigation. Forensic signature examination and forensic handwriting examination are both discussed below. The terms "examination" and "analysis" are often used interchangeably but, in the context of the work that FDS undertakes, their meaning is strictly scientific. Our examiners are forensic experts, not graphologists, and our work does not involve attempting to tell one's personality from their writing ("graphology") (Harris, 1952).

8.2 Normal Hand Forgery

During the creation of this class of non-genuine signature, the writer simply writes someone else's name. There is no attempt made to duplicate or make the forgery look like a genuine signature. Any resemblance to the genuine signature is coincidental. Usually, the perpetrator of this signature does not have a model signature at hand and/or the skill level or forethought to attempt an emulation. If he does not attempt to impart disguise to the writing, the resultant product will display characteristics of the forger's own handwriting. Armed with adequate standards of both the individual whose name is being used and exemplars of the suspect, the document examination may be definitive to the point that not only is the signature declared not genuine, but the forger is also identified (Herkt, 1986).

8.3 Simulation

The simulated signature, or "free hand forgery" as it is sometime known, is the usual bill of fare for the questioned document examiner. This forgery is constructed by using a genuine signature as a model. The forger generates an artistic reproduction of this model. Depending on his skill and amount of practice, the simulation may be quite good and bear remarkable pictorial similarity to the genuine signature.

Many simulations created with a model at hand will contain at least some of the general indicators of forgery, such as tremor, hesitation, pen lifts, blunt starts and stops, patching, and

static pressure. They will have a slow “drawn” appearance. The practiced simulation is most often a higher quality creation in that the model signature has been memorized and some of the movements used to produce it have become semi-automatic. This simulation can be written with a more natural fluid manner.

Both practiced and non-practiced simulations will still have notable shortcomings. The forger naturally puts his greatest effort into those parts of the name that he expects to fall under the greatest scrutiny. Although letter forms (especially the more prominent, large or beginning letters) may almost duplicate the genuine letters, proportions and height ratios will seldom be correct. Internal portions of the names (smaller, less prominent letters and pen movements) will usually display the greatest divergence from the correct form and movements found in the genuine signature.

8.4 Signature forged by tracing Methods

Traced forgeries are generally created by one of three methods: “transmitted light,” “carbon intermediate,” or “pressure indented image.” While tracings may not normally present much of a challenge to the document examiner trying to determine genuineness, the ability to identify the perpetrator is totally precluded. Tracing another’s signature, or for that matter another’s handwriting, is the paramount form of disguise.

Total agreement between the model and the questioned signature dictate that the questioned signature was a product of tracing. No two signatures or handwritings, even from the same person are ever totally duplicated (due to natural variation). Just as certainly, total agreement between two, three or more questioned signatures is adequate demonstrative proof of tracing. Of course, the document examiner faced with total agreement between a number of signatures must take care that the model signature (genuine signature) is not one of the signatures in question (Morris and Morris, 2000).

8.5 Transmitted Light Tracing

The transmitted light tracing is the simplest of the tracings to produce and the one most often encountered. The paper that is to receive the spurious signature is placed over a document bearing the genuine signature. These documents are then aligned so as to put the genuine signature directly under the selected location for the forgery. These two papers are then held up to a window or other light source, and the transmitted signature image is traced on the receiving document.

The indicators of a transmitted light tracing are similar to that of a simulation and the two are difficult to tell apart (unless the model for the tracing is located). Height ratios and proportions in the transmitted light tracing are generally right on the money, however. These two features are frequently incorrect in the simulation (Hilton, 1992).

8.6 Carbon-Medium Tracing

At times, a carbon-medium tracing is the method of choice, especially if the document to receive the tracing is too heavy a weight, such as cardboard, to allow for a good light transmitted image. The carbon tracing is crude method of tracing as it involves two steps; first tracing the writing with the help of the carbon paper and then retracing the drawn traced mark of carbon by pen. During the covering up the traced line, carbon deposition are seen around the periphery of the written line by pen. These are major signs of carbon tracing apart from slow writing speed, blunt start and ends, tremors etc.

Because of the almost non-existent use of this sensitized paper in modern day machine copying processes, most document examiners will likely never encounter this problem. However, on occasion a similar phenomenon can be found when NCR (National Cash Register – no carbon required) paper is employed (Huber and Headrick, 1999).

8.7 Pressure Indented Tracing

Similar to a carbon paper tracing, the indented line tracing is produced in essentially the same manner, but does not employ any intermediate reproduction medium. Heavier pressure is used when tracing over the model signature. This pressure leaves an indented "signature" on the receiving document. This is then covered over with a broad-tipped pen, although ballpoint is found on occasion.

Almost invariably, the writer misses portions of the indented line. This error may be easily observed using glancing (oblique) light. Other general indications of non-genuineness are similar to those found in simulated forgeries (Nickell, 2005).

9. Summary

Handwriting is the one of the primitive form of identification and mode of communication. It is developed from childhood with practice. Handwriting is an outcome from the process involving brain, hand and eye coordination. Through lifetime, a unique set of pattern is developed by the individual. There are some basic principles involved in handwriting examination like no two skill writers can have identical writing, if provided with sufficient writing and all the writings would not be same for an individual, it may vary from the same word to the letters which is referred as natural variations. On the basis of different class and individual characteristics, handwriting and signatures are identified and matched with the suspected or victims writing. The signatures are more prone to be forged during the course of financial transaction between two parties, the forensic experts utilize these identify features of handwriting, apply principles and distinguish between genuine and non-genuine writings. Handwriting and signatures identification and examination need expertise and proper knowledge to give as evidence in court of law.

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MODULE 24

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Component-I (B) Description of Module:

Items	Description of Module
Subject Name	Criminology
Paper Name	Ink and paper analysis and techniques

Module – 24

Ink and paper analysis and techniques

1. Introduction

Document authentication is so important for any kind of trade commercially, security of border and law enforcement organizations that these kinds of examinations correspond to a discrete division of Forensic Science. Questioned document (QD) experts make use of an extensive range of techniques to aid in their examinations ranging from initial visual assessment tools to advanced instrumentation for chemical analysis experiments. Within the last 20 years, numerous potential new instruments of analyzing the physical and chemical structure of historical artifacts have been introduced. Rapid development in technology and modern techniques had unclear relative importance, especially to experts in fields where these analytical techniques recently been introduced (1).

The rational analysis of material form in manuscripts and printed books without the use of electronic aids has a much longer, if erratic, history. In systematic bibliography, for example, the study conducted by Carter and Pollard of the forgeries by Thomas Wise in 1934 was one of the initial attempts at using thorough physical evidence of paper material and lettering to display convincingly the falseness of documents (2). Their findings were well-designed in their sense and straightforwardness and provided a practical example of the worth of vigilant and methodical physical observation, a point of view that had in the past been neglected or even ignored in support of the document's substance.

The requirement of non-invasive forensic examinations of papers as well as writing and printing inks are very much needed. It is necessary to do so in matters where a question arises as to: whether a document has been altered; when an entry was written and/or a document created; the order in which entries were written; whether a document is genuine or counterfeit; recovering and deciphering faded/bleached/obliterated/erased entries; whether documents or entries thereon are original or reproduction; the method of production of a document; whether multiple documents have a common source; and so on. Therefore, critical analysis of the paper material and ink used is very important in many cases and can be useful in a court of law.

2. Learning Outcome

From this module, students will learn:

How paper and ink evidences plays role in forensic investigations

The paper analysis and method used for the analysis of paper fibres

Type of paper documents involved for the investigations purpose.

How ink analysis is useful in age estimation of the documents

Different techniques available for the paper and ink analysis

3. Evidence That May Be Examined

Questioned matter may consist of identity cards, agreements, titles and deeds, wills, seals, stamps, bank cheques and notes, handwritten communication, documents generated by machined (ex: fax machines, photocopiers and computer printers), currency and other electronic documents. In various conditions, graffiti and digital signatures may also be analyzed; however, the examinee should be responsive that the assessment of these types of evidence can be challenging.

Documents without visible, identifiable marks may consist of important evidence if they were below some other documents when the writing was carried out. Documents that were tattered or burned may also provide evidence if reconstructed by using proper techniques. Even writing instruments, rubber stamps, used envelopes and makes/models of office apparatus or equipments in the perpetrator's custody may be taken into custody and analyzed by the investigator. Evidence could even be picked from the electronic signature file's metadata in digital documents, providing information such as who the person behind this and when the document was written (3).

3.1 Collecting the Known and Unknown

Forensic document experts must have known specimens for the comparison to the material in question. Known samples may come from any number of known sources, such as a particular ink or paper manufacturer or machine.

In cases concerning handwriting, samples are typically classified into two types: requested writing specimens and collected writing (Admitted) specimens. Investigator dictates a known writing material for the writer and writing obtained are called requested specimens. These specimens are carefully generated under controlled conditions, with the writer being closely observed. However, writings that were written by the suspect or victim prior to the examination are called collected writing specimens. Good quality basis of writing specimens may comprise items such as cancelled cheques, letters, diaries, signed receipts, medical records, real estate contracts, tax records or other signed legal documents (4).

4. Paper Examinations

Questioned document experts often are engaged to investigate a single page or many pages of paper upon which there are markings, handwriting, printing, copying and/or graphics. Preliminary examinations of questioned documents, especially paper entail testing the color, thickness, weight, weave pattern, and fiber examination consecutively to find the origin of the paper. Further analysis may consist of the spectrophotometric examination to determine ultraviolet characteristics and comparisons using instrumental assessment (5).

Through a side-by-side comparison from other sources of paper or matched up against a standard white paper, the color of a part or parts of the paper may be investigated. Along with a visual examination of all the sides of the paper, the expert should observe the internal color of the paper as well. By using a scalpel, scrape a paper carefully without disturbing other important elements and observe, as this may change during the processing of printing paper. Measuring calipers for paper or micrometers may be used to determine the paper thickness, while weight of paper may be determined by using a sensitive weighing scale. Forensic examiners also evaluate paper for internal or surface weave patterns. Surface weaves are unusual, however these are easily visualized with oblique lighting. Internal weaves are more frequently seen on paper and can be observed with the help of transmitting light. To finish, analysis of paper fiber is

a destructive method that allows experts to classify the type and quantity of fibers as a result of the pulping process. In questioned documents, a very small piece paper produced with wood fibers may be used and split up in water. For cotton fiber-based paper, it may perhaps be required to apply a weak acidic solution to fragment the paper into its individual fibers. Watermarks also may be useful to experts as a resource for identifying the kind of paper, producer, and date of production. Watermarks are commonly visualized merely by using transmitted light or soft x-rays, which produces a depiction of the solidity of fibers (6).

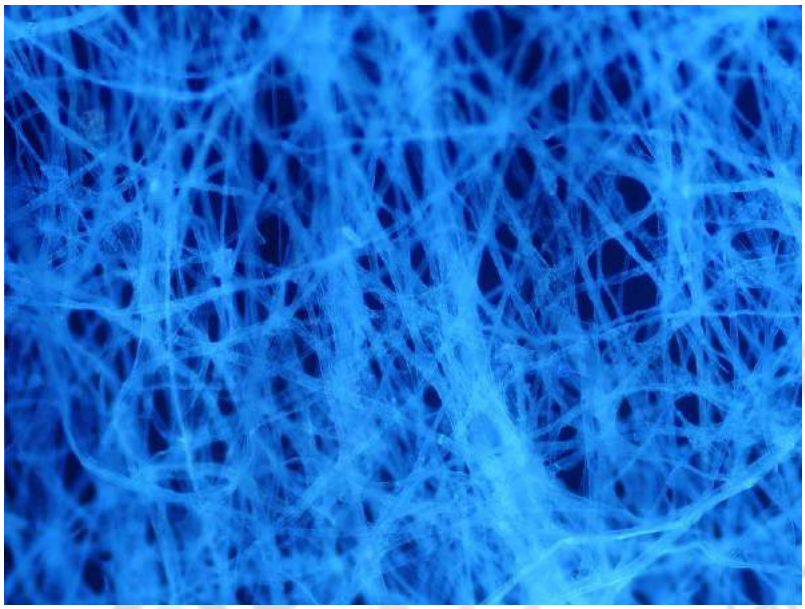

Fig 1. The microscopic structure of paper: Micrograph of paper autofluorescing under ultraviolet illumination. The individual fibres in this sample are around 10 µm in diameter (Courtesy: Wikipedia).

5. Typewriters

With the advancement in technology and the boom of the computer age, typewriters have mostly discontinued in usage of documentation, document experts still may be given cases to examine typewriter written documents. Whichever assessment involving typewriting should contain an examination of the class characteristics of typewriters, typestyle, horizontal spacing, and make and model, and individual characteristics of the typewriter and defects (7).

Typewritten documents may be mapped out back to the source typewriter on which they were written by identifying class characteristics of the machine (e.g., if it is manual/electric, carbon film ribbon/ fabric ribbon, design of typing) and individual discrepancies across machines due to wear and tear, scratch or mishandling. The system of TYPE classification is one of the tools in which experts may categorize the typestyle which is used in a typing the document, which may lead to the recognition of the make and model of the source machine. If possible, the forensic expert should investigate the specific machine(s) suspected to have been employed in making of questioned documents in order to evaluate individual characteristics (8).

6.1 Typewritten and Machine-Printed Documents

Documents which are typewritten, printed, faxed, and photocopied are exposed to modification and extension, replacement of page, and cut and paste from original to fake documents. The quality of fax documents and photocopies is relatively not good, in comparison to the original document which makes these documents, particularly vulnerable to modifications or alterations for the purpose of fraudulent documents. Even though structural characteristics are frequent still apparent, slight details, such as hesitations, pen lifting, and retouching may not be replicated.

The primary step that is taken while examining any typewritten and printed documents is to establish the printing technology types involved in generating and printing the particular document. Secondly, it should be determined whether the document which is questioned is an original or a forged, and if there were numerous methods involved in the printing of the document (ex: a document which is printed that was again photocopied and/or faxed). When these factors are identified, the examiner may start looking for other factors such as typography, formatting, and copy deformation. Adobe Photoshop® or similar software might be used to evaluate line direction and spacing, which may be specifically useful to identify irregularities or alterations in the text.

If typewritten or machine-produced documents are in question, every page of the questioned document should be vigilantly compared to all of the other pages of the document, and, whenever possible, compared to samples which are collected from the source machine(s).

6.2 Photocopy and Facsimile (FAX) Machines

Questioned document (QD) examinations where facsimile (FAX) machines generated documents are involved often comprise queries regarding the genuiness of a replicated signature or writings, apprehensions around whether data or information has been changed or altered, added, or erased from a document, or queries about precisely when a fax was sent. Transmitted faxes are frequently in low resolution and printed likewise, compared to documents that are photocopied or printed (9). Consequently, fine details are not clear which need special attention during the examination of handwriting or typed writing may not be imitated. Efficient document examination in forensics may be hindered if there is an inadequate amount of material which are under question or if the quality of evidence is not good. It had been reported in previous research that during transmission faxes may experience considerable dimensional changes that can affect the size or even deformation, which further complicate the examination of transmitted questioned documents. Generally the poor quality of faxes are transmitted, they are more prone to modification, though, a careful examination should be done to look for any discrepancies in pixilation in an entire document, in addition to any changes in handwriting or print type, any spelling, punctuation or formatting of the documents (10)**.**

Any document investigation in forensics comprising a fax machine also should take account of of the Transmit Terminal Identifier (TTI), which is basically found in the caption of any transmitted document. The TTI consist of data, such as the name of the sender and fax number of the sender and recipient, and the transmission date and time (11). These data may be very useful to the examiner as a way of recognizing the make and model of the source and recipient machine, and the date and time of transmission. Though, this data should be analyzed carefully, as the TTI is programmable, hence alteration is possible by a trained executor. Some of the fax machines also permit the user to readjust programs of some of the formatting features, which makes it further harder to correctly distinguish the source machine’s make and model.

To conclude, for any other technology, fax machines are vulnerable to built-up defects or defects obtained through regular use or abuse. These types of defects may happen in the source machine, the recipient machine, or in both, and must be distinguished from the background that may take place during communication. Consequently, when faxed documents are questioned for originality, both the source and receiving fax machines should be taken as evidence, and sample faxes from both machines transmitted around the date created by the TTI.

6. Computers and Printers

The progressively more ever-present utilization of computers ensuing in computer-generated documents has made more difficult for the document examiner to analyze these documents. Documents generated through computers are very vulnerable to modifications, such as addition of text, cut and paste, and even replacement of page. Consequently, investigators must think about the uniformity of the entire document in order to find any signs of modifications or tampering. For example, the investigator must establish whether numerous printers or other technologies were employed in making the document, in addition to examining any other possible irregularities. If any substitution of page is suspected, the writing or printing date also should be examined, as sequential discrepancies can be helpful in disgracing questioned documents.

When computer-generated document are encountered, the examiner initially tries to categorize the printing process by recognizing the technology used for printing. For example, the investigator establishes whether the text was printed in color or black-and-white ink, if ink or toner was used, and whether the process of printing was impacted or non-impacted. Examination of computer printouts should be carried out carefully which may permit investigators to recognizing the printer type which is used; it is likely that a number of overall mechanical deficiency exclusive to a printer discloses individualized imperfections that permit the printout to be identified back to the particular machine. Though, in contrast to typewriters, it is very hard to connect the document in question back to the particular computer on which it was typed (1).

In addition to identifying the printer's type that generated the document in question, the typeface itself should be examined. Examination of the font and line spacing should be done, as discrepancies may be slight but pinpointing of a modification or addition to the genuine document. The forensic investigator will also analyze the printout to establish the type of paper and ink used which is common with other documents, as well as taking cautious note of any watermarks, and hole patterns by staple, etc. These recognizing characteristics do not always gives confirmative evidence that a document has been modified or tampered with, but in a number of cases may show convincingly that a document is not genuine. For example, in a case where a page is replaced in a property will that is printed on paper or with ink that was not existing at the time of the signing of the original (12).

7. Writing and Printing Inks

Usually ink analysis is important part of the investigation procedure, and ink analysis is the determination of specific composition of chemical compounds used for the manufacturing of ink by using wide variety of chemical and physical testing. Non-destructive methods for the examinations, such as visual analysis, examination under microscope, observing under ultraviolet and infrared lights are generally the primary step taken to categorize the type of ink used in a questioned document (13). Additionally, destructive method of analysis may also be required to differentiate among types of ink. Chromatographic technique, especially Liquid

chromatography may be performed to facilitate the determination of the chemical composition of the inks found in a questioned document. One of the few traditional destructive methods employed by forensic experts, a tiny piece of the paper in the document containing the ink is taken, dissolved in solvent to analyze the ink composition. Comparison of ink's composition can be done with International Ink Library, more than 9,500 inks database that is preserved by the U.S. Secret Service (14). Chemical testing are essential in the assessment of printing inks because these tests also permit examiners to give an estimate of when the document was written. This may be meticulously prominent in the forgery cases; Ex: it may be ascertained that the ink used in a document is recently added as per its purported age.

Document experts are frequently asked not only to recognize the type of ink used in a questioned document, but also the origin of the ink. Identifying the ink's source on a questioned document may be helpful for examiners to detect any fraud entries or alterations or omissions in a document. Ex: - If an entry in a contract/will may be added with another ink that may have similar color and texture, but will be chemically different from original writing on the rest of the document, which suggests that it was not present at the time period of its original writing when the document was made. Differentiating inks can be carried out initially by visual examination, and then non-destructive methods, and chemical methods, true identification of the precise source of the ink (i.e., the exact pen) is improbable. More probably, the assessor will be able to mark out the ink to the particular type, class, and or ink brand, and recommends that it is scientifically not matched from the suspected source. Spectroscopic examination by Infrared or ultraviolet rays gives different fluorescence patterns which can easily distinguish two different inks.

Fig 2. White light and Raman image of crossing ink (Courtesy : http://www.renishaw.com/en/forensics--7980).

8. Seals and Stamps Analysis

Official documents may consist of markings from rubber stamps, embossed seals, watermarks, or other mechanically-printed marks which symbolizes genuineness of documents. Classification of Stamps is done on the basis of the source of ink rather than the type of dye material. There are mainly four classifications of stamps: first the pre-inked stamp, the flat-dye stamp, the hand stamp, and the self-inking stamp (15). When seals and stamps are examined, it is vital that the forensic investigator initially identify that the marking(s) were certainly made by a seal or stamp, as not being generated by computer. Once this is established, the experts may analyze the specific features of the markings, basically identifying such defects that may be exclusive to an individual stamp. These defects may be made during manufacturing, such as defective die substance, deformation, or misalignment, or defects due to use (e.g., dirt, accumulated ink, or fibers) or misuse. The initial inspection of a impression of questioned stamp is to inspect it microscopically, during that time experts may be able to recognize a number of factors, including the ink source and condition of the ink die (16).

If possible, the expert should try to evaluate the questioned stamp impression that is suspected of making it. Before performing any method, it is essential to photograph the stamp impression before making any additional impressions so as to conserve its original nature (e.g., ink saturation, dirt, fibers). Many impressions from sample should then be taken with the suspected stamp, to understand angle variations and pressure with which the stamp is applied. A side-by-side comparison can then be carried out with the questioned impression, and results as to the source of the impression may be made (17).

9. Techniques and advancement for the paper and ink analysis

The examination of inks for investigations of counterfeiting, fraud, forgery, and other crimes, such as letters related to terrorist attacks is one of the most important forensic applications of advance techniques where precision is very much required. The terms thin-layer chromatography (TLC) and high-performance TLC (HPTLC) (18) will often be used indistinguishably to represent either or both techniques, because the elements discussed are very similar between them. These methods are the most widely used chromatographic techniques, for the analysis of inks. Inks of interest include those from fountain pens, ballpoint pens, roller ball pens, toner-based printers, inkjet printers, and solid ink printers. Forensic analysts look for the source and date of an ink and comparison with other inks. Major advantages of TLC in an ink analysis are ease of use and low cost, high resolution of the components of ink formulations, especially for HPTLC, and visual detection of the colored components allowing convenient and rapid comparison of different ink formulations and batches.

In 1954, Brown and Kirk reported an application of paper electrophoresis to analysis of ink initially and its comparison to paper chromatography. These scientista used a diethylbarbiturate buffer and an low-cost, commercially available electrophoresis apparatus for the partition of more than 50 blue, blue-black and black writing inks. They achieved chromatographic separation using horizontal paper chromatography and two solvent systems (19). In 1963, Crown explained construction of power sources for electrophoresis using commonly available electronic equipment, such as radios (20). Soon afterwards, Thompson included aluminum citrate or acetic acid–butyric acid–water electrophoretic buffers, describing results superior to electrophoretic separations obtained using weak acidic or basic buffers or paper chromatography. Electrophoresis have not attracted as much attention as the various chromatographic techniques and many researchers consider it inferior to chromatography for ink separations.

Then Capillary electrophoresis, which is new analytical techniques and proved its importance in may forensic purposes and has many advantages. These advantages include high resolution, ability to quantitate, and short analysis time. The novelty of the method prompts a concise review of its operation and capabilities. Most importantly, CE has extraordinarily small sample requirements and it is possible to enact a separation with nanogram (or even picogram) quantities. This is advantageous in minimizing the destruction of the document being tested (21).

As a non-destructive analytical method, Raman spectroscopy often provides insufficient information to identify or differentiate the ink used for the preparation of a questioned document. Inks were successfully classified based on the total number of prominent bands in Raman spectra. It was found that more than 90% of the samples of the same type and color could be differentiated visually using only Raman spectra i.e. 94-95% for blue and black inks, respectively (22). As a result of this study, a flow chart has been constructed for blue and black ballpoint pen inks allowing their systematic identification. Raman spectroscopy proved to be a fast and precise technique for forensic ink analysis (23). Raman spectroscopy in conjugation with nanotechnology is also employed for the identification and detection of even very small quantity of ink which is quite common in forensics (24). Photocopy papers are identified using Fourier transform infrared spectroscopy (FTIR) in real quick time. This method is fast, sensitive and veracious identifying similarity in two photocopy papers (25). With these advancements in technologies, examination of the paper and ink had becomes more easy and reliable which helps experts to come to the definite opnion for the case .

Utlisation of advance techniques made the ink and paper analysis more promising and evidences from these techniques are quite strong then the conventional techniques. These should be employed in regular basis in the forensic labs for the betterment of evidence procurement.

10. Summary

Paper and ink are the integral part of the any document. Forgery of documents generally involve pen and material on which it was written, paper is commonly used material for the documents. Analysis of the paper and ink is very much essential in determination of possible forgery, age of the document, any crossing over of pen marks, involvement of two pens in single documents, addition or deletion of new pages in previous documents. Paper analysis is generally conducted to match the paper source and differentiate between to paper material. Analysis involves weighing, measing thickness and uevaluate paper for internal or surface weave patterns. Surface weaves are unusual, however, these are easily visualized with oblique lighting. Whereas Ink analysis is equally important in forensic point of view. Ink analysis is done to differentiate two inks by using different physical and chemical methods. Now a days, more advance techniques are available for the identification and detection of ink and paper. The senstitvity of these is quite high, even a minute quantity of ink may be detected by using these techniques. The paper and ink analysis are vey important and should be done by using appropriate advance techniques for the evaluation of forensic cases.

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Module : **26, Ballistics: history, classification of firearms and Ammunition**

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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Law
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Ballistics: history, classification of firearms and Ammunition
Module Id	LAW/CJA/VIII /
Objectives	To understand the role of ballistics in Forensic Science, classification of firearms • Terminology related with the firearms and ballistics • To learn about the history of firearms, different types of firing mechanisms used in ancient firearms
Prerequisites	Basic knowledge of Forensic Science, physics
Key words	**Firearms, bullet, cartridge, history, terminology**

Forensic ballistics is the analysis and interpretation of evidences by using scientific methods to establish the facts in any gunshot case.

Forensics Ballistics may divided into 3 sub-categories

(a) Internal

(b) External

(c) Terminal ballistics or wound ballistics

Internal Ballistics: The mechanism that occurs inside a firearm when a shot is fired. It may includes ignition mechanisms, barrel manufacturing techniques; factors responsible for creating and maintaining internal gas pressure; firearm recoil etc.

External Ballistics: It starts from the time when projectile leaves the muzzle end of the barrel and continue until it strikes the target.

Terminal Ballistics: The study of the projectile's effect on the target. The 'target' can be any solid or liquid object. If the target is a human or animal it is termed as "wound ballistics"

Classification of Firearms:

Small Arms

1. HANDGUNS: Firearms which can be fired from the single hand. Pistols, Derringers and Revolvers are the examples of handguns

Revolver is a firearm designed to be fired from the hand. It has rifled barrel and a revolving cylinder containing 5 to 7 chambers each of which holds one cartridge. They may be Solid frame (Samuel Colt 1835) type, Swingout type and Breakopen type.

Pistol is a firearm designed to be fired from the hand. It has a rifled barrel. It may be single shot, semiautomatic and fully automatic. It automatic pistol a removable magazine for storing cartridges is present.

2. RIFLES: Firearms which have rifled barrel and needs a shoulder support to fire. They may be

a. Single shot
b. Lever action
c. Bolt action
d. Pump action

e. Auto-loading (erroneously called "automatic rifles")

3. SHOTGUNS: Firearms with a smooth bored barrel and needs a shoulder support to fire. They may be
a. Single shot
b. Over and under
c. Double barrel
d. Bolt action
e. Lever action
f. Pump action
g. Auto-loading

4. SUBMACHINE GUNS: Fully automatic firearms having a rifled barrel and which fires pistol ammunition. They need a support of shoulder or the hip to fire.

5. MACHINE GUNS: Fully automatic firearms having a rifled barrel and which fires rifle ammunition. They need a support of shoulder or the hip to fire.

History of Firearms

1232: The Chinese who invented gunpowder (black powder) first used it in a weapon - gunpowder filled tubes aka rockets.
1364: First recorded use of a firearm - shooter lit wicks by hand that ingnited gunpowder that was loaded into the gun barrel.
1400s: Matchlock guns - first mechanically firing of guns. Wicks were now attached to a clamp that sprang into gunpowder that was placed in a "flash pan".
1509: Wheel lock guns - wicks were replaced the wheel lock that generated a spark for igniting the gunpowder.
1630: Flintlock guns - the flintlock did two things mechanically, it opened the lid of the flash pan and provided an igniting spark.
1825: Percussion-cap guns invented
1835: Colt revolver - first mass-produced, multi-shot, revolving firearms
1840: Pin-fire cartridges
1850: Shotguns
1859: Full rim-fire cartridge
1860: Spencer repeating carbine patented
1861: Breech loaded guns
1869: Center-fire cartridge

1871: Cartridge revolver

1873: Winchester rifle

1877: Invention of Double-action revolver

1892: Automatic handguns were used

Terminology:

Action:	One of the three major parts of a firearm. It loads, fires, and ejects an empty cartridge.
Barrel	Second part of the firearm. It is the metal tube through which the bullet is fired.
Black Powder	The old form of gunpowder invented over a thousand years ago and consisting of nitrate, charcoal, and sulfur.
Bore	The internal of the barrel
Breech	The rear end the barrel of a firearm. It is attached to action part of the firearm.
Bullets	Projectile
Butt or buttstock	Third part of the firearm. Also known as grip. It is the portion which is used to hold or support the gun
Caliber	The diameter of the bore in rifled weapons
Cartridge	Also called a "round". Made up of a case, primer, powder, and bullet.
Centerfire	The cartridge contains the primer in the center of the base, where it can be struck by the firing pin
Chamber	The portion of the "action" that holds the cartridge ready for firing.
Choke	A constriction of the barrel at the muzzle end in shotguns to reduce the dispersion of the pallets.
Double-action	Pulling the trigger both cocks the hammer and fires the gun.
Double barrel	Firearm with two barrels may be side by side or one on top of the other
Gauge	Diameter of the barrel on a shotgun in terms of the number of lead balls the size of the bore it would take to weigh one pound (10 gauge, 12 gauge, etc.)

Hammer	A metal rod or plate that strikes the cartridge primer to detonate the powder.
Magazine	Device for storing cartridges in a repeating firearm for loading into the chamber. Also referred to as a "clip"
Muzzle	The end of the barrel out of which the bullet comes.
Pistol	A handgun that uses magazine to store the cartridge
Primer	volatile substance used to ignite the main propellant powder
Revolver	Handgun that has a cylinder with holes to contain the cartridges. The cylinder revolves to bring the cartridge into position to be fired.
Rifling	Internal of the barrel is cut in to spiral grooves that give the bullet a spinning motion. The raised part between the grooves is called a "land".
Rimfire	The cartridge has the primer distributed around the periphery of the base
Safety	A mechanism on an action to prevent firing of the gun.
Shotgun	Firearm with smooth barrel. Small pellets (of lead) are used as the projectiles.
Sights	The device on top of a barrel to aim the target
Silencer	An extra device that fits over the muzzle of the barrel to muffle the sound of firearm
Single-action	Hammer must be pulled back manually every time to cock the firearm.
Smokeless powder	Propellant powder used in modern firearms. Produces less smoke comparative to old black powder. May be single base (Nitrocellulose alone) or double base (Nitrocellulose along with Nitroglycerine)
Stock	The part of the firearm used to hold it. Made up of Metal, wood or plastic

Classification of Ammunition:

SMALL ARMS AMMUNITION: A typical cartridge comprise of four major parts viz. cartridge case, primer, propellant and projectile.

1. CARTRIDGE CASE: It houses the other components of a cartridge. In rifled weapons usually made up of brass (70% copper 30% zinc). Shotgun cartridge case may be of plastic or paper. The main function of the cartridge case is to expand and seals chamber against rearward escape of gases at the time of firing.

Types of cartridge case:

On the basis of their shape:

a. straight ("always" pistol ammunition)
b. bottleneck ("always" rifle ammunition)is
c. tapered ("obsolete").

On the basis of the extractor flange and base of the cartridge:

a. Rimmed
b. semi-rimmed
c. rimless
d. belted,
e. rebated.

2. PRIMER: it is present near the base of the cartridge where firing pin or hammer strikes when trigger is pulled. It is a very sensitive material and explodes on compression and ignite the propellant. Commonly used primers are lead styphnate, barium nitrate and antimony sulphide.

On the basis of the location of the primer they may be-

a. Centre fire: Centrally placed primer assembly comprising primer cup (struck by firing pin), primer, anvil with flash holes. Boxer design (USA) or Berdan design (Europe).
b. Rimfire: No primer assembly. Primer spun into rim of cartridge case (rim struck by firing pin) and in contact with propellant.

3. PROPELLANT: Third component of the cartridge which burns to produce large volumes of gases under pressure.

Types of Propellants:

Black powder (charcoal, sulphur, potassium nitrate) now obsolete.

Smokeless powder

a. Single base: Nitocellulose alone
b. Double base: Nitrocellulose with nitroglycerine

Smokeless powder may be in the form of disc, flake or cylinder shapes. It may be ball and flattened ball (Winchester) which may be coated with silver-black graphite.

4. BULLET

function: the part of the cartridge which exits the muzzle.

composition:

(a) lead alloyed with tin and/or antimony with/without copper or copper alloy

"gilding" (less than 0.0002 inches thick).

(b) metal jacketed with lead or steel core and jacket of cupro-zinc, cupro-nickel or aluminium (0.0165 to 0.03 inches thick).

shape: (a) lead bullets - roundnose, wadcutter, semi-wadcutter, hollowpoint; generally all have cannelures or grooves. (b) metal-jacketed (i) full jacketing in military ammunition (ii) partial jacketing in hunting rifle and semi-automatic pistol ammunition: semi-jacketed soft point, semi-jacketed hollow point, Silver-tip (aluminium).

History and Development of Firearms

Hand cannons:

The earliest type of handgun was simply small cannon of wrought iron or bronze, fitted to a frame or stock with metal bands or leather thongs. These weapons were loaded from the muzzle end of the barrel with powder, wad and ball. A small hole at the breech end of the barrel, the touch hole, was provided with a pan into which a priming charge of powder was placed. On igniting this priming charge, either with a hot iron or lighted match, fire flashed through the touch hole and into the main powder charge to discharge the weapon.

Disadvantages:

Slow to fire and difficult to aim

Rain or damp weather had an adverse effect on the priming charge making it impossible to ignite.

Their first reported use is diffi cult to ascertain with any degree of certainty, but a number of instances are reported in Spain between 1247 and 1311. In the records for the Belgian city of Ghent, there are confi rmed sightings of the use of hand cannons in Germany in 1313. One of the earliest illustrations concerning the use of hand cannons appears in the fi fteenth century fresco in the Palazzo Publico, Sienna, Italy. The fi rst recorded use of the hand cannon as a cavalry weapon appeared in 1449 in the manuscripts of Marianus Jacobus. This shows a mounted soldier with such a weapon

resting on a fork attached to the pommel of the saddle. It is interesting to note that the use of the saddle pommel to either carry or aim

the hand guns could be the origin of the word ‘ pistol ’ , the early cavalry word for the pommel of the saddle being ‘ pistallo ’ . Combinations of the battle axe and hand cannon were used in the sixteenth century, and a number of these can be found in the Tower of London. One English development of this consisted of a large mace, the head of which had a number of separate barrels. At the rear of the barrels, a concealed chamber containing priming powder led to all the barrels. When the priming compound was ignited, all the barrels discharged at once.

Matchlock Firearm

This was really the first major advance in pistols as it enabled the weapon to be fired in one hand and also gave some opportunity to aim it as well. The construction of the matchlock was exactly the same as the hand cannon in that it was muzzle loaded and had a touch hole covered with a priming charge. The only difference was that the match, a slow - burning piece of cord used to ignite the priming charge, was held in a curved hook screwed to the side of the frame. To fire the gun, the hook was merely pushed forward to drop the burning end of the match into the priming charge.

Disadvantages:

The major defect with the matchlock design was that it required a slow - burning ‘ match ’for ignition. As a result, it was of little use for surprise attack or in damp or rainy conditions.

Wheel lock:

With the advent of the wheel lock the lighted match used in the matchlock was no longer necessary. This important innovation in the field of firearms design made ambush possible as well as making the firearm a practical weapon for hunting.

The wheel lock consisted of a serrated steel wheel, mounted on the side of the weapon at the rear of the barrel. The wheel was spring - loaded via a chain round its axle with a small key or spanner similar to a watch drum. When the wheel was turned with a spanner, the chain wound round the axle and the spring was tensioned. A simple bar inside the lock work kept the wheel from unwinding until released with the trigger.

Part of the wheel protruded into a small pan, the flash pan or priming pan , which contained the priming charge for the touch hole. The serpentine, instead of containing a slow - burning match, had a piece of iron pyrite fixed in its jaws. This was kept in tight contact with the serrated wheel by means of a strong spring. On pressing the trigger, the bar was withdrawn from the grooved wheel which then turned on its axle. Sparks produced from the friction of the pyrite on the serrated wheel ignited the priming charge which in turn ignited the main powder charge and fired the weapon.

Disadvantages:

The mechanism was complicated and expensive, and if the spanner to tension the spring was lost, the gun was useless.

Flintlock:

The ignition system which superseded that of the wheel lock was a simple mechanism which provided a spark by striking a piece of flint against a steel plate. The flint was held in the jaws of a small vice on a pivoted arm, called the cock. The steel, which was called the frizzen, was placed on another pivoting arm opposite the cock, and the pan containing the priming compound was placed directly below the frizzen.

When the trigger was pulled, a strong spring swung the cock in an arc so that the flint struck the steel a glancing blow. The glancing blow produced a shower of sparks which dropped into the priming pan igniting the priming powder. The flash produced by the ignited priming powder travelled through the touch hole, thus igniting the main charge and discharging the weapon.

The flintlock represented a great advance in weapon design. It was cheap, reliable and not overly susceptible to damp or rainy conditions. Unlike the complicated and expensive wheel lock, this was a weapon which could be issued in large numbers to foot soldiers and cavalry alike.

Percussion system:

The flintlock continued to be used for almost 200 years and it was not until 1807 that a Scottish minister, Alexander John Forsyth, revolutionized the ignition of gunpowder by using a highly sensitive compound which exploded on being struck. This

compound, mercury fulminate, when struck by a hammer, produced a flash strong enough to ignite the main charge of powder in the barrel. A separate priming powder and sparking system was now no longer required.

With this invention, the basis for the self - contained cartridge was laid and a whole new field of possibilities was opened up. Once this type of ignition, known as percussion priming, had been invented, it still took some time to perfect ways of applying it.

Shaw employed a small iron cup into which was placed a small quantity of mercury fulminate. This was placed over a small tube, called a nipple, projecting from the rear of the barrel. The hammer striking the mercury fulminate in the cup caused it to detonate and so send a flame down the nipple tube igniting the main charge in the barrel.

Pinfire system:

Introduced to the United Kingdom at the Great Exhibition in London in 1851 by Lefaucheux, the pinfire weapon was one of the earliest true breech - loading weapons using a self - contained cartridge in which the propellant, missile and primer were all held together in a brass case. In this system, the percussion cup was inside the cartridge case whilst a pin, which rested on the percussion cup, protruded through the side of the cartridge case. Striking the pin with the weapon's hammer drove the pin into the priming compound causing it to detonate and so ignite the main propellant charge. The pin, which protruded through the weapon's chamber, not only served to locate the round in its correct position, but also aided extraction of the fired cartridge case.

Rimfire cartridge:

It is a thin - walled cartridge with a hollow flanged rim. Into this rim is spun a small quantity of a priming compound. Crushing the rim with the firing pin causes the priming compound to explode, thus igniting the propellant inside the case. In the year 1855 Smith and Wesson manufactured the first revolver to fire rimfire cartridges.

Centre fire system:

This was the great milestone in weapon and ammunition development. In centre fire ammunition, only the primer cup needed to be soft enough to be crushed by the firing pin. The cartridge case could thus be made of a more substantial material which would act as a gas seal for much higher pressures than could be obtained with rimfire ammunition.

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Subject: **Law**

Production of Courseware

e- Content for Post Graduate Courses

Paper : **Forensic Science & Forensic Medicine**

Module : **27, Internal and external ballistics, identification of firearms and ammunition**

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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Law
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Internal and external ballistics, identification of firearms and ammunition
Module Id	LAW/CJA/VIII /
Objectives	To understand the role of ballistics in Forensic Science, internal and external ballistics, factors affecting external ballistics To correlate a suspected firearm recovered from the crime scene and fired bullet/cartridge Study of the different marks produced on the bullet, cartridge after firing
Prerequisites	Introduction to ballistics, ballistics terminology.
Key words	External ballistics, bullet, cartridge, striation marks, firing pin marks, identification

The term ballistics refers to the science of the travel of a projectile in flight. The flight path of a bullet includes: travel down the barrel, path through the air, and path through a target.

There are three types of ballistics, internal, external and terminal.

Internal Ballistics:

Internal ballistics is the study of what happens inside the firearm from the moment the trigger is pulled, firing pin hits the primer to the time until the bullet exits from the barrel. It is mainly concerned with propellant pressures, acceleration of the missile whilst it is in the bore, muzzle velocity and recoil.

When the firing pin strikes the primer, the priming compound explodes causing an extremely high temperature jet of flame to pass through the flash hole and into the propellant charge. This jet of flame, which is about 2000°C, ignites the propellant powder which burns at high speed to form a large volume of gas. This high - pressure gas accelerates the bullet down the barrel and out of the muzzle.

Nitrocellulose, which is the main propellant in modern firearms if ignited in an unconfined space burns gently. If it is in a confined space, the heat and pressure built up will accelerate the rate of combustion exponentially.

In a weapon, the propellant is confined within the cartridge case, the mouth of which is closed with a bullet. The round of ammunition is then supported by the chamber walls and standing breech of the weapon. Under these conditions, the pressure build - up will continue until it is sufficient to overcome the inertia of the bullet and start its acceleration down the bore. The heavier the bullet, the greater the resistance and the higher the pressure. The higher the pressure, the greater the rate of combustion.

External Ballistics:

External ballistics is the study of the missile's flight from when it leaves the muzzle until it strikes the target. The two main factors which affect the performance of a bullet on leaving the barrel are air resistance on its nose and the effect of the gravitational pull of the earth. As a result of these forces, the bullet will, on leaving the barrel, describe a downward curved path or trajectory.

The exact shape of this trajectory can be predetermined by knowing:

• The gravitational effect;

• The muzzle velocity;

• The angle of elevation of the barrel;

• The sectional density of the bullet;

• The bullet shape.

Terminal Ballistics:

Terminal ballistics deals with the behaviour of the missile once it reaches the target. This is obviously not concerned with simply piercing a paper target, but what the missile does once it encounters a material considerably denser than air. Whilst this will usually be concerned with the missile's performance and wounding capabilities in animal tissue, this could also include its performance in water, soil, brick, concrete, wood or bullet resistant materials.

Terminal ballistics is the study of missile penetration in solids and liquids. It can be subdivided into penetration potential, which is the capability of a missile to penetrate various materials and wound ballistics, which is the effect the missile has on living tissue.

Identification of firearms and ammunition

Firearms identification is often treated as a subspeciality of toolmark identification. A toolmark expert attempts to match tools like screwdrivers and crowbars to the marks they make when used on objects. "Ballistics" experts are more than toolmark specialists. They are generally experts in many aspects of firearms and testify about topics ranging from whether a specific object is, legally, a firearm, to intricate reconstructions of crime scene evidence.

When investigators find a bullet at a crime scene, it can tell an examiner the caliber of the gun that fired it, the type of bullet, and possibly the manufacturer and model of the firearm. If police find expended cartridge cases, these also indicate the caliber of the weapon used, its type (rifle/shotgun/revolver/semiautomatic pistol), and possibly the firearm's manufacturer.

If police also recover a gun from a suspect, an expert would likely be able to match the bullet and cartridge case to that specific firearm. Experts can do this by looking at

the marks the firearm makes on the cartridge and the bullet as it is fired. When a cartridge is fired, the firing pin strikes the primer. This impresses the firing pin's mark into the soft metal of the primer. The primer contains a tiny bit of explosive, which, when hit, ignites the propellant. The propellant burns rapidly, producing gases that exert pressure in all directions—on the head of the cartridge case, on the walls of the cartridge case, and on the bullet.

The bullet is the only part able to move, and is forced out of the barrel, leaving the cartridge case behind. Most firearms have a rifled barrel. Parallel spiral grooves are cut into the inner surface of the barrel. The space between the grooves is called the lands. The grooves twist to the right or left. The number of grooves, their width and depth, and the angle of the twist (pitch) vary by manufacturer.

As a bullet passes through the barrel, it engages the lands, forcing the bullet to rotate. The spin acts like a gyroscope to stabilize the bullet and keep its nose pointed in a consistent direction. The spin makes the bullet more accurate over longer ranges. Because the bullet literally scrapes along the side of the barrel, the land and groove's impressions and other microscopic details are etched into the side of the bullet. These fine microscopic details are called striations or striae.

A cartridge case may also receive striated marks from the extractor and magazine lips in firearms that have these features. Newton's third law requires an equal and opposite reaction to any action. When a bullet is fired, the cartridge is pressed into the breech by the gas pressure. This impresses any marks on the steel breech face onto the back of the softer metal cartridge and the primer. The primer is also pressed back toward the firing pin, which may further impress its mark. The cartridge case may also be marked by the ejector in a firearm, which has this mechanism. These marks are called impressed marks. The marks, which identify the gross properties of the firearm—caliber, number of lands and grooves, and direction of rifling twist—are the firearm's class characteristics. The marks are often visible to the naked eye. These will be the same for any bullet fired from any firearm of the same make and model, and often of several different makes and models.

Trying to match a recovered bullet or cartridge case to a specific firearm is more difficult. Firearm identification assumes that there are individual characteristics that are unique and consistent to one specific firearm. In theory, it is not possible to make two machined surfaces that are microscopically identical. Even rifled barrels manufactured consecutively can be distinguished because the cutting and grinding tools are blunted and worn each time they are used, leaving minute variations. Similarly, firing pins and the breech are believed to leave unique markings. Normal wear and maintenance, corrosion, rust, dirt, and debris will change markings over time, creating both permanent individual characteristics and temporary accidental characteristics. These changes can make it easier to tell one firearm from others made by the same manufacturer.

If a firearm is recovered, the examiner compares microscopic marks on the cartridge or bullet recovered from the crime scene with test bullets and cartridge cases fired from the recovered weapon into a water tank or bullet trap to see if the markings are consistent. If no weapon has been recovered, the examiner compares the crime scene bullets to each other, and the cartridge cases to each other, to see if the markings are consistent

Bullet class characteristics:

- Caliber of Bullet
- Composition of bullet
- Number of lands and grooves (usually 4 to 6 but range from 2 to 22).
- Diameter of lands and grooves.
- Width of lands and grooves.
- Depth of grooves.
- Degree of twist (twist is the number of inches/cms of bore required for one complete rifling spiral).
- Direction of rifling twist (commonly right/clockwise, less commonly left/counter- clockwise e.g. Colt).

Bullet individual characteristics:

- Imperfections of grooves (most pronounced in lead bullets).
- Imperfections of lands (most pronounced in jacketed bullets).

- Striation Marks produced on the bullet surface due to the imperfection of the internal of the barrel

Class and individual characteristics on the cartridge case

- Type of breech block marking
- Size, shape and location of extractor marks
- Size, shape and location of ejector marks
- Size, shape and location of firing pin marks and firing pin drag marks
- Chamber marks
- Magazine marks

Fingerprints are rarely recovered from firearms but may be obtained from cartridge cases.

Number and twist of Lands and grooves: The Number of lands and grooves are the amount of hill and valley protruding up and down in a helical pattern within the bore, while the twist of the lands and grooves is the direction in which the helical patterns move in the bore of a firearm which has been subjected to conventional rifling.

The width, depth, and pitch of lands and grooves: The width of the lands and grooves is the distance between two lands; the depth of the lands and grooves is how deep the raised portion of the barrel is to the actual caliber of the firearm; the pitch of the lands and grooves is the angle of the groove edge relative to the width and steepness of the groove. These are all class characteristics which also imparted from a firearm to a fired bullet.

Caliber of the weapon: The caliber of the weapon is the diameter of the bore measured from land to land. The caliber is one of the most obvious class characteristics which is also imparted during the making of bullets

Class characteristics of cartridge case

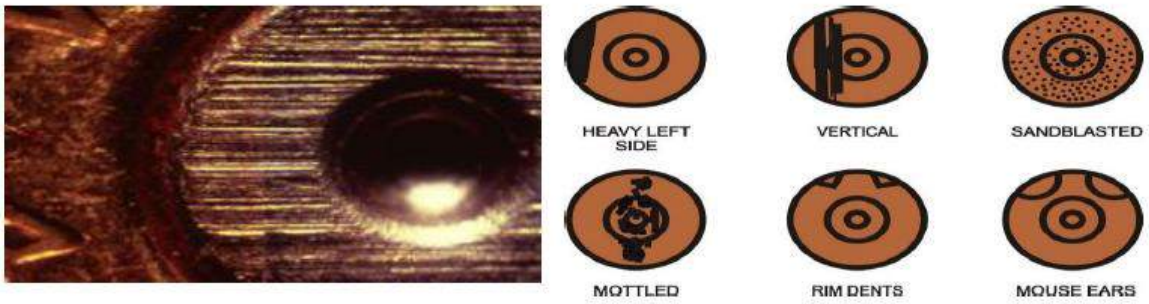
Some Class Characteristics of cartridges are due to the impressions/markings imparted from the weapon to which it was fired from; other class characteristics can be linked to the manufacturer, and make of the cartridge for a particular weapon and purpose

Firing pin impressions: Indentation of the primer of a centerfire cartridge case or the rim of a rimfire cartridge case when struck by the firing pin

– Showing Different firing pin marks imparted by two different types of weapons (Glock and Smith and Wesson).

Firing pin drag marks: Striated tool marks produced when a projecting firing pin contacts a cartridge or shot shell during extraction and ejection.

Breech face marks: Negative impression of the breech face of the firearm found on the head of the cartridge case and/or primer after firing



Primer shearing marks: Striated tool marks caused by the rough margins of a firing pin hole (aperture) scraping the primer metal during unlocking of the breech of a firearm

Chamber marks: Individual microscopic marks placed on a cartridge case by the chamber wall as a result of chambering, expansion during firing or extraction

Extractor marks: Striated tool marks produced on a cartridge or cartridge case from the operation of an extractor (usually found on or just ahead of the rim)

Ejector marks: Tool marks produced on the head of a cartridge case, from contact with the ejector (generally at or near the rim)

Ejection port marks: Striated marks produced by hard contact between the ejection port of a firearm and a rapidly moving ejected cartridge case

Magazine marks: Striated marks produced on the periphery of a cartridge as it moves from the lips of a magazine towards the chamber during feeding

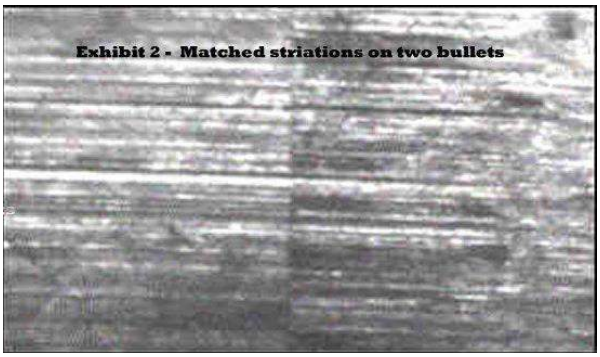
The Manufacturer of the Cartridge: This is the company which manufactures cartridges for various types or a specific type of weapon

Shape and Caliber of Cartridge: The Shape of the cartridge speaks to whether the cartridge was designed for rimmed, rimless or belted firing; while the caliber is the size of the cartridge as it relates to the type of weapon which it can be fired from.

Cartridge Composition: This speaks to the material used to compose the cartridge. Some cartridges are designed with harder materials to facilitate the high pressure heat during firing, some of these cartridges spent casings can be reused; Other cartridges are designed in order to not degrade or to lose lustier and strength over time; while some are made with materials such as paper or plastic relative to particular weapon.

Individualizing characteristics of Firearm and Bullet:

Striations in the lands and grooves of a firearm, and the lands and grooves of a fired bullet. Striations are imparted into the bore of a firearm during rifling, as the lands and grooves or are being formed inside the barrel of a firearm. These lands and grooves along with their striations then impart themselves onto the bullet when it is fired from a weapon. The striations in the lands and grooves of the weapon will provide a direct link to the rifling process and manufacturer that made the weapon; while the striations in the lands and grooves from a fired bullet will provide a direct link to the bore of the specific firearm it was fired from, as well as a direct link to other bullets fired from the same weapon.



Individualizing characteristics of Firearm and Cartridge

Type of Breech-face mark: The area around the firing pin, which is against the head of the cartridge or shotshell during firing is the Breech face. Different weapons have different types of Breech face marks. Eg. Glock pistols possess a rectangular Breech face pattern, as opposed to a 9mm Lugar LC pistol. Within the Breech face pattern, there are minute impressions which can be identified microscopically; these are the individual characteristics which are imparted onto the cartridge casing when its head is forced back onto the Breech block during discharge of the firearm.

Shape of ejector and extractor marks: The shape of ejector and extractor marks are also marks imparted onto the cartridge after firing. The ejector and extractor can impart individualizing characteristics on the head of the shell casing, based on the theory that no two ejector and no two extractor is shaped the same way.

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Paper : **Forensic Science & Forensic Medicine**

Module : **28, Gun Shot Residue, Determination of range of fire, firearm injuries**

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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Law
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Gun Shot Residue, Determination of range of fire, firearm injuries
Module Id	LAW/CJA/VIII /
Objectives	To understand the role of ballistics in Forensic Science To learn about Gun shot residue, its composition, identification, collection and analysis To determine the range of fire by which bullet is fired To understand the types of injuries inflicted to the body
Prerequisites	Introduction to ballistics, type of powders, their composition.
Key words	GSR, range of fire, injuries

On pulling the trigger the firing pin of a firearm strikes the primer of a cartridge the primer compound ignites sending a flame into the cartridge case. Propellant in the cartridge case starts to burn, causing it to change from a solid material to a gas. This change creates a large pressure within the cartridge, which in turn forces the bullet down the barrel and down range. Pressure building behind the bullet decreases as the bullet exits the muzzle of the firearm.

When the bullet exits the muzzle, pressure behind it blows the gunshot residues out of the firearm's barrel with high velocity. The residues are expelled from the barrel in a smoky cone shaped pattern. Gunshot residue travels a certain distance after emitting the muzzle of the barrel and leaves a pattern around the entry hole.

Gunshot residues can also be emitted from other areas of a firearm. The muzzle-to-garment distance can vary considerably depending on the firearm and type of ammunition being used. Short-barreled firearms and lower velocity cartridges will not normally expel residues as far as a high velocity rifle. At shorter distances however, they may deposit greater concentrations of gunshot residues. Also, gunpowder can come in several forms such as ball, flake, disc, and others. Ball powder being spherical in shape is more aerodynamic than say a particle of flake gunpowder and as a result will travel farther. A number of other variables can influence the amount of gunshot residues that may reach a target; therefore, it is essential that the firearm and ammunition used in the shooting incident be recovered.

Composition of Gunshot Residue:

Gunshot residue is normally a combination of gunpowder residues and lead residues. More and more ammunition manufacturers are using lead free or low lead propellants because of the toxicity of lead. Gunpowder residue can contain unburned gunpowder particles, partially burned gunpowder particles or the carbonaceous soot from completely burned gunpowder.

Modern smokeless gunpowder, and black powder, contains nitrate compounds. Black powder normally contains a combination of potassium nitrate (75%), charcoal (15%), and sulfur (10%). Smokeless powders can either be single

based or double based. Single based gunpowder will contain nitrocellulose (cellulose hexanitrate) as its main ingredient. Double based gunpowder contains nitrocellulose and nitroglycerin (glyceral trinitrate) as its base. Some triple-based powders are also now available.

When either of these types of gunpowder burns the residue left behind will be in the form of a nitrite-based compound. Nitrite particles when emitted from the muzzle of a firearm will strike a nearby target and either be imbedded in the target's surface or leave a deposit of nitrite residue.

Lead residues will be in a vaporous or particulate form and can come from a couple sources within a discharged cartridge. The most common source is the primer. Primers are used to start the ignition process in cartridges and commonly contain lead styphnate, barium nitrate, and antimony sulfide compounds. However, some newer primer compounds are being used that are lead and/or barium free.

Cartridges containing lead based primers, when ignited, produce a vaporous cloud of residue that is expelled from the muzzle of the firearm. Additional vaporous lead residues can be produced when the hot gases pushing a lead bullet down a barrel melt lead from the base of the bullet.

A third form of lead residue will be in a particulate form. Particulate lead residue comes from minute lead particles that are shaved from the sides of a lead bullet as it travels down the barrel. Lead particulate has more mass than vaporous lead and travels greater distances. Also, gunpowder particles can be coated by the vaporous lead residues and leave what appears to be a lead particulate deposit upon striking the target.

The amount of lead residue emitted from a gun can vary slightly from shot to shot. Fouling in the barrel from previous shots can slightly increase the amount of lead residue emitted from one shot to the next.

Gunshot residue collection:

When a firearm is shot, in addition to the projectile(s), a mass of debris comes out the muzzle. These gunshot residues (GSR) can include various primer residues, residues from projectiles, and partially burned and unburned gun

powered particles. The examination and analysis of GSR on items of evidence can allow determinations to be made as to weather a hole or defect is consistent with being caused by a bullet (or other firearm- Relatedprojectiles).

Additionally, GSR can be transferred to an individual by discharging a firearm, handling a firearm or fired ammunition components, or by contact with another object that has GSR on it. The presence of GSR on a person may provide useful information linking an individual with an action that could transfer this residue to them. As a very general guide, after four to eight hours it is unlikely that residues will be found on a live and mobile individual's hands unless steps have been taken to preserve such evidence (e.g. bagging the hands). The residue can persist for longer periods of time on some areas of interest such as on the deceased, on clothing or other stationary objects. The decision to collect a sample is affected by many variables and must be based on the investigative information available.

Since 1933 several collection and analysis methods relating to GSR have been employed. The most popular method of collection is lifting micro-traces from a substrate upon which GSR has been deposited by multiple pressings of adhesive material until the tackiness of the adhesive has gone. The adhesive material is attached to the head (smooth and flat) surface of a SEM stub as that does not require carbon coating, one that is polished smooth and flat, and does not contain elements of high atomic number.

Both skin and clothing are suitable for the stub method of collection. Specifically, in relation to the hands of the shooter one stub is pressed along the thumb and forefinger and a second along the palm of each hand (resulting in four stubs).

Sticky tape, specialized Micro vacuum cleaners, vacuum lifting onto a filter disc for clothing, plastic shafted, alcohol moistened cotton swabs are other means of collection.

Collection by tape and aluminium stub for use in a SEM is superior to that of liquid adhesives and swabs.

Particle Type	Elemental Composition(s)	Designation
3 – Component Particle	Pb-Ba-Sb	Characteristic of GSR
2 – Component Particle	Pb-Ba; Pb-Sb; or Ba-Sb	Consistent with GSR
1 – Component Particle	Pb-rich; Ba-rich; or Sb-rich	Commonly associated with GSR

GSR particle types formed from the discharge of a firearm.

Examination of GSR:

When a firearm is discharged and the bullet strikes a surface, gunshot residues are deposited, particularly at close range. These residues may be reproducible and therefore have evidentiary value. Some residues are visible and others require chemical treatment in order to visualize them.

The preliminary visual and microscopic examinations of gunshot residues should be given first priority because subsequent chemical testing can dislodge residues or alter the appearance of physical effects.

Residues should initially be observed and evaluated by the unaided eye and with a low power (3x-30x) stereomicroscope. Infrared (IR) imaging may be used to visualize heavy soot on dark or bloody clothing.

Chemical Tests:

Modified Griess Test: The Modified Griess Test is performed first on the exhibit because it will not interfere with later tests for lead residues. The Modified Griess Test is a test to detect the presence of nitrite residues. As described earlier, nitrite residues are a by-product of the combustion of smokeless gunpowder. When a firearm is discharged nitrite particles are expelled from the muzzle of a firearm and can be imbedded in or deposited on the surface of a target. The Modified Griess Test is the primary test used by firearms examiners to determine a muzzle-to-garment distance.

The Modified Griess Test is performed by first treating a piece of desensitized photographic paper with a chemical mixture of sulfanilic acid in distilled water and alpha-naphthol in methanol. Desensitized photographic paper is obtained

by exposing the paper to a hypo solution. The photographic paper will no longer be light-sensitive but will be reactive to the presence of nitrite residues.

The exhibit being processed is placed face down against a piece of treated photo paper, with the bullet hole centered on the paper. The back of the exhibit being examined is then steam ironed with a dilute acetic acid solution in the iron instead of water. The acetic acid vapors will penetrate the exhibit and a reaction takes place between any nitrite residues on the exhibit and the chemicals contained in the photographic paper. The resulting reaction will appear as orange specks on the piece photographic paper.

Dithiooxamide Test:

It is also known as the Rubeanic Acid Test and is a chemically specific chromophoric test for the presence of cuprous (copper-bearing) material. Copper-jacketed bullets represent a considerable percentage of ammunition evidence in criminal cases.

Copper is used in the following types of ammunition:

- Military and sporting jacketed bullets fabricated from gilding metal (a 90/10 copper/zinc alloy) or commercial bronze (a 95/5 copper/tin alloy)
- Rimfire bullets coated or plated with copper or brass (a 70/30 copper/zinc alloy)
- Revolver bullets with copper jazckets
- Nickel-plated bullets, e.g. Silvertip bullets

The test identifies a bullet wipe or bullet splash caused by the copper-bearing particulate in the form of bullet jacket fragments found around the perimeter of a bullet hole. While the test is not particularly useful for distance determinations, it can detect residues consistent with the discharge of a firearm or the passage or impact of a copper-jacketed bullet.

The chemistry of the Dithiooxamide Test is comprised of the following process:

- Material from the perimeter of a suspected bullet hole is exposed to an ammonia solution.
- The same material is exposed to a solution of dithiooxamide dissolved in ethanol. If cuprous material is present, a copper complex with a characteristic color forms.

- A dark gray-green color indicates the presence of copper-bearing material in bullet wipe.
- A blue-pink color indicates the presence of nickel (e.g., silver-tipped bullets).

Sodium Rhodizonate Test: This chemical test is designed to determine if lead residues are present on the exhibit. The Sodium Rhodizonate Test is performed by spraying the exhibit with a weak solution of a mixture of Sodium Rhodizonate and distilled water. This solution has a dark yellowish/orange color. The exhibit is then sprayed with a buffer solution which causes the background color to disappear.

The Sodium Rhodizionate reacts with any lead that may be present and turns the lead a very bright pink. The pink color is only an indication of the presence of lead residue and to confirm the presence of lead residue the area can be treated with a diluted Hydrochloric Acid solution. If the pink turns to a blue then the presence of lead is confirmed.

Instruments useful in detection of Gunshot Residue

The major methods for detection of primer residues are analytical and qualitative. Analytical methods include neutron activation analysis (NAA) as well as atomic absorption spectrophotometry (AAS) and inductively coupled plasma mass spectroscopy (ICP-MS).

Scanning electron microscopy with energy dispersive analysis by x-ray detector (SEM-EDX) and atomic force microscopy (AFM) are used to identify the primer residue qualitatively. An X-ray analyzer can be beamed directly onto the particles visualized with SEM, so that the energy dispersive pattern can be generated, giving the elemental composition of the particles.

For these methods, samples must be obtained from the skin surfaces of a victim at the scene. Delay in obtaining residues, movement, or washing of the body prior to autopsy will diminish or destroy gunshot residues. A rapid loss in numbers of GSR particles occurs from 1 to 3 hours post firearm discharge, though maximum recovery times of 1 to 48 hours have been reported.

Bullet Wounds

Gunshot residues emitted from the muzzle will travel out to distances of approximately 3 and 5 feet in most firearms but in some cases can travel even greater distances. At the 3-5 foot range the gunshot residues may only consist of a few trace particles and make determining the firing distance difficult if not impossible.

As the firearm gets closer to its target the residue concentrations increase and the actual size or diameter to the pattern gets smaller. At around 18-24 inches most firearms will start to deposit considerable concentrations of gunshot residues that may or may not be visible to the eye.

At distances of less than around 12 inches heavy concentrations of visible gunshot residues will normally be deposited.

When the muzzle of the firearm gets next to or is in contact with the target, hot gases escaping from the muzzle at high velocity will typically rip, tear, shred, and/or melt the material of the target. A very intense deposit of gunshot residues will be found around the margins of a contact or near contact entrance hole.

There have actually been cases where a hard contact gunshot (muzzle pressed hard against the victim) caused the residues to blow through the wound tract in the victim and be deposited around the inside of the exit hole of the victim's clothing.

Entry Wounds

The features vary depending on the range from which the weapon is fired—contact, close (intermediate) range or longer (indeterminate) range.

A gunshot wound is a controlled explosion and the bullet is accompanied from the gun by a jet of flame, a cloud of gas, burning and unburnt grains of gunpowder and soot from burnt gunpowder. Entry wounds may show the stigmata of the explosion to a lesser or greater extent.

(A) Contact wound

The muzzle is pressed against the skin. The heat of the discharge causes scorching or charring of the wound. The gases produced by the explosion of the cartridge enter, stretch and split the skin producing a stellate or cruciform tear. The tissue at the margin of the wound may contain soot and powder.

(B) Close range (Intermediate range)

The wound is inflicted at less than arm's length i.e. < 2 - 3 feet. The particles of partly burnt or unburnt powder from the muzzle are driven into the skin around the entrance wound giving a stippled appearance called "powder tattooing" or "powder burns". The area may be blackened by soot. Soot may be wiped off the skin, but powder tattooing cannot be wiped off. The bullet hole may be round or split, the latter being relatively common when there is underlying bone.

(C) Longer (Indeterminate) `range

The range is > 2 - 3 feet. The gun is too far from the skin for the products of the explosion to have any effect. Therefore the appearance of the wound is due entirely to the bullet. The wound is usually round (but may be split by "tail-wag" if the gun is fired from the extreme of its effective range causing the bullet to lose its gyroscopic spin and start to tumble).

Marginal abrasion/Abrasion collar/Abrasion ring

The margin of the entry wound in some close range and longer range injuries may be abraded (“marginal abrasion”, “abrasion collar” or “abrasion ring”) as the bullet inverts the skin and abrades the epidermis as it enters. The shape of this abrasion may help in determining trajectory.

Grease ring

The inner edge of the abrasion collar may be black due to grease or lubricating oil and metal particles from the bullet.

Exit wounds

These show none of the stigmata of the explosion or soiling seen in the entry wound. An exit would may be the same size as the entry wound, but may be smaller or larger depending on the range, type of weapon, type of bullet, the tissues being traversed by the bullet, etc.

In a contact shot the entry wound is split by the explosive gases and is therefore usually larger than its corresponding exit wound. However, if the bullet comes out carrying bone e.g. a shot to the skull, the exit wound may be larger than the entry.

In a distant shot the exit wound may be the same size or slightly smaller than the entry. In general, exit wounds tend to be split with irregular, everted edges. As a rule, exit wounds DO NOT show an abrasion collar, but exceptionally, this may occur if the skin was pushed up against a hard surface, e.g. concrete wall or floor at the time the bullet exited. This is known as a shored exit wound.

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A Gateway to all Post Graduate Courses

An MHRD Project under its National Mission on Education through ICT (NME-ICT)

Subject: **Law**

Production of Courseware

e- Content for Post Graduate Courses

Paper : **Forensic Science & Forensic Medicine**

Module : **29 Forensic Odontology: personal identification, determination of age, Bite marks Analysis**

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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Law
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Forensic Odontology: personal identification, determination of age, Bite marks Analysis
Module Id	LAW/CJA/VIII /
Objectives	To learn about the different types of dentition present in child and adult person, their age of eruption and shading, mixed dentition Determination of age from dental examination Identification of person from bite marks analysis in cases of sexual offences.
Prerequisites	Basic knowledge of Biology
Key words	Teeth, mixed dentition, bite marks,

Forensic odontology is the application of dental science for the purpose of legal investigations. It involves identification of the offender with certainty by comparing dental records of bite mark left on the victim or at the scene. It may be identification of human remains on the basis of dental records.

Forensic odontologists are experienced and specialized dentists who use their knowledge to identify unknown remains and bite marks of an individual. Forensic odontologist may be called by police officers to assist the investigation.

Forensic odontologists are generally called to:

- Identify unknown human body or remains which cannot be identified by other means like face, fingerprints etc.
- In case of mass disasters such as plane crashes and natural calamities.
- To link a person with bite mark injuries, in cases of assault or suspected abuse
- Estimate the age of the person from skeletal remains

Personal identification for establishing the individuality of the person:

In humans, there are twenty temporary teeth and thirty-two permanent teeth in both jaws. The deciduous and permanent teeth erupt earlier in the lower jaw than upper jaw except lateral incisors. In females teeth erupt about a year earlier. The eruption of tooth depends on the several factors like hereditary, environmental, nutritional and endocrinal factors.

Among 32 permanent teeth there are four incisors, two canines, four premolars and six molars in each of jaw. The temporary teeth are twenty comprising of four incisors, two canines, and four molars in each jaw. The development of tooth begins with the formation of cellular tooth germ within the alveolar bone in the shape of the crown. The tooth has three parts a crown, neck and root that are embedded in the jaw. There are certain differences in the appearance of deciduous and permanent teeth.

Incisors—Incisors have chisel shaped crown which is convex on labial surface and concave on lingual surface, with constricted neck and has single root. They have chewing surface and cutting edges.

Canines—Canines are large compared to the incisors. The crown is conical shaped and concave on its labial surface but slightly concave on its lingual surface. The

masticatory edges tapers and projects beyond the level of other teeth. It also has single root. They have single cusps.

Premolars—Premolars are also known as bicuspids. They are smaller and shorter than the incisors and canines and the crown is circular. The chewing surface is bicuspid with a groove between them. They also have a single root.

Molars—Molars are the largest of the entire tooth. The crown is cubical and is convex on both lingual and labial surfaces. In upper jaw, first molar has stable configuration with 4 cusps, second molar is very different individually and has 3 cusps. Third molar is less mineralized than others and may have chalky spots. Also, upper molar has three roots. In lower jaw, first molar has 5 cusps, 3 buccally and 2 lingually whereas second and third molars have 4 cusps each.

Features	*Temporary teeth*	*Permanent teeth*
Size and weight	Smaller and lighter	Larger and heavier
Colour	China white	Ivory white
Incisors	Vertical	Projected forwards
Neck	More constricted	Less constricted
Presence of ridge	Between neck and body	No ridge
Root of molars	Smaller and more divergent	Longer and less divergent
Replacement by	Permanent teeth	Not replaced
Total number	Twenty	Thirty two
Types	No premolars, 8 molars	8premolars and 12 molars

Differences between primary and secondary dentition

Determination of age of the person from dental records

Approximate age of the individual can be determined by teeth examination. Estimation of age can be done by the

- Presence of deciduous dentition and stages of eruption
- Period of mixed dentition
- Different stages of eruption of permanent teeth
- Loss of deciduous teeth

In Children At birth, the rudiments of all temporary teeth and first permanent molars are there. In children and young person the chronological calcification and eruption of teeth gives their ages. **Wisdom tooth (3rd Molar):** During the age of 14-20 years, the stage of development of third molar is of particular importance to determine the age. The lateral oblique X-ray of maxilla and mandible show the development of third molar and root completion of second molar. The body of jaw grows posteriorly and

ramus is elongated after eruption of second molar and a space is created for the third molar.

Mixed dentition: It is the time when both the temporary and permanent teeth are present in the jaw. The period starts from 6th year of life when the first molar erupts and continue till the canine falls (up to 11 years).

Successional teeth: These are ten in number in each jaw. Permanent tooth replaces the temporary except the permanent premolars that erupt in place of deciduous molars.

Superadded teeth: Those teeth which do not have deciduous predecessors and erupt behind the temporary teeth. All permanent molars are superadded as the first permanent molar erupts while other deciduous teeth are present.

There are a particular number of teeth in different ages in children that is:

- 5 years—There are 20 teeth, all are temporary
- 6 years—Mixed dentition and the number of teeth is 21-24 due to eruption of first permanent molar.
- 7-11 years—24 teeth (mixed dentition) with eruption of other permanent teeth replacing the temporary ones.
- 12-14 years—24-28 teeth due to eruption of second molar
- 14-17 years—28 teeth as there is no eruption.
- 17-25 years—32 teeth due to eruption of third permanent molar
- 25 years and above—thirty-two teeth

Type of teeth	*Age of eruption of temporary teeth*	*Age of appearance of permanent teeth*
Lower central incisor	5-6 months	7-8 year
Upper central incisor	6-7 months	7-8 year
Upper lateral incisor	7-8 months	8-9 year
Lower lateral incisor	8-9 months	8-9 year
Canines	1½ years	11-12 year
First premolar	Absent	9-10 year
Second premolar	Absent	10-11 year
First molar	1year	6-7 year
Second molar	20-30 months	12-14 year
Third molar	Absent	17-25 year

Age of appearance of deciduous and permanent teeth

Determination of Age from Dentition in Adults and Older Age

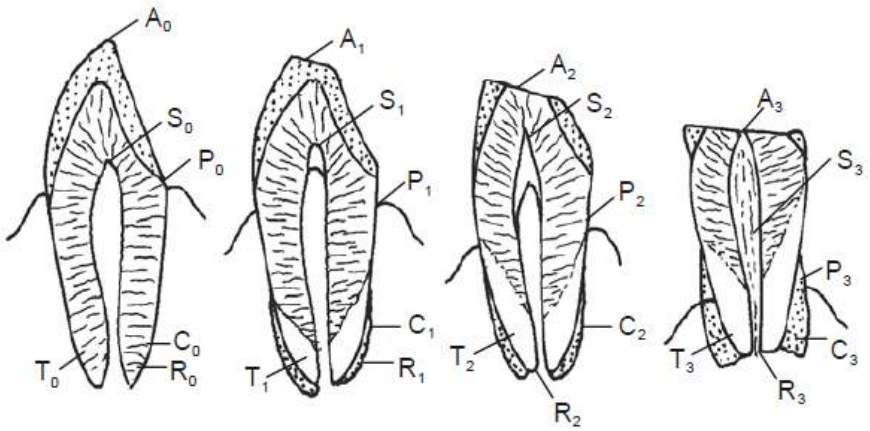
In mandible the center of ossification of jaw appears at 2nd month of intrauterine life and symphysis menti fuses by 18-20 years. The changes in mandible with age are: When eruption has ended and the person has achieved adult dentition, it is necessary to apply other methods that occur due to the normal wear and tear and age of the person.

Features	Infancy	Adult	Old age
Angle formed by ramus with body	Obtuse	Right angle	Obtuse
Body	Shallow and small	Thin and elongated	Shallow and big
Ramus	Short and oblique	Stunted	Long and oblique
Condylar process	At lower level than coronoid process	Above the level of coronoid process	Neck of Condylar process is bent backwards
Mental foramen	Placed near to the lower border of ramus and mandible	Midway between upper and lower border	Near the alveolar margin

Age changes in Mandible

Gustafson's method: Estimation of age in the adults can be determined by studying the progressive changes in an individual tooth.

• Attrition: It is wearing and tearing on the opposing mastication surface of the teeth of the upper and lower gums due to continuous friction. Attrition is categorized in four degrees: A0—No attrition, A1—Attrition within enamel A2—Attrition within dentine A3—Attrition exposes to soft pulp



Gustafson's method

Periodontosis: When the maintenance of teeth and gums is not proper, there is regression of gums and periodontal tissue. There is loosening of the teeth, exposure of length of root and deposition of stony hard debris over a long period. According to the length of exposure of root, periodontosis may be categorized in following degrees

P0—No Periodontosis or no root exposure P1—Exposure of less than 1/3rd of the part of the root next to crown P2—Exposure of more than 1/3rd of the of the root but less than 2/3rd. P3—Periodontosis beyond 2/3rd of the length of the root near the crown.

• Secondary dentine: As age advances there is deposition of secondary dentine tissue in pulp cavity. The process progress until whole of pulp cavity is replenished and the size of cavity decreases. In mandibular teeth, it starts from above and in maxillary from below. The reasons may be ageing, pathological conditions, dental caries etc. There are categorized in four degrees of secondary dentine formation: S0—No deposition S1—Deposition in the upper part S2—Deposition in the half of the pulp cavity from above S3—Almost whole of the pulp cavity is involved.

• Root resorption: This decaying change involves both cementum and dentine that shows grooves. First apex is involved then extends upwards. It is categorized as R0—No root resorption. R1—Seen only in some parts. R2—Seen over a large area. R3—Involves both cementum and dentine.

• Cementum apposition: Cementum deposition increases due to change in the surface of tooth near the end of roof and forms incremental lines. It is categorized in four degrees: C0—Only normal layer of cementum is noticed. C1—Slightly greater than normal. C2—Thick layer has occurred. C3—When a heavy layer is present.

• Root transparency: It occurs in the root from below upwards in the lower jaw and above downwards in the upper jaw due to rarefaction of dentine tissue. It is categorized as R0—No transparency noticed anywhere R1—Transparency noticeable mostly over apical region R2—Transparency up to 1/3rd from the apical region R3—Transparency noticeable up to 2/3rd of the length of the root from apex.

Out of the six criteria, transparency of the root is the most reliable one for age estimation.

The total score obtained is applied to a regression formula and the age is estimated below:

$$\text{Estimated age (years)} = 11.43 + 4.56 \times (\text{Total score})$$

Other criteria for personal identification:

1. Any extractions, recent or old from the condition of the socket.
2. Any fillings, number, position and composition.

3. Artificial teeth may be of gold, porcelain or stainless stain.

4. Prosthetic work in mouth such as bridge work or braces.

5. Crowned teeth.

6. Broken teeth.

7. Pathological conditions in teeth, jaws or gums

8. Congenital defects like enamel pearls, carabelli's cusps or ectopic teeth.

9. Malpositioned teeth which are rotated or tilted.

10. General state of care and hygiene like caries, plaque, tobacco staining, gingivitis etc.

Bite Marks Analysis:

Criminals may leave bite mark impressions at the crime scene, they may be in food, chewing gum or, more commonly, on the victim. When a bite mark is found, numerous steps should be taken. Once the mark has been sufficiently photographed, saliva sample is taken from the area for DNA evidence. Casts or moulds can then be made. Comparison can be done if another bite impression is found or standard teeth impression is taken from a suspect.

Bite marks have been divided into seven classifications:

- Haemorrhage: A small bleeding spot is found
- Abrasion: Undamaging mark on the skin is observed
- Contusion: Ruptured blood vessels, bruising etc.
- Laceration: presence of punctured or torn skin
- Incision: Neat and clear puncture of the skin.
- Avulsion: Removal of the skin.
- Artefact: Bitten off piece of the body

Police may sometimes found apple or piece of cheese with teeth marks. The unusual bite mark on the objects may also be there due to some dental abnormality. 'Plastic' marks on objects such as butter, cheese, lard, wax or chocolates should be stored in refrigerator to preserve them and prevent from melting. Fruits especially Apples are

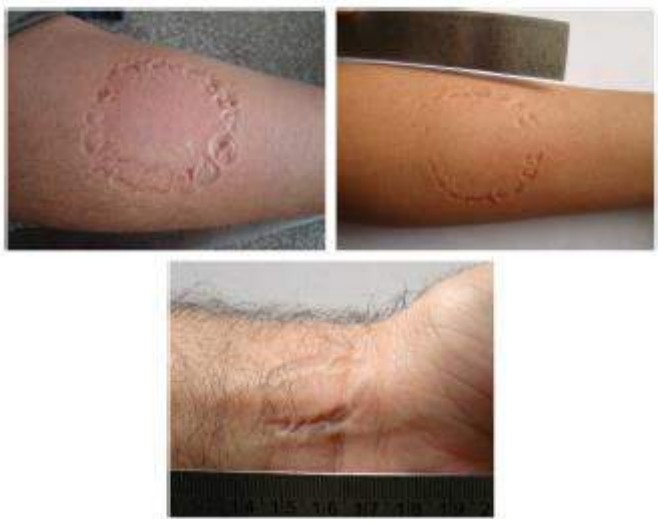
preserved in Campden solution (Meta bisulphate fluid) used for fruit bottling. Photographs are taken at right angles to the bite. Salivary traces should be swabbed.

Bites are commonly seen in cases of:

1. Child abuse cases: The bite marks may be present on any area of the body. The common sites are the arms, hands, cheeks, buttocks, trunk and shoulders. Bites are examined whether the size of the mark is same as of adult dentition. If bite mark is of small size it could be due to bite by the sibling and when it is of different size it could be animal bite.
2. Sexual assault: Sexually oriented bites may be caused at any parts of the body namely Breasts, neck, shoulders, thighs, abdomen, pubis or vulva.
3. Police officers by the resisting offenders.
4. Sporting events: Bite marks are produced when the victim manages to bite the assailant during any type of sports or games.
5. In assaults anywhere on the body.
6. Self inflicted bite marks: Mostly found on the forearms of the children caused by themselves. Sometimes arms may be pushed into the child's mouth to stop crying or due to intense pain; Mentally challenged and psychologically disturbed people may also inflict bite on themselves.
7. At scene of crime: In some cases, the criminals may leave their teeth marks on the substance left at the scene. These bite marks may be encountered on inanimate objects like food stuffs or fruits etc.

Nature of Bite Marks:

Bite mark comprise of punctate haemorrhages varying from small petechiae to large Ecchymoses merging in to a confluent central bruise. Front teeth causes bite marks from canine to canine with an invariable gap at either side representing the separation of upper and lower jaw. A circular or shallow oval bite by human and deep parabolic arch or U shaped is characteristic of an animal bite. Teeth may cause clear separate marks that run in to each other as continuous, intermittently broken lines. There may cause abrasions, bruises and lacerations or a combination of all. Identification from bite marks is possible if incisors and canines has some characteristic and unique features.



Images of different bite marks

Bite Mark Investigation

1. Photograph of Bite mark should be taken from different angles; from a directly perpendicular viewpoint with a plane of film at right angles to that of the lesion, with an accurate scale

2. Swabbing of saliva: To identify or exclude assailant; 80% of the people are 'secretors' who exude blood group enzymes in the saliva. Cotton swabs are rubbed on to the bite to get the sample. These are then preserved and sent for further examination.

3. Impression of bite mark: Plastic substance is laid over the bite mark that hardens and produces permanent negative cast of the lesion. Plastic substance is made with a rubber or silicone based medium containing a catalytic hardener or Plaster of Paris (water based plaster).

Matching the bite mark with the suspect:

1. Informed consent should be taken in writing before examination of the suspect

2. Oral consent with at least one witness, if not written to be taken

3. Dentition examined and points determined and recorded by diagram and writing

4. Photographs should be taken.

The points to be noted in bite marks are:

1. Presence of full or partial denture; were they worn at the time of incidence?

2. Number of teeth in the upper and lower jaw.

3. Charting of missing teeth.

4. Estimate of bite overhang; whether there is an edge-to-edge occlusion or an undershoot projection of lower teeth.

5. Recording of any broken teeth or teeth with significant individual abnormalities are charted and described.

6. Any irregularity or marked variation in cutting edge profile of any front teeth.

7. Evaluation of size and prominence of any teeth especially canines and incisors.

8. Any developmental abnormalities are to be noted.

9. Recording of any abnormality in orientation of any tooth such as twisting (rotation) of antero-posterior tilting or double row of teeth; any gap or irregular spacing: (i) Six upper and six lower front teeth give the most information. (ii) Canines may provide particular help. (iii) Premolars and molars are rarely useful due to being posteriorly positioned in the jaw.

Medico-legal Importance of Dental Study

1. Identification of the individual can be done from the dental study. Other factors for identification include: • The habits such as chewing tobacco are also helpful for identification. • Peculiarity in setting of the teeth may be familiar and may help in identification. • As the teeth resist decomposition, they are important for identification even for a long time after death as peculiarity of setting of teeth, evidence of any missing tooth or any artificial dentures help in proving the identity of the person. • Occupation can be known if there is a notch under tooth e.g. in case of tailors.

2. Grievous hurt: Fracture, Dislocation of tooth amounts to grievous hurt according to section 320 (7) I.P.C..

3. The teeth resist putrefaction and the presence of heavy metals in suspected poisoning case can be detected for a considerable period after death.

4. In chronic phosphorus poisoning, evidence of phossy jaw and affection of teeth and gums are characteristic.

5. Bite mark over the articles or food help towards detection of the criminal.

6. Bite mark on private parts, breasts, cheeks, neck of a girl are suggestive of some sexual instinct.

7. Artificial dentures when dislodged can sometimes cause choking in the elderly.

8. Pink teeth: In putrefied bodies, near gum line, teeth are of pink colour. It is due to dentine being stained by haemoglobin products

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Subject: **Criminology**

Production of Courseware

- Content for Post Graduate Courses

Paper : **Forensic Science and Forensic Medicine**

Module : **Alcohol: Types of Alcoholic beverages, countrymade liquor, illicit liquor, detection of alcohol in blood and breath (breathalyzer)**

Role	Name	Affiliation
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Co-Principal Investigator		
Paper Coordinator		
Content Writer/Author	Dr Priti Sharma	
Content Reviewer		

DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Alcohol: Types of Alcoholic beverages, country made liquor, illicit liquor, detection of alcohol in blood and breath (breathalyzer)
Module Id	
Objectives	Learning Outcome: • To make the learners understand about alcohol abuse and its legal elements. • To make learners understand the types of alcoholic beverages and its effects on body • To describe procedure for field sobriety testing. • To describe laboratory procedure used to detect alcohol in blood and breath.
Prerequisites	General understanding of Forensic Science and its application in crime solving.
Key words	Alcohol, Abuse, Breath, Body Alcohol Concentration, breathlyzer. Drunk, road accident.

1. Introduction

Alcohol is a legally available drug that is consumed pervasively due to it significant mood altering effects. Since it causes addiction on prolonged consumption, it is considered as a drug of abuse and so, a socioeconomic burden for the society. Given this, alcohol is a significant element in a wide range of cases originating from negligence to criminal act.

As per the World Health Organization, harmful use of alcohol results in approximately 2.5 million deaths per year, and 4% of all deaths worldwide as attributable to alcohol.[1] The alcohol related harm is not limited to heavy drinkers or those suffering from alcohol use disorders but also extends to persons who drink moderately or occasionally as well as to persons who do not drink but become victims of alcohol related accidents or aggression. A report showed 70% of road accidents in India due to drunken driving which costs 1.34 lakh lives each year.[2] There are also incidents of mass death due to consumption of illicit forms alcohol which are easy to be misused due to their cheap cost and easy availability. Alcohol imparts significant impairing effects on a number of aspects of human cognition and performance. This results in several cases of violations of the law in which consumption of alcohol is a fundamental component.

This module covers knowledge about how to deal with cases caused due to alcohol abuse. Apart from being a sociological burden, alcohol is a culprit being various crimes. This requires knowledge of its nature, effect on the body, manner and collection and preservation of evidence, etc.

2. Alcohol and Laws in India

At present, India does not have a national alcohol policy. However, the Ministry of Social Justice and Empowerment has Alcohol and Drug Demand Reduction and Prevention Policies.

Prohibition is incorporated in the Constitution of India among the directive principles of state policy.[3,4] According to this “The state shall regard the raising of the level of nutrition and standard of living of its people as among its primary duties and in particular, the state shall endeavor to bring about prohibition of the use except for

medicinal purposes of intoxicating drinks and of drugs which are injurious to health." Alcohol policy is under the legislative power of individual states. Prohibition, enshrined as an aspiration in the Constitution, was introduced and then withdrawn in Haryana and Andhra Pradesh in the midi-1990s, although it continues in Gujarat, with partial restrictions in other states – Delhi, for example, has dry days. There was an earlier failure of prohibition in Tamil Nadu. Excise department regulate and control the sale of liquor in the NCT of Delhi. Retail supply of alcohol is also regulated which prohibits consumption and service of liquor at public places.[5] This also prohibits employment to any person (male under the age of 25 years or any female) at any licensed premises either with or without remuneration in part of such premises in which liquor or intoxicating drug is consumed by the public. Similarly no individual should possess liquor at one time more than the prescribed limit without special permit. In Bombay, the production, manufacture, possession, exportation, importation, transportation, purchase, sale, consumption and use of all intoxicants is prohobited.[6] The advertisements of cigarette and alcohol on TV/Cable is completely prohibited.

There is rule in Bombay[8] which provides that any person, who is found drunk or drinking in a common drinking house or is found there present for the purpose of drinking, shall on conviction, be punished with fine which may extend to five hundred rupees. Further, any person found drunk and incapable of controlling himself or behaves in a disorderly manner under the influence of drink in any street or thoroughfare or public place or in any place to which public have or permitted to have access, shall on conviction, be punished with imprisonment for a term which may extend to one to three months and with fine which may extend to two hundred to five hundred rupees.[9]

3. Types of Alcohol and Alcoholic Beverages

There are different types of alcohol. Some of them are used in chemistry laboratories and industry, e.g. isopropyl and methyl alcohol. Isopropanol, or isopropyl alcohol is also used in industrial processes as well as in home cleaning products and skin lotions. It is also commonly known as "rubbing alcohol". Methanol, or methyl alcohol or wood alcohol has been used as an industrial solvent and is also commonly

available as methylated spirit. It is found in cleaning solvents, paint removers, photocopier developer and anti-freeze solutions. As such, it is often available in large quantities inexpensively. It is similar to ethanol but the end product after it is digested by the body is formaldehyde, which is poisonous. This is responsible for "alcohol poisoning". Methanol poisoning leading to blindness has been known to occur on consuming even small amounts.

Another type of alcohol is ethyl alcohol, also known as ethanol. It is a thin, clear liquid with harsh burning taste and high volatility. Ethyl alcohol is used as a reagent in some industrial applications. For such use, ethyl alcohol is combined with small quantities of methanol, with the mixture being called "denatured ethanol" to prevent theft for human consumption. Alcohol is the active ingredient of various drink, liquors and sprits. It is notorious due to its consumption by human beings for its intoxicating and mind-altering effects.

Alcoholic beverages are made by fermentation of sugary and starchy substances, followed by distillation to increase alcohol concentration. The active ingredient in them is ethyl alcohol or ethanol. Based on the distillation and percentage of alcohol, alcoholic liquors are classified into distilled and undistilled as described below:

Distilled Products

Rum (50-60%), Whisky, Brandy, Gin (40-45%), Sprits

Undistilled Products

Beer (4-11%), Wines, Burgundy, Champagne (10-15%)

Brief description of alcoholic beverages:

Wines are made from a variety of fruits, such as grapes, peaches, plums or apricots. The most common wines are produced from grapes. The soil in which the grapes are grown and the weather conditions in the growing season determine the quality and taste of the grapes which in turn affects the taste and quality of wines. When ripe, the grapes are crushed and fermented in large vats to produce wine.

Beer is also made by the process of fermentation. A liquid mix, called wort, is prepared by combining yeast and malted cereal, such as corn, rye, wheat or barely.

Fermentation of this liquid mix produces alcohol and carbon dioxide. The process of fermentation is stopped before it is completed to limit the alcohol content. The alcohol so produced is called beer. It contains 4 to 8 per cent of alcohol.

Whisky is made by distilling the fermented juice of cereal grains such as corn, rye or barley. Scotch whisky was originally made in Scotland. The word "Scotch" has become almost synonymous with whisky of good quality.

Rum is a distilled beverage made from fermented molasses or sugarcane juice and is aged for at least three years. Caramel is sometimes used for colouring.

Brandy is distilled from fermented fruit juices. Brandy is usually aged in oak casks. The colour of brandy comes either from the casks or from caramel that is added.

Gin is a distilled beverage. It is a combination of alcohol, water and various flavours. Gin does not improve with age, so it is not stored in wooden casks.

Liqueurs are made by adding sugar and flavouring such as fruits, herbs or flowers to brandy or to a combination of lcohol and water. Most liqueurs contain 20-65 per cent alcohol. They are usually consumed in small quantities after dinner.

4. Country made Liquors

Country liquor, an unbranded, highly potent alcohol drink is produced by distilleries and sold through separate distribution channels. Country liquor is made from a variety of raw materials and has different names in different parts of the country. Their manufacture is based on indigenous ingredients, eg., fenny, toddy, and arrack. Country liquor are, the cheapest form of alcoholic beverages. Some locally available fruit fly lures such as molasses, sugar, country liquor, fresh date palm juice and fermented date palm juice are used as raw ingredients.

Arrack is a traditional drink produced (both legally and illegally) by distilling fermented molasses, raw brown sugar, palm wine, rice or palm sugar. It has an alcohol content ranging from 20% to 40%. Palm wine, another traditional beverage produced from either the coconut tree or other palm trees, has an alcohol content ranging from 20% to 40%. Daru, a drink distilled from the flowers of the mahwa tree, has an alcohol content ranging from 20% to 40%.

There is a thriving market for illicitly made country liquor.[10] Country liquor is consumed in rural areas and by low-income groups in urban areas. The country liquor

market is regional market with small manufacturers spread across the country but is estimated to be around 2.5 times the Indian Made Foreign Liquor (IMFL) market.

Types of local brews in the countries of the South-East Asia Region

Country	Local brews
Bangladesh	Bangla Mad, Cholai, Tari
Bhutan	Ara
India	Arrack, Desi Sharab, Tari, Tharra
Indonesia	Palm wine
Nepal	Raksi, Tadi, Chayang, Tomb
Sri Lanka	Toddy, Arrack
Thailand	Oou, Krachae, Namtanmao, Sartha, Waark

5. Illicit liquor

Any alcoholic beverage made under unlicensed conditions is called illicit liquor. Usually sub-standard raw material is used in their preparation, which often are contaminated with toxic chemicals and thus dangerous to consume.[11] The illicit market in India is increasing at an alarming rate, in seven main sectors (two of which are alcoholic beverages and tobacco), according to a recent report by FICCI CASCADE (Federation of Indian Chambers of Commerce & Industry Committee Against Smuggling and Counterfeiting Activities Destroying the Economy).[12]

Moonshine, also known as white lightning, hooch or Tennessee white whiskey, is a high-proof distilled spirit, generally produced illicitly. Moonshine can be contaminated, mainly from materials used in construction of the still (an apparatus used to distill miscible or immiscible). Some manufactures use old automotive radiators as condensers in stills which is the source of contamination by glycol, lead and products from antifreeze which are poisonous and potentially deadly.

Alcohol concentrations above about 50% alcohol by volume are flammable and therefore dangerous to handle. This is especially true during the distilling process when vaporized alcohol may accumulate in the air to dangerous concentrations if adequate ventilation has not been provided.

Another form of alcohol i.e., methyl alcohol or methanol, is consumed by poor section of society due to its similarity in taste and smell with ethyl alcohol and poor production cost. However, methyl alcohol is extremely toxic - 10 ml can cause blindness and 30 ml can cause death within 10 to 30 hours. Although methanol is not produced in toxic amounts by fermentation of sugars from grain starches, contamination is still possible by distillers using cheap methanol to increase the apparent strength of the product. Sometimes, industrial methyl alcohol or denatured spirit is added as a mixture of ethanol and methanol by illicit brewers to save costs. There have been incidents where chemicals like organophosphorus compounds have also been added to illicit liquor.

6. Effects of Alcohol

The effects of ethanol vary progressively as the blood alcohol concentration (BAC) increases. At low BACs, the effects of alcohol consumption include euphoria, talkativeness, and reductions in anxiety and inhibitions. At progressively greater BACs, speech may become slurred, and dizziness or significant loss of coordination may be observed. Further increases to BAC may be accompanied by drowsiness, emotional lability, confusion, and loss of consciousness. Uncontrolled overdose can result in fatal respiratory depression.[13]

Depending on BAC concentration, alcohol causes various other impairments to a number of faculties related to psychomotor performance. These include impairment in ability to divide attention over multiple tasks, reaction time, risk or hazard perception, and motor coordination which affect the safe operation of a motor vehicle. This results in causing various vehicle accidents. So, drunken driving is listed as one of the most predominantly reported offenses directly related to alcohol consumption. To control this, a legal limit is defined by the jurisdiction of each nation beyond which a person is held under criminal act.

The consumption of alcohol may also be associated with an increased probability of occurrence of a number of other kinds of offenses. One such offense is sexual assault. A significant amount of research has examined the incidence of the use of alcohol alone or mixed with drugs in various cases of sexual assault. Since alcohol suppresses behavioural inhibitions, thus influencing decision-making skills or risk perception, excessive alcohol consumption also leads to substantial impairment and perhaps even unconsciousness, which can place an individual under considerable risk for attack.

7. Drunken Driving

Drunkenness is defined as the condition produced in a person who has taken alcohol in a quantity sufficient to cause him to lose control of his faculties to such an extent that he is unable to execute the occupation on which he is engaged at the material time. Across the world, governments have defined different acceptable blood alcohol levels for driving. However, there is no minimum threshold below which alcohol can be consumed without risk. With rise in blood alcohol concentration, there is progressive loss of driving ability due to increased reaction time, over confidence, impaired concentration, degraded muscle coordination and decreased visual and auditory acuity.

Figure 1: Diagram of increased driving risk in relation to blood-alcohol concentration.

As per laws in India,[14] " Driving by a drunken person or by a person under the influence of drugs - whoever while driving or attempting to drive a motor vehicle or

riding or attempting to ride, a motor cycle - (a) has in his blood, alcohol in any quantity, howsoever small the quantity may be or (b) is under the influence of a drug to such an extent as to be incapable of exercising proper control over the vehicle shall be punishable for the first offence with imprisonment for a term which may extend to six months or with fine which may extend to two thousand rupees or with both; and for a second or subsequent offence, if committed within three years of the commission of the previous similar offence, with imprisonment for a term which may extend to three thousand rupees, or with both". Till mid November, 1994, drinking and driving was not allowed to be mixed up. Any alcohol in the blood, howsoever, small the quantity has been an offence till November l994 but now after November 1994 the law has been amended. Now up to 30 milligrams of intake per 100m1 of blood has been permitted to driver before getting behind the wheel.

8. Field Sobriety Testing

A police officer who suspects that an individual is under the influence of alcohol usually conducts a series of preliminary tests before ordering the suspect to submit to an evidential breath or blood test. These preliminary, or field sobriety, tests are normally performed to ascertain the degree of the suspect's physical impairment and whether an evidential test is justified. Field sobriety tests usually consist of a series of psychophysical tests and a preliminary breath test. A portable handheld roadside breath tester is used for this purpose.

Horizontal-gaze nystagmus, walk and turn, and the one-leg stand constitute a series of reliable and effective psychophysical tests**.** Horizontal-gaze nystagmus is an involuntary jerking of the eye as it moves to the side. A person experiencing nystagmus is usually unaware that the jerking is happening and is unable to stop or control it. The subject being tested is asked to follow a penlight or some other object with his or her eye as far to the side as the eye can go. The more intoxicated the person is, the less the eye has to move toward the side before jerking or nystagmus begins. Usually, when a person's blood-alcohol concentration is in the range of 0.10 percent, the jerking begins before the eyeball has moved 45 degrees to the side. Higher blood-alcohol concentration causes jerking at smaller angles.

Walk and turn and the one-leg stand are divided-attention tasks, testing the subject's ability to comprehend and execute two or more simple instructions at one time. The ability to understand and simultaneously carry out more than two instructions is significantly affected by increasing blood-alcohol levels. Walk and turn requires the suspect to maintain balance while standing heel-to-toe and at the same time listening to and comprehending the test instructions.

During the walking stage, the suspect must walk a straight line, touching heel-to-toe for nine steps, then turn around on the line and repeat the process. The one-leg stand requires the suspect to maintain balance while standing with heels together listening to the instructions. During the balancing stage, the suspect must stand on one foot while holding the other foot several inches off the ground for 30 seconds; simultaneously, the suspect must count out loud during the 30-second time period.

9. Forensic Analysis of Evidence

Forensic analysis of the role of alcohol in a particular case requires an understanding of the extent of intoxication or impairment, which, in turn, is reflected by the BAC at the time of the incident. In practice, measurement of BAC involves the collection of blood samples or breath measurements, depending on the type of offense (for example, breath analysis is typically done in driving-related offenses, whereas blood sampling is generally done in the course of the examination of victims of sexual assault). Breath alcohol analysis uses instrumentation specifically designed for that particular purpose; analysis of blood samples is generally done by enzymatic methods or gas chromatography. Once a BAC measurement is made, a correction is usually applied to account for the amount of alcohol eliminated from the blood through metabolism and other processes between the time of the incident and the time of sample collection.

9.1. Collection of Samples

In cases where alcohol is suspected to be a drug of abuse, it is essential to determine BAC. Ideally, brain should provide the exact alcohol content responsible for the behavioral changes in subject, however, it is not possible to do so in live subjects due to the obvious reason. So, toxicologists concentrate on the blood, which provides the medium for circulating alcohol throughout the body, carrying it to all tissues,

including the brain. An alternative to venous blood is capillary blood from fingertip. However, the blood sample through fingertip is relatively very small in volume and does not allow procedural repeat and further analyses of sample. So, it is not considered a sample of choice for this purpose. From the medicolegal point of view, blood-alcohol levels have become the accepted standard for relating alcohol intake to its effect on the body.

So, venous whole blood provides as an ideal medium to identify whether the person has consumed alcohol beyond the statutory legal limits during the act. Venous blood is collected by venipuncture of cubital vein. The sample is collected by the authorized medical officer at the request of the police in clean uncontaminated, leak proof containers. The vial containing blood sample is added with proper preservative to prevent blood coagulation.

During collection, various precautions are warranted to maintain the integrity of sample. Non-alcoholic swabs are one such requirements. To meet these requirements, special kits for forensic purpose are available in the market. Further, skin at the injection site may carry certain microorganism which may contaminate the sample. These microorganism intervene with the accurate measurement either by consuming alcohol in blood as energy source or by producing alcohol from sugar present in blood through fermentation. In both cases, the results are compromised and thus hinder the judicial process. Sample storage temperature also plays an important role. The optimum storage condition for blood sample is refrigeration at 4 degree C. The samples can be optimally stored for a period upto 6 months at this temperature.

In cases of death, venous blood from arm or leg should be collected during post-mortem for BAC determination. In many cases, blood of uncertain origin (heart, vein or artery) may accumulate in the chest and get mixed with interstitial fluid. This blood sample if analyzed for alcohol content will give erroneous result and thus should be avoided. In any case, blood sample which is mixed with body fluid or blood of uncertain origin should not be collected.

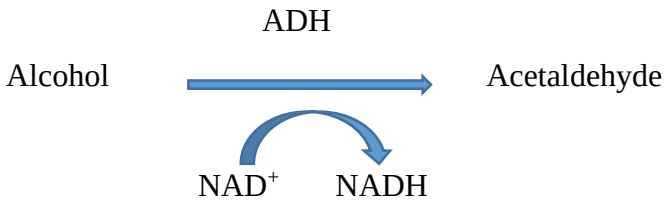
9.2. Method for BAC Determination

9.2.1. Chemical Method: Wet chemical method based on reduction-oxidation reaction was devised by E.M.P. Widmark, a Swedish scientist in 1920. In his pioneer work, alcohol condensate distilled from whole blood was suspended above dichromate-acid solution in an enclosed flask. Now, based on the amount of alcohol present, the sodium dichromate solution is reduced which is measured. It is simple and accurate method which has been used abundantly by laboratories to measure BAC. This method modified in 1950 and known as modified Widmark method is still in use by many laboratories due to its simplicity and accuracy.

Albeit being a precise method of choice for BAC determination, this method suffers some limitations. One such limitation is the use of corrosive chemicals which make the process less than desirable to use. Another limitation is that this method cannot differentiate ethanol from similar alcoholic compounds such as methanol and propanol and thus lacks in specificity.

9.2.2. Biochemical Method:

The biochemical method, first developed in 1950, was based on enzymatic oxidation and has underwent lot of modifications since then. However, the basic mechanism of this method has remained the same. Alcohol in the presence of enzyme alcohol dehydrogenase (ADH) gets converted into acetaldehyde in the presence of coenzyme nicotinamide adenine dinucleotide (NAD^+) which is reduced to NADH. The formation of NADH is directly proportional to concentration of alcohol in sample being analyzed. The NADH is measured on the basis of absorption of ultraviolet (UV) radiation at 340 nm.



This principle has been utilized to develop kits dedicated for alcohol determination in blood samples. It is a good method of choice for batch analyses in forensic laboratories keeping in mind the high frequency of such cases reported on daily basis.

9.2.3. Instrumental Technique

Gas chromatography (GC) is a good method of choice for separation and identification of volatile compounds. This technique is widely used because of its ability to resolve a highly complex mixture into its components, usually within minutes. This technique separates mixtures on the basis of their distribution between affinity for stationary liquid phase and a moving gas phase. Many compounds have a tendency to become closely associated with other compounds through attractive forces, while others do not. For example, ethanol (the alcohol found in alcoholic beverages) will easily mix with water, while vegetable oil will not; there is no attraction. This attraction or tendency for association is often called *affinity*. Ethanol has a high affinity for water, while vegetable oil does not. Chromatography utilizes the differences in affinity of compounds for separation.

In gas chromatography, separation is on the basis of affinity with phases called as mobile phase and stationary phase. The mobile phase is nothing but a gas called the *carrier gas,* which flows through a column. The carrier gas is chemically inert and is generally nitrogen or helium. The stationary phase is a thin film of liquid within the column. Nowadays, a more advanced type of column called capillary column is used instead of simple *packed column where* stationary phase is a thin film of liquid fixed onto small granular particles packed into the column. This column is usually constructed of stainless steel or glass and is 2 to 6 meters in length and about 3 millimeters in diameter. Capillary columns have a very thin film of liquid directly onto the column's inner wall and are composed of glass. These are much longer than packed columns—15 to 60 meters in length and very narrow, ranging from 0.25 to 0.75 millimeter in diameter.

For the separation of components of a mixture, the sample under investigation is injected into the heated injection port with a syringe where it is immediately vaporized. The carrier gas fed into the column at a constant rate carries the compounds through the column. The column itself is heated in an oven in order to keep the sample in a vapour state as it travels through the column. Now, the affinity principle plays its role. Components with a greater affinity for the moving gas phase travel through the column more quickly than those with a greater affinity for the stationary liquid phase. Eventually, after the mixture has passed the column, it

emerges separated into its components. A simplified scheme of the gas chromatograph is shown in Figure 2.

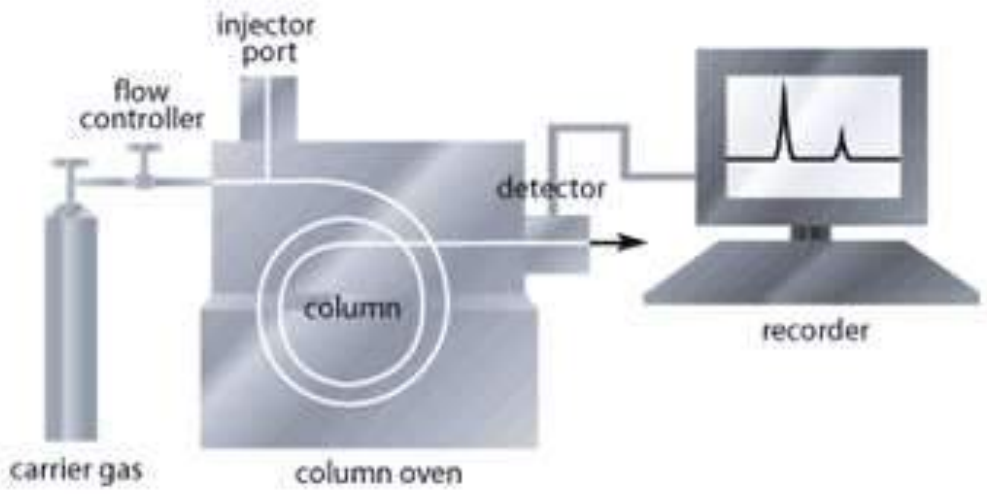


Figure 2: A Typical Set-up of Gas Chromatography

The headspace technique is one of the accepted technique which is suitable for analysis of volatile components in solid or liquid mixture samples. In this technique, in a closed container, either the sample is taken directly from the gas phase or the gas is trapped and concentrated prior to analysis. This type of extraction techniques are known as headspace analysis.[15] The headspace injection technique has great advantages over other methodologies, namely providing a clean injection, resulting in lower spending of gas chromatograph consumables; it is simple, minimizes the possibility of artifacts during the analysis, diminishes the possibility of contamination and accurately quantifies analyte.

As each component emerges from the column, it enters a detector. There are various types of detectors which differ in function. One type of detector called Flame Ionizing detector (FID) uses a flame to ionize the emerging chemical substance, thus generating an electrical signal.

The signal from detector is recorded onto a strip-chart recorder as a function of time which is called a *chromatogram.* A gas chromatogram is a plot of the recorder

response (vertical axis) versus time (horizontal axis). A typical chromatogram shows a series of peaks, each peak corresponding to one component of the mixture. The time required for a component to emerge from the column from the time of its injection into the column is known as the *retention time,* which is a useful identifying characteristic of a material. Figure 3 shows the chromatogram.

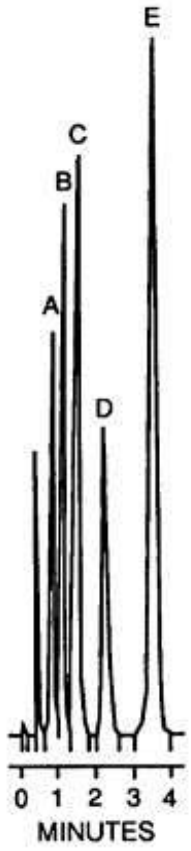


Figure 3: Gas chromatographic separation of common volatiles: (A) methanol, (B) acetone, (C) ethanol, (D) isopropanol, (E) butanol.

Gas chromatography is an extremely sensitive technique which gives fast results. It cannot only be used for identification of volatile compounds but can also yield quantitative results. The amount of substance passing through the GC detector is proportional to the peak area recorded; therefore, by chromatographing a known concentration of a material and comparing it to the unknown, the amount of the sample may be determined by proportion. Gas chromatography has sufficient sensitivity to detect and quantitate materials at the nanogram (0.000000001 gram or $1 \cdot 10^{-29}$ gram) level.

Another type of detector which has gained widespread application with GC is Mass Spectrometry. The combination of gas chromatography and mass spectrometry provides the toxicologist with a one-step confirmation test of unequal sensitivity and specificity. The separated components of sample leave GC column and enters the mass spectrometer, where it is bombarded with high-energy electrons which causes the sample to break up into fragments producing a fragmentation pattern or mass spectrum for each sample. This mass spectrum is a unique pattern for most compounds, and thus referred as a "fingerprint" that can be used for identification.

9. Breath Analysis:

Over the past few years, breath testing has been established as an accepted method of choice for testing of alcohol testing and its associated effects on body. Despite many challenges, breath analyses has expanding forensic applications owing to following reasons: 1. Less invasive sampling; 2. Field testing; 3. Fast analyses and reporting of results; 4. Minimal training required for operation; 5. No health risk associated with sample collection in contrary to blood sampling. These advantages have made breath alcohol testing an easy and fast technique which can be used by surveillance team after any incident take place in which alcohol consumption is a responsible factor. Not only this, the testing can also be used to prevent any such possible incident in future by stopping the person who has consumed alcohol beyond the statutory legal limits.

9.1. Biological Principle:

Following oral intake, alcohol is distributed through simple diffusion to all over the body water. Blood transports this alcohol to lungs via pulmonary circulation where it gets distributed to alveolar and bronchial air through simple diffusion. This partitioning occurs at a fixed ratio (1:1750) which is governed by Henry's Law. According to this, when a volatile chemical (alcohol) is dissolved in a liquid (blood) and is brought to equilibrium with air (alveolar breath), there is a fixed ratio between the concentration of the volatile compound (alcohol) in air (alveolar breath) and its concentration in the liquid (blood), and this ratio is constant for a given temperature. The temperature at which the breath leaves the mouth is normally 34°C. At this temperature, experimental evidence has shown that the ratio of alcohol in the blood to

alcohol in alveoli air is approximately 2,100 to 1. In other words, 1 milliliter of blood will contain nearly the same amount of alcohol as 2,100 milliliters of alveolar breath.

9.2. Analytical Methods

A breath tester is simply a device for collecting and measuring the alcohol content of alveolar breath. Many recent advances in alcohol measurement have led to differences in the instrumentation of device. However, the basic mechanism of sampling remains the same i.e., sampling of alveolar air. This requires the subject to blow into a disposable mouthpiece that lead into a cylinder where last portion of breath (alveolar breath) is trapped. Further, all the breath testing instruments are based on the principle that the amount of alcohol in 2,100 milliliters of alveolar breath approximates that in 1 milliliter of blood at a temperature of 34 degree C.[16]

There are various types of devices for alcohol measurement in trapped breath sample. The first successful commercial breath-test device, known as the Breathalyzer (Figure 4), was developed in 1954 by R. K. Borkenstein, who was a captain in the Indiana State Police. This was based on wet chemistry where alcohol in breath sample is oxidized in the presence of dichromate acid solution (potassium dichromate and sulfuric acid). This brings change in color of dichromate-acid solution which is measured optically to measure alcohol in accordance with Beer's Law. [16]

Figure 4: Photograph of a Breathalyzer

Around 1970, breathlyzer was phased out and replaced by computerized instrumentation which were free of chemicals use. These devices made use of a beam of Infra-red radiation wherein alcohol in sample cell was passed through infra-red radiation filtered to select a particular wavelength at which alcohol shows absorption. The alcohol concentration was measured on the basis of decrease in signal which is proportional to the amount of alcohol in breath sample. The signal is detected by a photoelectric detector. This information is processed by an electronic microprocessor, and the percent blood-alcohol concentration is displayed on a digital readout (Figure 5).

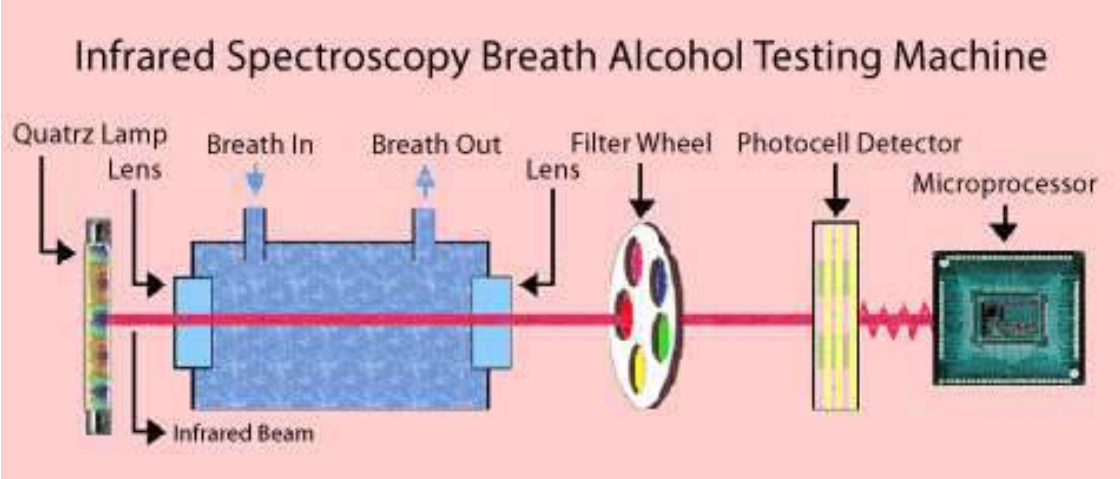


Figure 5: Schematic diagram of an infrared breath-testing instrument**.**

Another approach for measuring alcohol in breath is to use a **fuel cell detector.** A fuel cell converts a fuel and an oxidant into an electrical current. In evidential breath-testing devices that use this concept, breath alcohol is the fuel and atmospheric oxygen is the oxidant. Alcohol is converted in the fuel cell into acetic acid, generating a current that is proportional to the quantity of alcohol present in the breath (Figure 6).

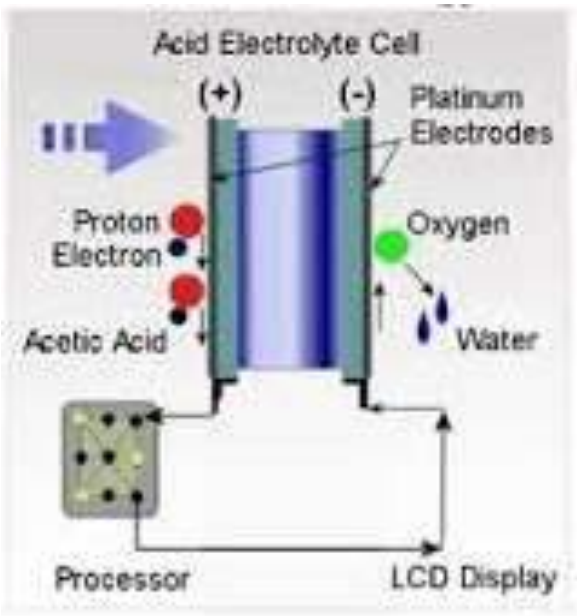


Figure 6: Schematic diagram of a fuel Cell Technology based breath testing instrument.

Albeit the simplicity in instrumentation of these devices, there are certain crucial consideration which need to be introduced while sampling and taking measurement. It should be ensured that alcohol is measured in alveolar breath (deep lung breath) of the subject. To do so, these instruments have a *slope detector* which ensures that while subject blows into the instrument, the consecutive breath measurements of the breath sample show little or no rate of change in breath alcohol concentration. This ensures that the breath sample being measured is alveolar or deep-lung breath and thus most closely relates to the true blood-alcohol concentration of the subject being tested. Another consideration is to avoid measuring "mouth alcohol" resulting from regurgitation, belching, recent intake of an alcoholic beverage or recent gargling of an alcohol-containing mouthwash. This may result in higher alcohol concentration in the exhaled breath than the concentration in the alveolar breath. To avoid this possibility, the operator must not allow the subject to take any foreign material into his or her mouth for a minimum of fifteen to twenty minutes prior to the breath test so that the mouth alcohol, if present gets dissipate. Further, the independent sample measurements in duplicate should be made to avoid the chance of any error from the operator, mouth alcohol, instrument component failures, and spurious electric signals.

Summary:

Alcohol is abused largely due to its mood altering effects. Consumption of alcohol creates a state of drunkenness to the subject which leads to various acts arising out of negligence or with criminal intent. The extent to which an individual is under the influence of alcohol is usually determined by measuring the quantity of alcohol in the blood or the breath. In India, the legal limit for Blood Alcohol Concentration (BAC) upto 30 mg per 100 ml of blood has been set, however, enactment of these legal measures requires strict actions and seriousness among law enforcement agencies.

The legal limit is checked during field sobriety testing which also contains various psychological tests such as horizontal-gaze nystagmus test, walk and turn, and the one-leg stand. The BAC determination requires collection of blood or breath from subject. Breath is tested on the basis of various principles such as oxidation reduction in dichromate-acid solution, fuel cell chemistry, infrared spectroscopy. Among these, infrared spectroscopy is one of the most commonly adopted method among law enforcement agencies. Blood sample from vein is also tested for determination of blood alcohol. Gas chromatography is the most widely used approach for determining alcohol levels in blood. Blood must always be drawn under medically accepted conditions by a qualified individual. A nonalcoholic disinfectant must be applied before the suspect's skin is penetrated with a sterile needle or lancet. Once blood is removed from an individual, it is best preserved sealed in an airtight container after adding an anticoagulant and a preservative.

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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Arson: definition, chemistry of fire, analysis of arson exhibits
Module Id	
Objectives	Learning Outcome: • To make the learners understand definition of arson and the chemistry of fire. • To make learners recognize the telltale signs of arson • To describe how to collect physical evidence at the scene of a suspected arson • To describe laboratory procedures used to detect and identify hydrocarbon and explosive residues
Prerequisites	General understanding of Forensic Science and its application in crime solving.
Key words	Fire, hydrocarbon, residues, arson, origin, accelerant, inflammable.

1. Introduction:

Fire is a spontaneous burning process which has huge devastating effects on property and person. Crime investigators often encounter with fire scenes which show observable signs pointing towards its deliberate origin. The fire with deliberate origin or the intentional fire has been differentially termed as 'Arson'. Arson has been committed throughout human history. Its definition as a crime originated in old English common law, where the term "arson" referred specifically to a fire set by one person against the dwelling of another.

There are a number of reasons why investigation team may suspect arson i.e., deliberate setting of fire. Arson often present complex and difficult circumstances to investigate. The damage caused may range through structures, inhabited or not, as well as vehicles or any other personal property. The perpetrator normally has thoroughly planned the criminal act and has left the crime scene long before any official investigation reaches. So, the criminalist's function is very important since he or she is trained to detect and identify relevant chemical materials collected at the scene which help in reconstructing the crime and in identifying trace amounts of gasoline or kerosene in debris or igniters used in setting the fire.

A fire can have many accidental causes, including faulty wiring, overheated electric motors, improperly cleaned and regulated heating systems, and cigarette smoking which usually leave no chemical traces. Thus, the final determination of the cause of a fire or explosion must consider numerous factors and requires an extensive on-site investigation.

In India, arson crimes are prosecuted under section 435 of Indian Penal Code. It defines that whoever commits mischief by fire or any explosive substance intending to cause, or knowing it to be likely that he will thereby cause, damage to any property to the amount of one hundred rupees or upwards 1[or (where the property is agricultural produce) ten rupees or upwards], shall be punished with

imprisonment of either description for a term which may extend to seven years, and shall also be liable to fine

This chapter takes the reader from the beginning stages of a fire investigation in evidence collection and evaluating a fire scene at the laboratory. Such knowledge helps to reconstruct the case and finally provides evidences which will proof for or against their intentional origin of fire. The primary aim of this module is to describe in detail the intricacies about nature of fire and how a fire scene is investigated.

2. Chemistry of Fire

Fire may be defined as a transformation process during which oxygen is united with some other substance i.e., fuel to produce noticeable quantities of heat and light (a flame) by the process of oxidation. This is simple to understand by diagrammatic representation of fire triangle as shown in Figure 1. The three corners depict that fuel, oxygen and heat are required for sustaining fire.

Figure 1: Fire Triangle

This needs to be understood here that not all oxidation proceeds in the manner that one associates with fire. For example, oxygen combines with many metals to form oxides. Thus, iron forms a red-brown iron oxide, or rust. Furthermore, to start fire, an energy input is needed to cross the energy barrier between the reactants and the products of a reaction. The higher this barrier, the more energy required to initiate the

reaction. The energy barrier in the conversion of iron to rust is relatively small, and it can be surmounted with the help of heat energy present in the surrounding environment. But to ignite the gasoline, the energy barriers is quite high, and a high temperature must be applied to start the oxidation of these fuels. Hence, before any fire can result, the temperature of these fuels which is known as ignition temperature must be raised to a value that will allow the heat energy input to exceed the energy barrier. Once the combustion starts, enough heat is liberated to keep the reaction going by itself. In essence, the fire becomes a chain reaction, absorbing a portion of its own liberated heat to generate even more heat. The fire will burn until either the oxygen or the fuel is exhausted.

So, we can picture an oxidation reaction, taking place when molecules combine or collide with one another. Essentially, the faster the molecules move, the greater the number of collisions between them and the faster the rate of reaction. The physical state of fuel and temperature essentially affects this pace. A fuel achieves a reaction rate with oxygen sufficient to produce a flame only when it is in the gaseous state, for only in this state can molecules collide frequently enough to support a flaming fire. This remains true whether the fuel is a solid such as wood, paper, cloth, or plastic, or a liquid such as gasoline or kerosene. In the case of a liquid fuel, the temperature must be high enough to vaporize the fuel. The vapour that forms burns when it mixes with oxygen and combusts as a flame. The **flash point** is the *lowest* temperature at which a liquid gives off sufficient vapour to form a mixture with air that will support combustion. Once the flash point is reached, the fuel can be ignited by some outside source of temperature to start a fire. With a solid fuel, the process of generating vapor is more complex. Wood, or any other solid fuel, burns only when it is exposed to heat that is hot enough to decompose the solid into gaseous products. This chemical breakdown of solid material is known as **pyrolysis**. The numerous gaseous products of pyrolysis combine with oxygen to produce a fire.

We may now consider the conversion of iron to rust as an example of an extremely slow oxidation process, a situation that exists because of the inability of the iron atoms to achieve a gaseous state. For this reason, the combination of oxygen with iron

to produce rust is restricted to the surface area of the metal exposed to air, a limitation that severely reduces the rate of reaction. On the other hand, the reaction of methane and oxygen is an example of oxidation in which all the reactants are in the gaseous state. Hence, this reaction proceeds rapidly, as reflected by the production of noticeable quantities of heat and light (a flame).

In summary, three requirements must be satisfied if combustion is to be initiated and sustained:

1. A fuel must be present.
2. Oxygen must be available in sufficient quantity to combine with the fuel.
3. Heat must be applied to initiate the combustion, and sufficient heat must be generated to sustain the reaction.

3. Examination of Scene

The investigation team following arrival at the scene should gather as much information as possible from police officers and fire officers around them. The fire fighters or police give first hand information about the fire which point towards the possibility of 'intentional fire'. Initially the CSI should thoroughly record the scene both photographically and diagrammatically; video is an excellent tool for recording the scene for possible future reconstruction as it records in low light conditions and provides the viewer with a 360-degree view. A search of the fire scene must focus on finding the fire's origin, which will prove most productive in any search for an accelerant or ignition device.

3.1. Locating the seat of fire

There are a number of clues which help in locating the seat of the fire. Low burning where the floor is most damaged and high burning where the ceiling is most damaged may help locate the seat of the fire. Burn patterns are classic indicators, with the 'V' pattern burn having the seat of the fire at its base. Figure 2 shows a photograph indicating origin of fire. But the investigation team should be careful in jumping to conclusions as some materials may burn more quickly than others or may be affected

by draughts or fire fighting. Glass and plastics melt towards the heat produced by the fire, so called thermal indicators, can also be of use in locating the seat. Smoke damage may travel away from the fire so will help in its location. Depth of charring to wood may be a rough indicator to locate seat of fire (Dehaan 1997).

Figure 2: A photograph showing classic V pattern at origin of fire.

3.2. Signs of 'deliberate fire'

In a search to determine the specific point of origin of a fire, the investigator may uncover telltale signs of arson. The fire may be suspected to have originated intentionally if it has multiple origins of fire (also called seat of fire). The firefighters or the witness may also inform about the same person hanging around a number of fire scene. If the fire had been very severe, developing rapidly and spreading through a property, this indicates that an accelerant may have been used. An accelerant is anything that speeds up the growth of the fire. Although usually associated with liquid fuel, such as petrol or paraffin, an accelerant could equally be straw or newspaper. A

liquid fuel accelerant will typically leave a pool burn on the surface on which it has been burning. As the vapour from the liquid fuel burns it creates a pool or halo shape on the surface. There may be evidence of separate and unconnected fires or the use of "streamers" to spread the fire from one area to another. Additionally, the presence of containers capable of holding an accelerant or the finding of an ignition device certainly will arouse suspicions of an arson-caused fire.

Other signs of deliberate fire are sign of breaking door or window, tempering of fire appliances, unusual arrangement of furniture perhaps piled around the seat of the fire, theft, removal of articles dear to the arsonist from the building for safe keeping prior to the ignition of the fire. The fire may also be set to cover up and destroy evidence of another crime such as a murder or theft.

3.3. Recovery of samples from the scene

While looking for evidences that may highlight the cause of fire, the investigators have to look near area around the origin of a fire. Debris from areas around the origin, as well as areas showing potential pour patterns, is collected to test for accelerant residues at the laboratory. For the same purpose, an onsite screening may be made using a highly sensitive portable vapor detector or "sniffer" (see Figure 3). This device can rapidly screen suspect materials for the presence of volatile residues by sucking in the air surrounding the questioned sample. The air is passed over a heated filament; if a combustible vapor is present, it oxidizes and immediately increases the temperature of the filament. The rise in filament temperature is then registered as a deflection on the detector's meter. Although, this test does not provide conclusive remark, but it does provide the investigator with an excellent screening device for checking suspect samples at the fire scene. The sniffer dogs that have been trained and conditioned to recognize the odour of hydrocarbon accelerants are also commonly used to search and screen the questioned sample for the presence of accelerant residues.

Figure 3: Photograph of a vapour detector

As a matter of routine, two to three quarts of ash and soot debris must be collected at the point of origin of a fire when arson is suspected. The collection should include all porous materials and all other substances thought likely to contain flammable residues such as wood flooring, rugs, upholstery, rags, etc. Specimens are to be immediately packaged in airtight containers so no loss of possible residues can occur through evaporation. New, clean paint cans with friction lids are good containers because they are low cost, airtight, and unbreakable and are available in a variety of sizes (Figure 4). Wide-mouthed glass jars are also useful for packaging suspect specimens, provided that they contain airtight lids. Cans and jars should be filled one-half to two-thirds full, leaving an air space in the container above the debris. Large bulky samples should be cut to size at the scene as needed so that they will fit into available containers. Plastic polyethylene bags are not suitable for packaging specimens because they react with hydrocarbons and permit volatile hydrocarbon vapors to be depleted.

Figure 4: Evidence sampling Metal Cans

The collection of all materials suspected of containing volatile liquids must be accompanied by a thorough sampling of similar but uncontaminated control specimens from another area of the fire scene. This is known as *substrate control*. For example, if an investigator collects carpeting at the point of origin, he or she must sample the same carpet from unburnt part, where it can be reasonably assumed that no flammable substance was placed. In the laboratory, the sample is tested to ensure that that it is free of any flammables. This procedure reduces the possibility and that the carpet was exposed to a flammable liquid such as a cleaning solution during normal maintenance. In addition, laboratory tests on the unburned control material may help analyze the breakdown products from the material's exposure to intense heat during the fire. This is because common materials such as plastic floor tiles, carpet, linoleum, and adhesives can produce volatile hydrocarbons when they are burned. These breakdown products can sometimes be mistaken for an accelerant.

Fluids found in open bottles or cans even if they appear empty must be collected and sealed since they may contain trace amounts of liquids or vapors. Also, a thorough search of the scene should be made for igniters. The most common igniter is a match. Normally, the match is completely consumed during a fire. However, there have been cases in which, by force of habit, the arsonist tossed aside the half burnt match which can be recovered later by the investigator. This evidence may prove valuable if the

investigator can successfully fit the match to a match box found in the possession of a suspect. In addition, an arsonist can construct many other types of devices to start a fire. These include a burning cigarette, ammunition, a mechanical match striker, electrical sparking devices, and a "Molotov cocktail (as shown in Figure 5)." Relatively complex mechanical devices are much more likely to survive the fire for later discovery. The broken glass and wick of the Molotov cocktail, if recovered, must be preserved as well.

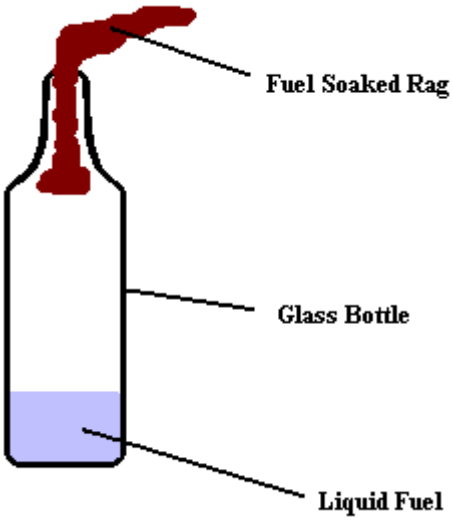

Figure 5: Molotov Cocktail

One important piece of evidence is the clothing of the suspect perpetrator. If the suspect is arrested within a few hours after the fire, residual quantities of the accelerant may still be present in the clothing. In such cases, the each clothing item should be collected and placed in a separate airtight container, preferably a new, clean paint can. The forensic laboratory can detect extremely small quantities of accelerant materials in such clothing material making it a good piece of evidence especially if the residues pattern match with the type recovered from the scene of fire.

When recovering samples, care must be taken by the CSI not to contaminate the evidence. It is essential that clean, protective outer garments (including hand and footwear) are worn, tools used to recover samples are thoroughly clean (some police forces use disposable shovels) and samples recovered from the scene are transported as soon as possible to the forensic laboratory.

4. Examination of exhibits at the laboratory

Debris from fire scene provides various evidences to prove or disprove arson. A forensic chemist performs examination of debris to detect the presence of accelerant. However, he/she should not only examine the residual content of debris, but also perform the gross search of debris. For this, the debris is to be searched in controlled laboratory conditions with good lighting to identify any item that may have caused the fire, such as a lighter or cigarette. He should not rule out the possibility that the arsonist may have intentionally left the device or device may have escaped the damage caused by fire.

The forensic chemist will then examine the debris for the presence of liquid accelerants, such as petrol or paraffin. The air left in the nylon bags containing the debris is the source for the check for these accelerants. This air is recovered from the sample debris contained inside the airtight jars by heating them. When the container is heated, any volatile residue present in the debris is driven off and trapped in the container's enclosed airspace. The vapor is removed from the container using various methods and then injected into the GC which is one of most commonly used technique for detecting and characterizing flammable residues. Gas chromatograph separates the hydrocarbon components and produces a chromatographic pattern characteristic of a particular petroleum product.

To separate volatile accelerant residue from the fire scene debris, **headspace method** as shown in Figure 6, is the most commonly used and conventional technique. In this, the container containing fire debris is heated from outside at temperature not reaching beyond 60^{o}C. The collected vapour in the airspace is then collected using a syringe

which is punctured through the container wall and through suction, all the vapour is collected. This sample air is then injected in the GC as described earlier for analysis.

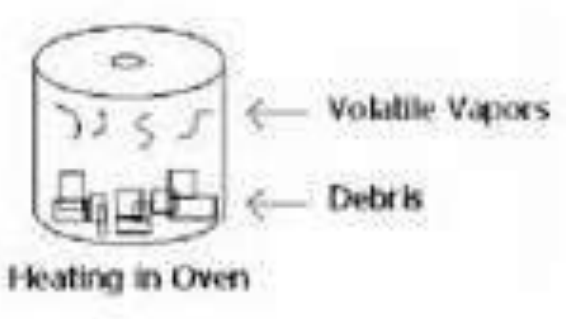

Figure 6: Headspace technique

Albeit various advantages, there is also a shortcoming of headspace technique which owes to limited volume of vapour that can be collected inside the syringe. This shortcoming has been resolved by the introduction of another method called *vapor concentration*. This is also called as Passive Headspace Method. In this method, as shown in Figure 7, a charcoal-coated strip, similar to that used in environmental

monitoring badges, is used. This strip is placed within the container holding the fire scene debris. The container is then heated to about 60°C for about one hour. As a result, the accelerant vapour in significant quantity get collected into the container airspace and finally get adsorbed onto the charcoal strip. Once the heating procedure is complete, the strip is easily removed out from the container and the accelerant is recovered from the strip by washing with a small volume of solvent (preferably carbon disulfide). The solvent is then injected into the gas chromatograph where it is again volatilized for analysis. The major advantage of using vapor concentration with gas chromatography is its extreme sensitivity due to adsorption onto the charcoal strip.

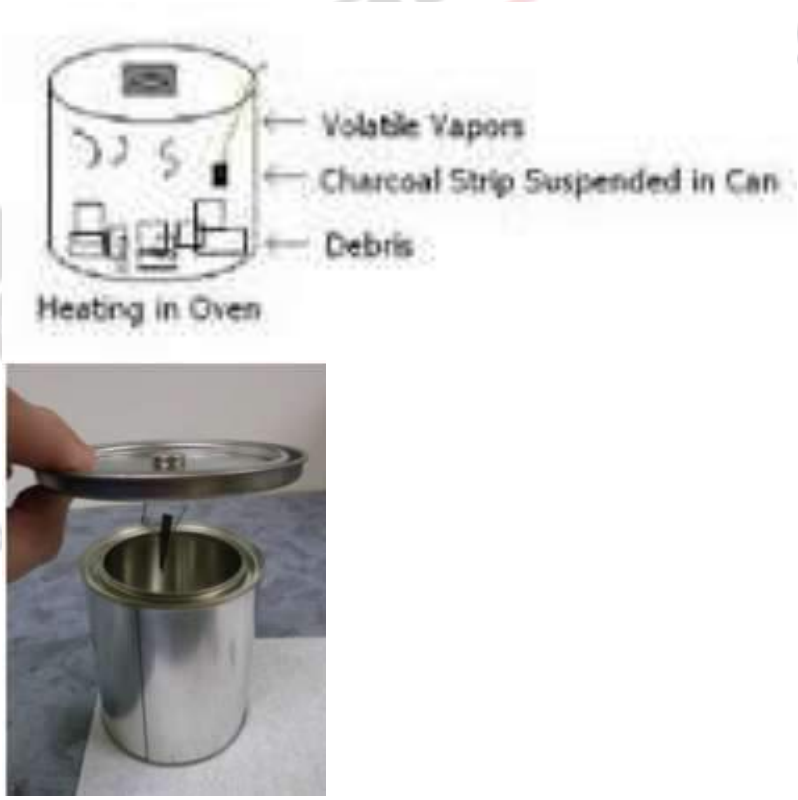

Figure 7: Vapour concentration using charcoal strip

When the vapor is injected into the gas chromatograph, it is separated into its components, and each peak is recorded on the chromatogram in the form of a characteristic pattern as shown in Figure 8. The typical set up of GC recording is shown in Figure 9.

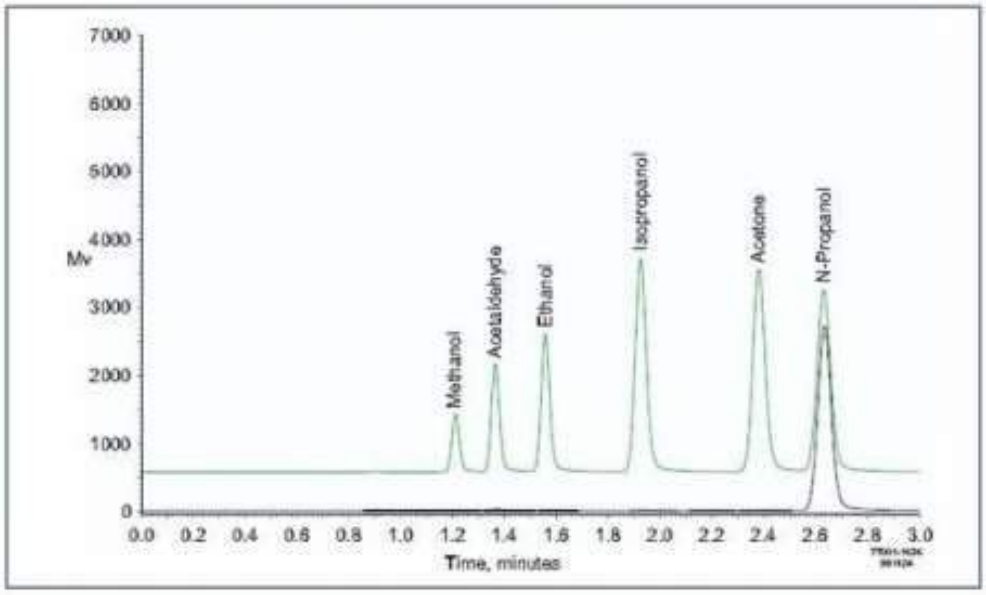

Figure 8: Typical Gas Chromatograph of known standards

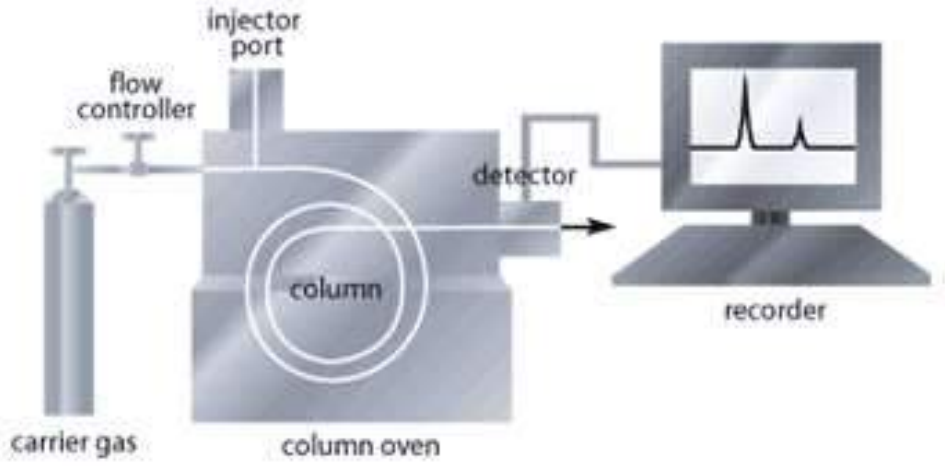

Figure 9: A Typical Set-up of Gas Chromatography

The chromatogram pattern of vapour residue in question is then matched with patterns of known standards of petroleum products to recognize the accelerant type. For example, in Figure 10, a gas chromatographic analysis of debris recovered from a fire site shows a chromatogram similar to a known gasoline standard, thus proving the presence of gasoline. In the absence of any recognizable pattern, the individual peaks can be identified when the investigator compares their retention times to known hydrocarbon standards (such as hexane, benzene, toluene, and xylenes). At present, it is not possible to determine the brand name of a gasoline sample by gas chromatography or any other technique. Fluctuating gasoline markets and exchange agreements among various oil companies make this difficult.

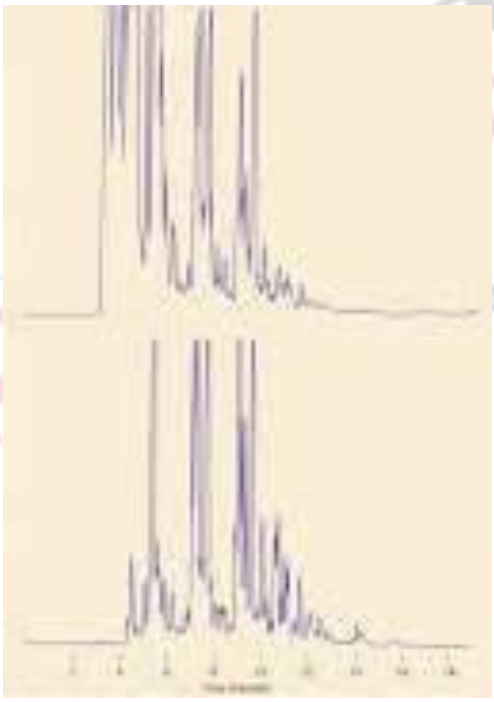

Figure 10: Gas Chromatograph of vapour from genuine gasoline standard (Top) and of vapour recovered from debris at site of fire (Bottom). Courtesy: New Jersey State Police.

Further, in some cases, the interpretation based on GC chromatogram is quite difficult, if not impossible, due to mixture of accelerants or from heat generated pyrolysis products of materials burnt at the fire scene. In these cases, gas chromatography combined with mass spectrometry has proven to be a valuable technique for solving difficult problems in the detection of accelerant residues.

In the mass spectrometer, the material enters a high-vacuum chamber where a beam of high-energy electrons is targeted at the sample molecules. The electrons collide with the molecules, causing them to lose electrons and to acquire a positive charge (commonly called ions). These positively charged molecules or ions are very unstable or are formed with excess energy and almost instantaneously decompose into numerous smaller fragments. The fragments then pass through an electric or magnetic field, where they are separated according to their masses generating a highly characteristic line pattern where each line represents a fragment of a different mass (actually the ratio of mass to charge), and the line height reflects the relative abundance of each fragment. The unique feature of mass spectrometry is that under carefully controlled conditions, no two substances produce the same fragmentation pattern. This generates a unique pattern like “fingerprint” of the substance being examined.

Complex chromatographic patterns thus can be simplified by passing the separated components emerging from the gas chromatographic column through a mass spectrometer. As each component enters the mass spectrometer, it is fragmented into a collection of ions. The analyst can then control which ions will be detected and which ones will go unnoticed. In essence, the mass spectrometer acts as a filter allowing the analyst to see only the peaks associated with the ions selected for a particular accelerant. In this manner, the chromatographic pattern can be simplified by eliminating extraneous peaks that may obliterate the pattern.

Summary:

Arson is the act of deliberately setting things on fire. When a fire occurs, oxygen combines with a fuel to produce noticeable quantities of heat and light (flames). If combustion is to be initiated and sustained, a fuel must be present, oxygen must be available, heat must be applied to initiate the combustion, and sufficient heat must be generated to sustain the reaction. Fire requires heat, oxygen and fuel for its sustenance however, to initiate it requires ignitor which may be flame, electric spark, blast, etc. In any case of fire, the arson investigator needs to examine the fire scene for signs of arson.

As soon as the fire has been extinguished, the investigator should search the fire scene to find the fire's origin. This site contains useful evidence to explain the cause of fire. Some telltale signs of arson include evidence of separate and unconnected fires, the use of "connectors" to spread the fire from one area to another, and evidence of severe burning found on the floor as opposed to the ceiling of a structure. The importance of porous materials at the fire origin is due to the fact that it contains the residues of accelerant used by arsonist. So, porous materials such as carpet, bed sheet, curtains, clothes, etc. should be collected and packed in air tight metal/glass containers to avoid loss of volatile compounds.

In the laboratory, the volatile component is separated from the debris collected from the fire scene using techniques such as headspace and vapour concentration which involves application of heat to separate the volatile sample. They differ on the basis that in headspace, the separated volatile sample is collected in syringe while in passive headspace, it is adsorbed on charcoal strip. In any case, the sample is identified using gas chromatograph which is the most sensitive and reliable instrument for detecting and characterizing flammable residues. Most arsons are initiated by petroleum distillates such as gasoline and kerosene. The gas chromatograph separates the hydrocarbon components and produces a chromatographic pattern characteristic of a particular petroleum product. By comparing select gas chromatographic peaks recovered from fire-scene debris to

known flammable liquids, a forensic analyst may be able to identify the accelerant used to initiate the fire.

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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Forensic Entomology: Life cycle blow flies, Forensic application
Module Id	----
Objectives	Learning Outcome: • To make the learners understand science of insect and its forensic significance. • To help the learners in determination of time since death. • To educate the learners to the Life cycle of blow flies. • To teach the learners to understand the decomposition time of dead body.
Prerequisites	General understanding about entomology.
Key words	Forensic Entomology, Blow flies, Post Mortem Interval (PMI)

Forensic Entomology: Study of insects to the criminal investigation.

The forensic entomologist job includes number of techniques about the life cycle of insect species like succession, larval weight, larval length, and accumulated degree hour technique. The use of insect behaviour to estimate the time of death is not a current concept. The initial recorded crime investigation with insects was in 1235 A.D. in China. Sung Tz'u, a Chinese "death investigator," wrote a book entitled. The Washing Away of Wrongs. This medico-criminal entomology case was recounted as a murder by slashing, which occurred in a Chinese village, and the local death investigator was deputized to solve the crime. After some ineffective questioning, the investigator had all the villagers bring their sickles to one spot and lay them out before the crowd. Flies landed on only one of the sickle sticks. This was due to blood being spattered on the sickle. The owner subsequently broke down and confessed to the crime.

Job of Forensic Entomologist

1. Identification of insects at various stages of their life cycle, such as eggs, larva, and adults.

2. Collection and preservation of insects as evidence.

3. Estimate for the postmortem interval or PMI (the time since death). Based on dependent factors such as identification of insects or their stages, weather conditions, location and condition of the body etc.

4. Justification before the court to explain insect-related evidence found at a crime scene.

Most insects used in investigations are in two major orders:

A. – Flies (Diptera)

B. – Beetles (Coleoptera)

Importance of Species succession:-

Some species feed only a fresh corpse, while another species prefer to feed on one the dead for two weeks. Experts should find other insect species that prey on the insects feeding on the corpse. Which may gives clue to missing species.

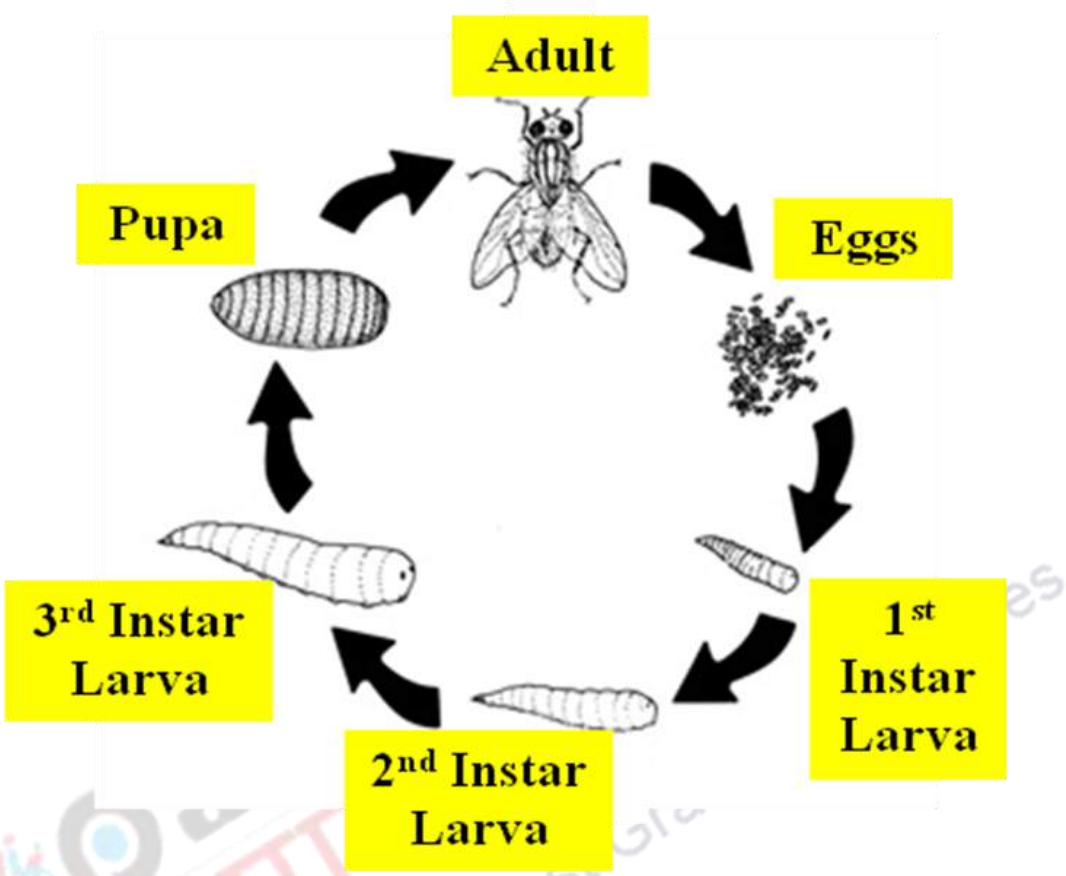
Importance of dependent factors:- Weather data is also an important tool in analyzing insect evidence from a corpse. Investigators will make note of the temperature of the **air**, **ground** surface, the **interface area** between the body and the ground, and the **soil** under the body as well as the temperature inside any **maggot masses**. They will also collect weather data related to daily **temperature** (highs/lows) and **precipitation** for a period of time before the body was discovered to the time the insect evidence was collected.

Other factors that might affect their PMI estimates:

1. Was the body enclosed in an area or wrapped in a material that would have prevented flies from finding the corpse and laying eggs?
2. Were other insect species present that may have affected the development of the collected species?
3. Were there drugs or other poisons in or on the body that might have affected the larvae's development?

Blow Fly Metamorphosis

Blow flies are fascinated to dead bodies and often arrive within minutes of the death of an animal. Blow flies have a **complete** life cycle with **egg**, **larva**, **pupa**, and **adult** stages.



1st – Adult flies lay **eggs** on the carcass especially at wound areas or around the openings in the body such as the nose, eyes, ears, anus, etc.

2nd – Eggs hatch into **larva** (maggots) in 12-24 hours

3rd– Larvae continue to grow and **molt** (shed their exoskeletons) as they pass through the various instar stages.

1st Instar - 5 mm long after 1.8 days

2nd Instar - 10 mm long after 2.5 days

3rd Instar – 14-16 mm long after 4-5 days

4th – The larvae (17 mm) develop into pupa after burrowing in surrounding soil.

5th – **Adult** flies emerge from pupa cases after 6-8 days.

Examples of Diptera (Flies)

Early Stage Decomposition

Blow & Greenbottle Flies (Calliphoridae)
Metallic thorax and abdomen

Flesh Fly (Sarcophagidae)
Striped thorax

Late Stage Decomposition

House Fly (Muscidae)

Cheese Skipper (Piophilidae)

Examples of Coleoptera (Beetles)

Early Stage Decomposition

Carrion Beetles (*Silphidae*)
Adults & larvae feed on fly larvae

Early to Late Stage Decomposition

Rove Beetles
(*Staphylinidae*)
Predator of fly eggs

Clown Beetles
(*Histeridae*)
Predator of fly eggs

Late Stage Decomposition

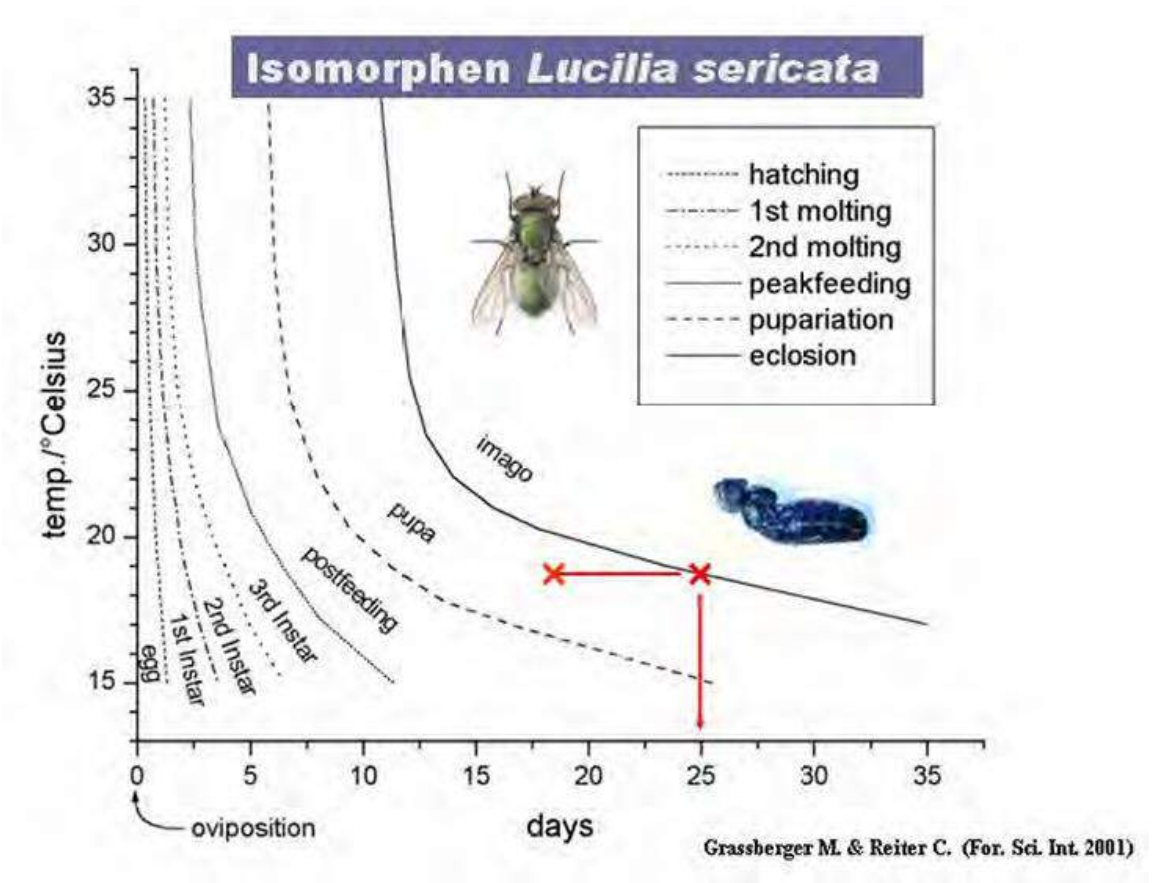
Ham & Checkered Beetles
(*Cleridae*)
Predator of flies & beetles;
also feed on dead tissue

Skin Beetles (*Dermestidae*)
Feed on dried skin & tissues

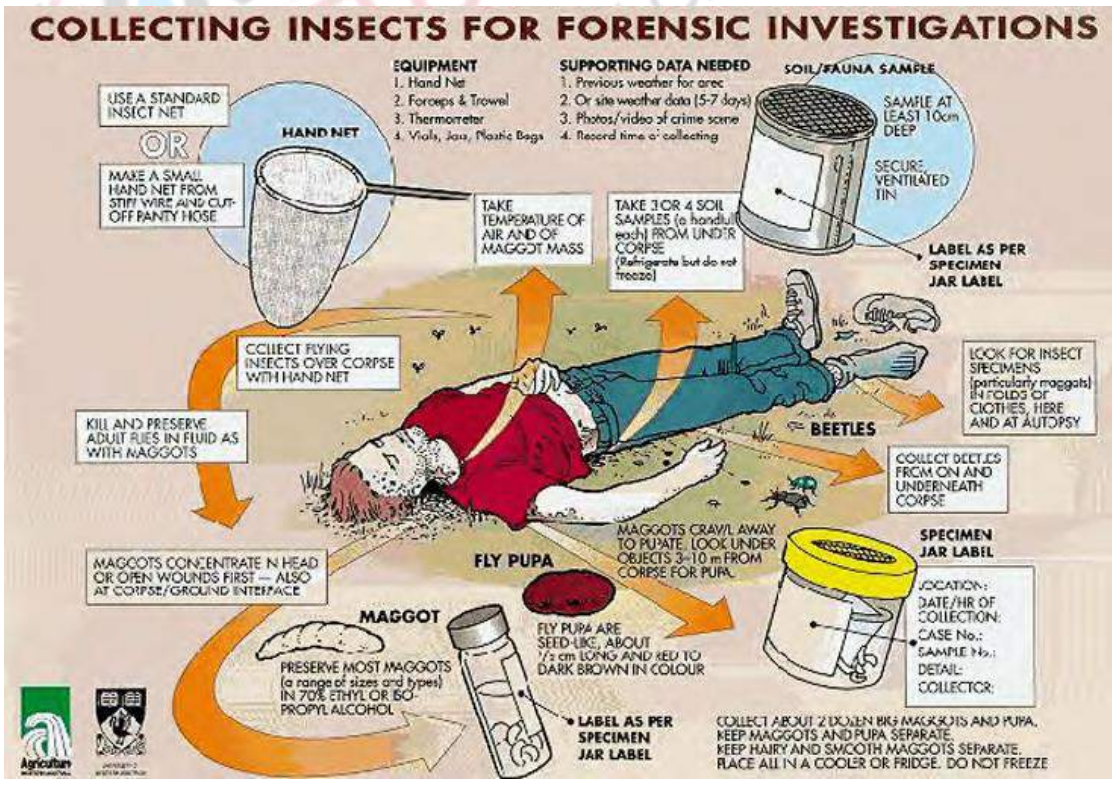
Hide Beetles
(*Scarabidae*)
Usually the last to arrive

After death, body temperature drops, rigor mortis sets in, and variety of insects and other invertebrates attract toward the dead body. Flies, especially the Calliphoraidae (green bottle and blue bottle fly) larvae or maggots (Diptera), figure mainly in the invasion of tissue. Usually females of the genus Calliphoraidae oviposit appear within minutes following death. Thus, the flies leave an evidence trail of egg batches, white to yellow and 2 mm in length, in the mouth, nose, ears, wounds and, if exposed, the anus and the genitalia within minutes of death. These natural body openings provide moist, humid cavities, which

enhance egg hatching and larval survival.



Grassberger M. & Reiter C. (For. Sci. Int. 2001)



Source: Neal Haskell and Paul Catts, *Entomology and Death: A Procedural Guide*, Clemson,

Forensic significance of entomology

Forensic entomologist estimate PMI by examining the insect population on or near the body. Expert can also estimate how long the deceased has been lying in a particular location by the soil and insects beneath the deceased. If there is a difference in the estimates, and the analysis of the soil suggests a short PMI while the analysis of the body fauna suggests a longer PMI, one can determine that the body has been moved. One can also estimate how long the body has been lying at a certain place by assessing the plants and the soil surrounding the body.

Can insects mutely give us precious information about a crime? The experts at the American Board of Forensic Entomology say we should be listening to insects through the evidence they provide us. Can they tell us when and where someone was murdered, or even who did it? Can they tell us what type of explosive material was used in a bombing? This study and numerous green bottle blowflies may help us decide that we should be listening.

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3. http://www.kathyreichs.com/entomology.htm
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7. http://www.forensicflies.com/beetles.htm

8. Starkeby, M., “Ultimate Guide to Forensic Entomology: Introduction to Forensic Entomology,” Web-only essay,URL< http://folk.uio.no/mostarke/forens_ent/introduction.html>, accessed 5 January 2004.

9. K. Smith, A Manual of Forensic Entomology (New York: Cornell University Press, 1986), 20-23.

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A Gateway to all Post Graduate Courses

An MHRD Project under its National Mission on Education through ICT (NME-ICT)

Subject: **Law**

Production of Courseware

- Content for Post Graduate Courses

Paper : Forensic Science and Forensic Medicine

Module : Forensic medicine and medical jurisprudence, inquest, dying declaration, exhumation. Law in relation to medical profession.

Role	Name	Affiliation
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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Forensic medicine and medical jurisprudence, inquest, dying declaration, exhumation. Law in relation to medical profession.
Module Id	LAW/CJA/VIII/33
Objectives	Learning Outcome: • To make the learners understand the need for Medical laws concerning the rights and responsibilities of medical professionals and their patients • To make the learners understand of various processes of jurisprudence in the application of medical science to legal problems. • To acquaint the learners with the process relating to exhumation.
Prerequisites	General understanding of Medical law, concerning the rights and responsibilities of medical professionals and their patients including confidentiality, negligence and other torts related to medical treatment especially medical malpractice and criminal law and ethics.
Key words	Jurisprudence, exhumation, medical negligence, malpractice, inquest.

Forensic science: 1,2

- ✓ Forensic science is the application of science to criminal and civil laws. During the course of an investigation, forensic scientist collect, preserve and analyze the evidences scientifically. Or forensic science is the application of scientific knowledge and methodology to legal problems and investigations.

- ✓ Forensic science is comprised of different areas of science, biology, chemistry, physics, genetics, medicine, anthropology, psychiatry and toxicology etc.

- ✓ Apart from collection, preservation and examination, forensic scientist presents expert testimony to courts.

- ✓ With the use of fingerprint and other identification techniques in criminal investigations, modern forensic science came in limelight. These days applications of forensic science in legal issues have gained more popularity became more common as every area of science has a potential bearing on law.

Forensic medicine: 2,3

- ✓ Forensic implies something to forum while medicine is a science of cure and preserving health. Forensic science is the branch of medical science which deals with the application of medical knowledge in order to prove facts in criminal or civil cases.

- ✓ Such applications can be applied in cases such as vehicular accidents, to establish the fact that whether the accident is responsible for injuries or injuries are causes prior to accident, in case of death to ascertain time of death, in case of sexual offences like crime actually happened or not.

- ✓ The area of a forensic scientist is not restricted to his own field only but he uses the knowledge of other branches of medical science to solve the problem of forensic medicine.

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1 J. Prahlow, Forensic Pathology for Police, Death Investigators, Attorneys, 17 and Forensic Scientists, DOI 10.1007/978-1-59745-404-9_2,
2 Parikh's Text book of medical jurisprudence Forensic Medicine and Toxicology CBS publisher and distributors PVT.LTD.
3 anil aggrawal's internet journal of forensic medicine and toxicology, introduction to forensic medicine and legal procedures prevalent in india - part i,volume 2, number 1, january - june 2001.

Medical jurisprudence: 2,3,4

- ✓ Medical jurisprudence is the legal aspect of practicing medicine.

- ✓ Medical jurisprudence includes doctor-patient relationship, duties towards the patient, rights and duties of doctor himself and medical negligence.

- ✓ Doctors are obligated to certify persons for compensation, insurance plans, to certify and issue birth and death certificates, to determine when a mentally disturbed person to be detained to protect him and others. Such routine works are some frequent task under Medical jurisprudence.
- ✓ Medical jurisprudence may be involved in cases like paternity testing or genetic relationships, in cases involving injuries or death from violence.

Medical ethics: 5, 6

Medical ethics is basically the moral principles that guide the medical professionals to deal with each other, their patients and with the state as well. Few type of subjects that may are relevant on medical ethics may include:

- ✓ Patient autonomy and their right to refuse or choose treatment
- ✓ Non-malaficence
- ✓ Beneficence
- ✓ Dignity
- ✓ Honesty
- ✓ justice

3 Mohammed Iliyas Sheikh, must know aspects of medical jurisprudence for medical professionals, NHL journal of medica sciences/ Jan 2013/vol 2/issue, 1

4 Anil Aggrawal's internet journal of forensic medicine and toxicology, introduction to forensic medicine

5 Dikshit P C, Text book of Forensic Medicine and Toxicology, PEEPEE publisher and distributors (P) LTD.

6 Simpson's Forensic Medicine, 13th Edition, Jason Payne-James, Richard Jones, Steven B Karch, John Manlove, August 26, 2011 by CRC Press.

Indian legal system: 5,6

- ✓ The criminal procedure code, 1973 (CrPC) provides the machinery for crime investigation, apprehension of suspected criminals, collection of evidences, determining guilt or innocence and punishment of the guilty, public nuisance, prevention of offences and maintenance of wife, child and parents within the limitations of the union territories of India except Jammu & Kashmir and some other tribal areas. 5,6 It also constructs the duties of police in arresting, dealing and investigating the crime.
- ✓ The Indian Penal Code, 1860 (I.P.C) describes various crimes with their punishment in court of law.
- ✓ The Indian evidence act, 1872 (I.E.A.) provides set of rules and allied issues which govern the admissibility of evidences found at scene to reach a conclusion in the court of law.
- ✓ Criminal law describes the offences which are against the public interest namely person, property, and safety of public and security of the state.
- ✓ Civil law deals with disputes between two individual or parties.

Inquest : 2, 7

Inquest (in = in; quasitus= to seek) means judicial inquiry to ascertain a matter of fact. An inquest is a judicial inquiry particularly into the cause of death where the death is not natural. In such cases where death is under suspicion, investigation becomes necessary to apprehend and punish the culprit.

The unnatural death, is defined under section 174 of CrPC, is that

- A person has committed suicide, or
- killed by another person or
- killed by an animal or
- Because of an accident or

- Or some other circumstances raising suspicion of some foul play

Inquest can be conducted in number of cases like suicide, homicide, industrial accidents, domestic accidents, road accidents, infant deaths, operational deaths, negligence, abortion, drug or poisoning cases, sudden death or death in custody. There are four types of inquest, namely

- The Police inquest (conducted by a police officer)
- The Coroner's inquest (conducted by a coroner, not followed in India now)
- The Magistrate's inguest (conducted by a Magistrate)
- The Medical Examiner system (conducted by an official who is legally and medically qualified, prevalent in USA)

7- 174 CrPC

Police inquest: 2,8

✓ Police inquest (Section 174 Cr.P.C.) to be conducted by officer in charge of a police station or some other police officer empowered by the government.

✓ Police inquest is conducted in cases like suicide, homicide, accidental (killing by an animal or some machinery, death where suspicion arises that some other person has committed the crime or in cases like where death of a women takes place within 7 years of her marriage and a relative of her make a request in this behalf.

✓ On receipt of information of death, police reaches to the site and holds an inquiry with the people of locality.

✓ Police examines the situation and make a report describing the situation of body and wound, bruise, fracture or any other mark which give indication of the method of

instrument used to inflict the injury. This proceeding comes under section 174 and 176 of the code of criminal procedure which will be conducted by the concerned police officer and the Magistrate.

- ✓ In such cases of unnatural deaths, In addition to sending the first information report, it should be accompanied with inquest report and statements of witnesses attested by the panchayats summoned under section 175 Cr.P.C.

- ✓ If there is no foul play suspected, body is given to the relatives of the victim for cremation.

- ✓ In cases where there is suspicion of homicide, suicide, accident or any kind of suspicion of unnatural death, the police officer conducting the inquiry sends the body for post mortem to the nearest government hospital or to private hospital authorized to conduct medico legal examination.

8- Committee on Reforms of Criminal Justice System Government of India, Ministry of Home Affairs Report VOLUME I INDIA, March)

Magistrate's inquest: 2,3,9

- ✓ Magistrate's inquest (Section 176 Cr.P.C) to be conducted by District Magistrate/ Sub-divisional Magistrate, Executive Magistrate/ Judicial Magistrate.

- ✓ Magistrate inquest is based on the assumption that inquiry made by police is not always reliable.

- ✓ In cases where women commit suicide within 7 years of her marriage or in case of death of a woman where circumstances raise suspicion of some other person committing the crime, Magistrate inquest is held.

- ✓ Magistrate can hold an inquiry into the cause of death of any case mentioned under police inquest.

- ✓ In cases where person dies/disappears or cases like where suspicion of rape is there , inquiry is made by Judicial Magistrate in addition to the police inquest.

- ✓ In cases where it is considered expedient or necessary to examine of a dead body which already has been interred, the Magistrate may cause the body to disinter in order to know the cause of death.

Medical Examiner system: 2,9

This kind of inquest is common in most of the stats of USA. In this system a medical person is appointed to hold an inquest. The medical person owing his knowledge of medical sciences gathers the evidences and performs the autopsy. He doesn't have the power to summon and examine the witnesses. He submits his report to the district attorney.

9 Vij K, Text book of Forensic Medicine and Toxicology, principle and practice, Reed Elsevier India Private Limited.

Documentary evidences: 2

Documentary evidences comprise all the documents either written or printed to be produced in court of law for examination during a trial. The term document here includes any media by which information can be preserved. It may include the following documents:

1- Medical certificate:

It is the certificate or statement from a physician which is issued in relation to ill health, age , sex, insanity, pension disabilities or death. It can serve as a sick note (employee is unfit for work) or an evidence of health condition.

2- Medical Report:

A medical report may be an injury report, post mortem report, report on sexual offences, pregnancy, abortion or delivery etc.

3- Dying declaration: 2,5,10,11,12

- ✓ Dying declaration is a legal term used for ‘words said before death’. According to the section 32(1) of the Indian Evidence Act “when the statement is made by a person as to the cause of his/her death or as to any of the circumstances.
- ✓ According to the section 157 IEA, Dying declaration from a person is made before his death and should be supported by corroborative evidences.
- ✓ Dying declaration is found relevant in case of, when it correlates with cause of death and statement made by a person to any circumstances resulted in his death.

- ✓ The provision of dying declaration was made basically on two grounds (1) when the victim is the only eye witness and excluding his or her statement will not meet the justice (2) person is believed to tell truth at the time of death.
- ✓ Magistrate is called to record the declaration if time permits; otherwise a doctor can take the declaration either at the site or in the hospital. Depending upon the situation police officer, panchayat head or even relative can take the declaration.
- ✓ According to section 162 CrPC, dying declaration may be taken in form of first information report.

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10 critical appraisal of dying declaration, dr. r.k.gorea, dr. 11o.p.aggarwal, jiafm, 2004; 26(1). *issn 0971-0973.*

11 Gupta bd, jani cb. status of compos mentis in relation to dying declaration in burn patients. jiafm. 2004; 25(4):133 – 136

12 Indian Evidence Act, 1872, Criminal Manual. 14th ed. Lucknow: Eastern Book Company, 2003: p15)

- ✓ If the person dies before completion of the statement, the incomplete declaration is not admissible in the court.
- ✓ The doctor has to issue two certificates confirming the compos mentis of patient, one before the declaration and other when the declaration is concluded.

  The declaration may be oral but the person receiving it should record it in writing.

  The declaration should be recorded in presence of two disinterested witnesses.

  The declaration should be read over to the victim and he should affix his signature or thumb impression when concluded. It should also be signed by doctors and witnesses.

  The sealed declaration then sent to appropriate magistrate.
- ✓ The investigating police officer should not be present there when the declaration is being recorded.
- ✓ In case of dying declaration, if the person survives, the declaration does not has any legal value.
- ✓ Under section 157 IEA, dying declaration can be treated as corroborative evidence if the person survives.

Miscellaneous: it may include expert opinion from books or deposition from previous case proceedings, etc.

Exhumation: 9

Aggrawal A. Exhumation – medical and legal aspects. Anil Aggrawal's Internet Journel of Forensic Medicine and Toxicology 2001;2: available at http://www.geradts.com/anil/ij).

Duff EJ, Johnson JS. Some social and forensic aspects of exhumation and reinterment of industrial revolution remains. BMJ 1974; 1:563-7

- ✓ Exhumation (*ex*= out of, *humus*= ground) means out of ground or it is the authorized digging out of a dead person.
- ✓ Exhumation is both in civil and criminal cases, to find out a person's identity, establish cause of death or to decide some other relevant fact.
- ✓ In India, majority of people are Hindus who believe in cremation (burning) of body as soon as possible so exhumation is not of much importance in India. Only a few communities here believe in burying of body after death where exhumation might be useful to know the cause of death.
- ✓ Exhumation can be done where the autopsy was not done or had been done before burying the body but again needed after exhumation.
- ✓ Exhumation can be done in civil cases like insurance claims, accidental death claim, liability for medical negligence, compensation claims or disputed identity and criminal cases like criminal abortion, homicide cases, poisoning or criminal negligence.
- ✓ There is no time limit for exhumation in India.
- ✓ For exhumation written order is obtained from magistrate. The place of burial is identified correctly and magistrate, police officer and medical officer have to be present at the spot.
- ✓ According to section 176 (4) Cr.P.C. relatives are allowed to remain at the site throughout the process.

Procedure: 9, 13, 14 The grave is dug up to the level of coffin, photographs are taken and sketch can also be drawn about the position of body and coffin and corpse should be taken out carefully to avoid artefacts.

- ✓ No disinfectant should be sprinkled on the body.
- ✓ In case of skeletonisation the soil should be searched for objects like bullet, teeth, hyoid bone or metallic objects etc. If any fluid or debris is present in the coffin, it should also be collected.
- ✓ If injuries are present, there are chances that injuries on soft tissues may get distorted, so care should be taken while interpreting them.
- ✓ If poisoning is suspected, viscera should be kept for further analysis.
- ✓ If body is decomposed so badly that no tissue is left then hair, soil, teeth and bones should be collected. In such cases, ½ kg of soil from top, bottom and sides should be preserved for further chemical analysis.
- ✓ Whether the skeleton or a single bone is obtained for examination, should be analyzed for its authenticity (actually it is bone or not), origin of bone (animal or human bone), they belong to one or more individual, race of the person, sex determination, age, stature of the person it belongs, nature of injury, time since death and cause of death.

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13 ALEX KIRASI OLUMBE AND AHMED KALEBI YAKUB, Management, exhumation and identification of human remains: A viewpoint of the developing world, RICR Décembre IRRC December 2002 Vol. 84 No 848

14 M.A. Dada and D.J. McQuoid-Mason DJ, Introduction to Medico-legal Practice, Butterworths, Durban, 2001, pp. 341-343.

Law in relation to medical profession: 2, 9, 15, 16

There are number of medicine system like western medicine, traditional Chinese medicine, ayurvedic medicine in India and many native medicine systems from Africa and Asia. In spite of having their own tradition, conventions and code of conduct, the key principle espoused from the basis is called 'medical ethics' for all the systems. Changes influenced by society continue to evolve and change medical ethics time to time. The laws governing the medical practice undoubtedly vary country to country but principles of medical ethics are universal and followed by national and international organizations. The medical ethics are nothing but the moral principles to guide the medical professionals. In India, the enforcement is done by the Medical Council of India and state medical council.

Medical council of India:

- ✓ Medical council of India was established by Indian Medical council Act of 1956. A medical register is maintained foe India and for the matters concerned with it.

- ✓ The council consists of one member from each state nominated by the central government in consultation with the concerned state government, One member from each university to be elected from its medical faculty, One member from each state where the state medical register is maintained, who possesses the qualification included in the 1st, 2nd and part II of the third schedule, seven members to be elected from any state medical register who possess a qualification included under part I of the third schedule and eight members to be nominated by the central government.

- ✓ The main functions of Medical council of India includes; maintenance of medical register, medical education where it maintain the same standard for graduate and post graduate courses throughout India, recognition of foreign medical qualification to an Indian national with foreign degree, appeal against disciplinary action and warning notice in relation to professional misconduct.

Rights and privileges of a registered medical practitioner:

- ✓ Right to practice medicine
- ✓ Right to choose a patient
- ✓ Right to issue a certificate
- ✓ Right to add title to his name
- ✓ Right to recover his fees
- ✓ Right to appointment to public hospitals
- ✓ Right to give expert opinion in court
- ✓ Right to dispense medicine

Duties of a physician in general:

- ✓ Maintain the highest standard of professional conduct
- ✓ Respect the patient's right to accept or refuse the treatment
- ✓ Should avoid unfair discrimination
- ✓ Deal honestly with patient and colleges
- ✓ Should not provide specific products to patient to gain financial benefits.
- ✓ Certify only that which he personally verified.
- ✓ Respect the national and international code of ethics.

Duties of physician to patient:

- ✓ Examine the patient properly
- ✓ Bear in mind the obligation to respect human life
- ✓ Duty to exercise necessary care and skill
- ✓ When providing medical care, should act in patient's best interest
- ✓ Should own patients loyalty
- ✓ Give emergency service as a humanitarian duty
- ✓ Not enter into a sexual relationship with his/her patient.
- ✓ To prescribe medicine properly

Duties of physician towards colleagues:

- ✓ never criticize the colleagues
- ✓ never take fees from colleagues
- ✓ always help the colleagues
- ✓ consultation with the colleagues to provide the patient best assistance
- ✓ Should never undermine the patient-physician relationship of colleagues to attract the patient.

Duties of physician towards state:

There are basically two duties of a physician towards state-

1- Notifiable diseases

2- Geneva conventions

Notifiable diseases:

In case of communicable diseases like cholera, plague etc, it is duty of a doctor to inform the health authorities. In addition to this his duty also includes to inform the authorities about the birth and death, failing of which a civil suit can be brought against him but not the criminal suit.

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15 FORENSIC MEDICINE AND TOXICOLOGY, W.G. AITCHISON ROBERTSON, August 10, 2006, ISO-8859-1

16 Clinical forensic medicine, W.D.S McLay, Cambridge University Press 2009, ISBN-13 978-0-521-70568-4

Geneva conventions: 2, 9

According to Geneva conventions, 1949, a doctor is bound to provide medical assistance

- to a person of armed force (I convention)
- ship wrecked person (II convention)
- prisoner of war (III convention)
- civilian of enemy nationalist (IV convention)

The mentioned categories of persons should be provided medical assistance without any discrimination based on race, religion or political grounds.

Medical negligence (malpraxes) : 9

✓ In general the negligence is "the omission to do something which reasonable man could do or doing something which a prudent or a reasonable man could not do." While Medical negligence is defined as "want of reasonable care and skill or willful negligence on the part of the medical practitioner while treating a patient resulting in bodily injury, ill health or death." Or in other words since the doctor owes duty towards his patients, if there is some breach of the duty by the doctor due to which patient suffered damage is medical negligence. Medical negligence is a civil wrong, rarely the medical negligence may be renewed from a civil action to the criminal courts.

✓ In present times doctors too are very much prone to threat with an action of negligence. Even the patients who are provided with the best treatments with complete cure without cost are ready to sue the doctor. The matter of fact is, severe disability resulting from an accident during the course of an accident is not necessarily negligence.

✓ The doctor has right to refuse a patient for treatment but once he accepted to provide him medical assistance his duty towards the patient starts.

✓ There are certain circumstances where the doctor can refuse to accept the patient for treatment. The conditions are:

- If the deceased does not belong to doctor's area of specialization
- If the facilities needed are not available at that place
- the doctor himself is not well or any of the member of his family is not well
- If the doctor is busy in some family functions.

✓ During the emergency cases it is the moral and ethical duty of the doctor to provide medical assistance to the patient in order to save the life. If the patient cannot be accepted, doctor should make sure that the patient reaches to the nearest hospital as early as possible. In such case if there occurs some damage to the patient, he cannot sue the doctor.

✓ It is the duty of a doctor to exercise reasonable skill and care when the doctor-patient relationship is established.

✓ When a doctor accepts a patient with intent to heal, a doctor-patient relationship establishes and from that moment doctor is legally responsible to provide due care, breach of which makes the ground for medical negligence.

✓ For all the doctors who qualified the examinations and registered in the state medical council or Indian medical council, there is a minimum level of competence to protect the public from insufficiently qualified doctors.

✓ The doctor must use care, reasonable in circumstances. Like responsibility of recovery of swabs used in operation theatre lies with the doctor.

Precaution against medical negligence:

✓ Reasonable care, skill and attention to be taken

✓ Should never guarantee a cure

✓ Always obtain the informed consent from the patient

✓ Doctor should maintain proper and accurate record.

✓ Before injecting the hypersensitive drugs like penicillin or streptomycin , sensivity test should be performed.

✓ Medicine should be given in proper dosage

✓ Specialist should be consulted when needed

- ✓ A written informed consent should be taken from patient before the surgery.

Contributory negligence: Contributory negligence is generally a defense based on negligence. It is relevant when the claimants contributed to the harm they suffered through their own negligence. In medical scenario, it is the absence of reasonable care on part of patient or by his attendant that combines with the negligent action of the doctor resulted in the damage, for eg- not to provide full history to the doctor. In cases where doctor and patient boyh are negligent, doctor can take a good defense while when only patient is negligent it is called 'the negligence of the patient'.

Therapeutic misadventure: Therapeutic misadventure is the unexpected damage to the patient by the doctor while diagnosing or during the experiment. For eg- radiological procedures during diagnosis may prove fatal or foetal death in uterus while mother was given some drug during pregnancy.

The consumer protection act: 9

- ✓ The consumer protection act 1986 came into force on 15 april 1987 is a welfare legislation that mainly favors the workers.
- ✓ The complaint can be lodged in any places with or without engaging a lawyer by paying a nominal fee. The complaint may be filled by the district forum by
- ✓ The consumer to whom the service has been provided or agreed to be provided.
- ✓ Consumer association
- ✓ State or central government
- ✓ The limitation period for the complain to be lodged in all the forum is within two years from the date on which the cause of action has arisen.
- ✓ As penalty the person shall be punished with imprisonment ranging from one month to three years and fine from rupees two thousand to rupees ten thousand.

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An MHRD Project under its National Mission on Education through ICT (NME-ICT)

Subject:

Law

Production of Courseware

- Content for Post Graduate Courses

Paper : Forensic Science and Forensic Medicine

Module : Autopsy: Internal and external examination

Role	Name	Affiliation
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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Autopsy: Internal and external examination
Module Id	LAW/CJA/VIII/34
Objectives	Learning Outcome: • To make the learners understand about the human autopsy in order to know suspicious, violent or unknown cause of death. • Providing the learners an idea of Advantages and benefits of autopsy by classifying in benefits for medical practice, for deceased's families and for society. • The goal of an autopsy is to inform and help clinicians learn from mistakes and improve

	medical future practice in favour of next patients.
Prerequisites	General understanding of the medico legal and pathological autopsy with an insight to get better understanding of the causes of death.
Key words	Autopsy, thanatology, incision, haemorrhage, histopathology.

Autopsy

Introduction

Autopsy refers to the examination of whole body after death. Autopsy is also referred as post mortem, necropsy and thanatopsy. If the cause of death is known, still there is a provision to examine all the body parts and all the cavities to find out any contributory factor to death. To avoid miscarriage of injustice a proper autopsy is needed and to establish facts between the eyewitnesses and investigation team. A certified and experienced medical examiner carries out the post mortem to find out the answers of queries asked by the investigator, often the cause of death. 1,2.

Autopsy can be of two types: (1) medico legal autopsy (2) pathological autopsy. Medico legal autopsy is done on the request of investigative officer. In such autopsy consent of the relative is not required. The medical practitioner performs the post mortem to know the cause of death. (2) Pathological autopsy is one in which autopsy is done on the request of relatives and performed in pathological department. In such cases medical practitioner performs the autopsy of a particular or more organs where pathology is suspected to find out the cause of death. 3,4

Autopsy is performed with following objects:

- To identify unknown bodies
- To know the cause of death
- To know the manner of death (suicide, homicide or accidental)
- To find out time since death
- To get trace evidence and preserve them when needed
- To preserve the viscera when needed.

Procedure for autopsy: 2,3,5,6

External examination:

- A brief description of age, sex, race, height and weight should be made.
- A brief note of articles found on body (shirt, t-shirt, colour, button etc)
- Degree and distribution of rigor mortis and post mortem staining.

- Colour of eye, hair, any unusual appearance, congenital malformations, scar ar acne should be noted.
- Any evidence of disease, old injury, or medical surgery should be noted down. If possible with age of injury should also be noted down.
- In case of gunshot wounds, size and length should be described in inches or centimeters in relation to the head or sole and to the right nd left of midline.
- In case of injury caused by bullet, its place, intactness, condition of bullet, any deformity to bullet should be noted. Then bullet should be kept in an envelope with all the details like name of victim, date, postmortem details etc.
- When there is stab wounds, note should be made of its edges, dimensions and estimation of depth.
- An examination of presence of trace evidences such as soot, grease, paint or powder etc to be made.

Internal examination of the body during autopsy: 3,7,8

In the internal examination, the incision of the body is done through which we inspect the various organs and examine the cavity systematically.

Weigh of the organs and checking for the pathological diseases are also done in autopsy.

Incision must be adopted to suit the circumstances of case

The three major cavity of the body should be opened and examined these are:

- Skull
- Thorax
- Abdomen

Three types of incisions: 2,3,9

I-shaped incision

1. Y-shaped incision
2. Modified Y-shaped incision

In I-shaped incision,

- ✓ The incision is drawn from just above the thyroid cartilage to pubic symphysis avoiding the umbilicus and any injuries in the line of incision.
- ✓ This method is mainly used due to its simplicity and convenience.

In Y-shaped incision,

- ✓ Two incisions commence on either side of neck from 2-3cm behind the lobe of each ear to meet at manubrium sterni (called supersternal notch) and then continued as a single incision down to pubic symphysis.
- ✓ This method is used in which the more detail about neck is required.

In modified Y-shaped incision,

- ✓ Two incisions are made commencing on either side of the chest from anterior auxiliary fold, curving under the breast/nipples to xiphisternum and to be continued as a single vertical incision down to pubic symphysis.

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1 Wikipedia (https://en.wikipedia.org/wiki/Autopsy)

2 Dikshit P C, Text book of Forensic Medicine and Toxicology, PEEPEE publisher and distributors (P) LTD.

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9 Roulson, J., Benbow, E.W., Hasleton, P.S.: Discrepancies between clinical and autopsy diagnosis and the value of post mortem histology; a metaanalysis and review. In: Histopathology 2005, 47:551-559.

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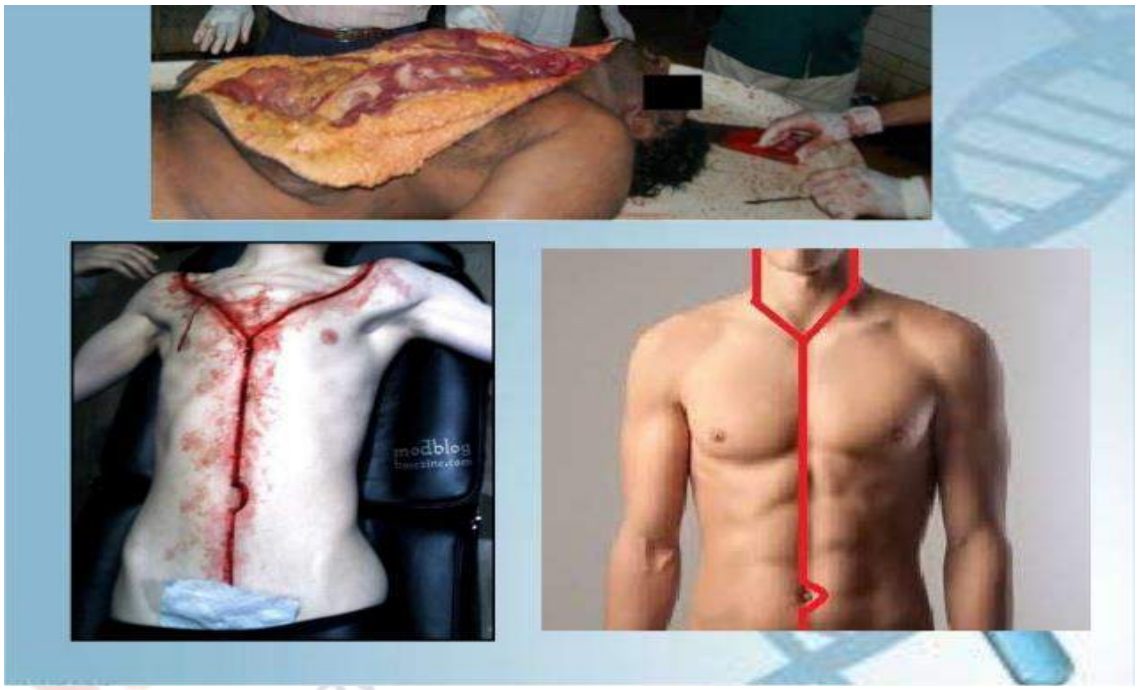

Order of examination: 8

Autopsy techniques may vary in order in which the organs are removed.

Virchow's technique:

This method has been used most widely. In this method organ are removed one by one. This technique follows the sequence: cranial cavity → the spinal cord → thoracic, cervical and abdominal organs.

Rokitansky's technique:

This technique includes in situ dissection combined with en block removal. This kind of study is preferred where infections like HIV and hepatitis B have to be prevented.

Examination of neck: 2,3,10

- In case of asphyxia deaths (hanging and strangulation) brain is taken out first to completely drain the blood from neck in order to examine the neck in bloodless field. The chest organs can be removed prior to neck dissection avoiding injuring the neck veins.
- In dissecting anterior neck structure the platysma muscle is examined for presence of bruises.
- The sternocleidomastoid muscles are left intact and the external jugular veins are then examined.
- Lateral clavicular head is detached. Suprahyoid and infrahyoid muscle groups are then examined, carotid sheath containing carotid arteries, internal jugular veins and the vagus nerve are examined.
- While dissecting the posterior neck structure which is suspected because of suffocation in traffic accidents and is recommended in all infant deaths occurring outside the hospital, the prevertebral fascia can be examined for evidence of traumatic injury, such as presence of crepitus. The fascia is then reflected from the underlying bone.
- The body is turned over and the superficial tissues including ligamentum nuchae is reflected from the occipital region inferiorly to the base of the neck, in order to expose the underlying soft tissues.

Internal examination of Thorax

Evaluation of coronaries:

- Before any form of cardiac dissection is applied, coronaries should be inspected for calcification & tortuosity.
- Examine the size, shape, position, number & patency of coronary artery Ostia.
- Heavily calcified coronary arteries, if possible, should be removed intact, decalcified and opened transversely.

- Coronary artery bypass grafts (saphenous veins, internal mammary arteries, radial arteries etc.) may be examined with longitudinal or transverse cuts.
- Examined by making serial cross section to check the ante mortem clots.
- Air embolism in heart chambers should be also checked.
- Subjects younger than 30 yrs or where the cause of death is non cardiac, coronaries may be opened longitudinally.

Examination of the Heart

- Open the right atrium by a cut from the inferior vena cava into the right atrial appendage.
- - Open the tricuspid valve laterally down to the apex of the right ventricle.
- - Cut from the apex of the right ventricle through the pulmonary valve into the pulmonary artery.
- - Join two pulmonary veins across the roof of the left atrium to view the inside of the chamber.
- Cut through the mitral valve orifice laterally down to the apex of the left ventricle.
- Cut from the apex of the left ventricle up through its outflow tract into the aorta.
- There are two variations in this final cut.
- It may be made through the anterior cusp of the mitral valve itself or pass anteriorly, leaving a flap of anterior wall of the ventricle hinged on an intact anterior cusp of the mitral valve.
- The enterotome is inserted into the :
- RA→ Tricuspid valve→ RV→ Pulmonary Trunk→ Pulmonary Vein→ LA→ Mitral Valve→ LV→ Ascending aorta.
- Heart should be eventually weighed and the various measurements of the circumference of the valves or the thickness of the ventricles etc are taken.

LUNGS:

- Autopsy examination of the lungs includes dissection of the pulmonary arteries, veins, removal of the lungs from the thoracic cavity and examination of the outer lung surfaces (pleura).
- Weighed before cutting as appreciable oedema fluid can run out during dissection.
- Dissect and examine the internal lung structures (arteries, veins and airways) should be done first then open the lungs with a knife to reveal the lung tissue (parenchyma).
- Examined for consolidations, edema, atelectasis, emphysema, tardieu spots, emboli etc.
- Finally examined the lung tissue under the microscope to look for abnormalities in the tissue and cellular level.

KIDNEYS:

- Size and weight are noted.
- Capsules are examined and excised carefully.
- Kidney is sectioned longitudinally the convex border of the hilum so that it splits into half and open the pelvis.
- Checked for calculi, inflammation etc.
- Ureter is cut and examined.

STOMACH:

- Stomach is opened along the greater curvature from the cardiac to the pyloric end after applying double ligatures.
- Size of pyloric ring is noted.
- Contents are examined for any nature of food which might be present and its state of digestion, smell, color, character, presence of foreign bodies.
- Mucous membrane is examined for congestion, haemorrhage, ulcerations or any other abnormality.

➢ POSTMORTEM EXAMINATION OF SPINAL COLUMN AND SPINAL CORD

- The spinal cord should be examined routinely in every postmortem examination on a patient with a disorder of central nervous system or any other head injury.
- Removal of the spinal cord may disclose that there has been an unsuspected fracture/dislocation of the cervical spine.
- The basic principle in the anterior approach to the spinal cord is to cut through the pedicles of the vertebrae so that the cord can be exposed by removing the vertebral bodies.
- After opening the brain the dura is cut open and checked for haemorrhage, inflammation, tumours, pus etc.
- Nerves are cut from below as they pass though the spinal foramina and the cord is separated from the foramen magnum.
- Cord is then sectioned transversely and serially, lastly, the vertebral column is examined for fractures or dislocations.

POSTMORTEM APPEARANCE OF TESTIS AND FEMALE GENITLIA

TESTES: 8

- Testes are examined for enlargement and malignancies.
- Vertical cross-sections are made through the lateral and median lobes and the prostate is split open for examination.
- Inguinal canal is incised from the peritoneal aspect and the loop of the vas deference is pulled to free it from the internal inguinal ring.
- The testes is pushed with one hand and pulled out of the scrotum easily by the other.

- These are cut longitudinally and checked for any clotted blood inside the scrotum and in the testis.
- These should also be sectioned and examined wherever necessary.

Female genitlia-

- Vagina and the uterus are cut either anteriorly or posteriorly up to the fundus.
- Two short incisions are made at the fundus from the main incision towards each cornu so as to expose the endometrium.
- Ovaries are sectioned longitudinally and the fallopian tubes are cut longitudinally.
- If the uterus contains a fetus, its age should be determined.

PRESERVATION OF VISCERA AND OTHER TISSUES

Viscera should be preserved if death is suspected to be due to poisoning either by the police or the doctor, Deceased was intoxicated or used to drugs, Cause of death not found after autopsy, Death due to burns. Advanced decomposition and Accidental death involving driver of a vehicle or machine operator.

The following must be preserved in all fatal cases of suspected poisoning.

(1) Stomach and its contents. If the stomach is empty, the wall should be preserved.

(2) The upper part of small intestine (about 30 cm. length) and its contents.

(3) Liver 200 to 300 gm.

(4) Kidney half of each as one kidney may be dysfunctional.

(5) Blood 30 ml. Minimum 10 ml.

(6) Urine 30 ml.

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10 Shojania, K.G., Burton, E.C.: McDonald, K.M., Goldman, I.: Changes in rates of autopsy - detected diagnostic errors over time: a systematic review. In: JAMA 2003; 289:2849–56.

CIRCUMSTANCES OF PRESERVATION 3,2

These are preserved for chemical analysis under the following circumstances:

1. When the investigating officer so requests
2. When the medical officer suspects the presence of poison by its smell or some other evidence while conducting autopsy on injury cases.
3. To exclude poisoning in instances where the cause of death could not be arrived at after a full autopsy and there is no natural disease or injury
4. In decomposed bodies
5. In alcoholics

- Any tissue which is likely to provide evidence should be preserved in 10% formalin for histopathological examination .
- When blood or other fluid is found within a body cavity,the quantity should be measured and recorded.

ROUTINE VISERA PRESERVATION INCLUDES:

- Stomach with its contents and proximal 30 cms of intestine with its content.
- Half of each kidney and 500gm of liver
- 100ml of blood
- Only the preservatives, which act as control sample.

Special preservation includes i. e of liver, heart ,brain ,bile ,lungs , vitrous humor, bone and uterus .

PRESEVATIVES USED

POISONING	PRESERVATIVE
In all cases of poisioning but acid poisoning (except carbolic acid)	Saturated salt solution
For acid poisoning except carbolic acid poisoning.	Rectified spirit

carbon monoxide poisoning	A layer of paraffin
All cases of poisoning including alcohol poisoning for blood.	Potassium oxalate and sodium fluoride.

LIST OF EVIDENCE

A list should be made of all the articles removed from the body, e. g, clothes, jewellery, bullets etc. They should be labelled, sealed, mentioned in the report and handed over to the police officer in exchange for a signed and dated receipt.

CHAIN OF EVIDENCE

It is necessary to preserve the chain of evidence by identifying the body and maintaining control of specimens removed at autopsy.

The defence attorney has a right to ask how specimen was taken, identified, preserved, and dispatched to the appropriate laboratory to ensure that no mistake in reporting has occurred.

Precautions to take while conducting a medico legal autopsy: 2,3

The following precautions are necessary:-

1) <u>Authorisation:-</u> Authorisation for a medicolegal autopsy is given by the coroner, police, or magistrate. When a dead body is sent for autopsy, it is always accompanied by a *dead body challan.*

A dead body challan is a requisition submitted by the investigating police officer to a medical officer while handing over the body for postmortem examination.

2) <u>Identification:-</u> The body of the deceased should be identified by the police constable who brought it or if necessary by the relatives in presence of the medical officer who should make a note of the names and addresses of such persons.

Especially in the case of unknown bodies, it is necessary to note all particular such as race, sex, religion, age, social status, height, weight, dental formula e.t.c.

3) Visit to the crime scene:- A crime scene visit is worth undertaking , when the scene exists.

The medical officer should proceed with the examination only after the scene has been documented by photograph, diagram, or sketch, and the search for physical and trace evidence is concluded.

While removing the body from crime scene to mortuary, the head and each hand should be enclosed in a paper bag secured by a tape.

4) History of the case:- The medical officer should obtain all available details of the case so that:-

a) He can take special care to examine a particular body part, example neck in a case of asphyxia death

b) He may use special equipment, example sexual assault kit

c) He can preserve finger nail scraping and clipping for trace evidence (hair, blood, or skin of the assailant)

5) Examination:- The examination should be done in day light. if the body is brought by the police at any time of night, an external examination should be carried out immediately with special reference to body temperature, postmortem lividity, rigor mortis, external injuies e.t.c.

The examination should be as thorough and complete as circumstances permit because:-

a) The obvious cause of death may not be the real cause of death.

b) Coincident diseases contributory to the cause of death may be found in more than one organ.

6) Verification of injuries:- The injuries recorded in the inquest report should be verified. Postmortem changes/injuries may have been misinterpreted as antemortem injuries. Misinterpreted should be carefully clarified. It is not commonly realized that skin and most body soft tissues tend to darken as then dry.

7) Preservation of viscera and tissues:- These are preserved for chemical analysis under the following circumstances:-

a) When the investigating officer so requests.

b) When the medical officer suspects the presence the poison.

c) To exclude poisoning

d) In decomposed bodies

e) In alcoholics

Any tissue which is likely to provide evidence should be preserved in 10% formalin for histopathological examination.

8) <u>List of articles:-</u> A list should be made of all the articles removed from the body, example clothes, jewellery, bullets e.t.c. they should be labeled, sealed, mentioned in the report, and handed over to the police officer in exchange for a signed and dated receipt.

9) <u>Chain of evidence:-</u> It is absolutely essential to preserve the chain of evidence by identifying the body and maintaining absolute control of the specimens removed at autopsy.

AUTOPSY ON DECOMPOSED, MUTILATED, FRAGMENTARY REMAINS AND BONES: 11,2,8,3

DECOMPOSED BODIES : - For the purpose of identification , remnants of genitalia, bones, hair, teeth are examined to determine the sex and age of the deceased since they resist putrefaction.

- Fingerprints can be extracted from the peeled off skin of the fingers.
- Examination of teeth and hair's peculiar characteristics can be useful in identity.
- Personal properties like clothing ,rings, tattoo ,watch, belt ,etc provide valuable data.

CAUSE OF DEATH :

- Nature of fractured bone give a lot of data .e .g-fracture of hyoid indicates case of hanging.
- Bullets or parts of weapon found in the body serves the same function.
- Uterus examination may reveal attempts of criminal abortion.
- Viscera must be preserved for subsequent examination.

MUTILATED BODIES AND FRAGMENTARY REMAINS:3

- A mutilated body is one which is disfigured, deprived of any part of the body.
- AGE: can be determined from state of epiphyses (end part of long bone); state of teeth, lower jaw; calcification of laryngeal and sterna cartilages and hyoid bone; changes in joints, etc.
- SEX: By gross and microscopic examination of internal genitals.
- RACE: from hair, skin, nasal aperture, incisors, skull, pelvis, etc.
- IDENTITY: from fingerprints, dental status, tattoo marks, scars, blood grouping. Evidence of any disease e. g, gall stones, uterine fibroids is corroborative.
- BONES: The source can be determined from gross anatomical characteristics of the bone, microscopic characteristics and by chemical analysis of bone ash.
- Age can be determined by state of epiphyses, state of teeth, calcification of laryngeal and sterna cartilage, cross section of mid shaft area of femur, tibia, fibula.
- Malunited fractures, healing fractures or bone

  Deformities if present are helpful in identity. Blood grouping and DNA profiling are also useful.
- It is difficult to establish the cause of death unless there are some clues for e. g, fractures of hyoid, skull, ribs, etc.

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Production of Courseware

e- Content for Post Graduate Courses

Paper : Forensic Science and Forensic Medicine

Module : Time since death: rigor mortis, liver mortis, algor mortis, decomposition

Role	Name	Affiliation
Principal Investigator	Prof. (Dr.) Ranbir Singh	Vice Chancellor, National Law University, Delhi
Co-Principal Investigator		
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Content Reviewer		

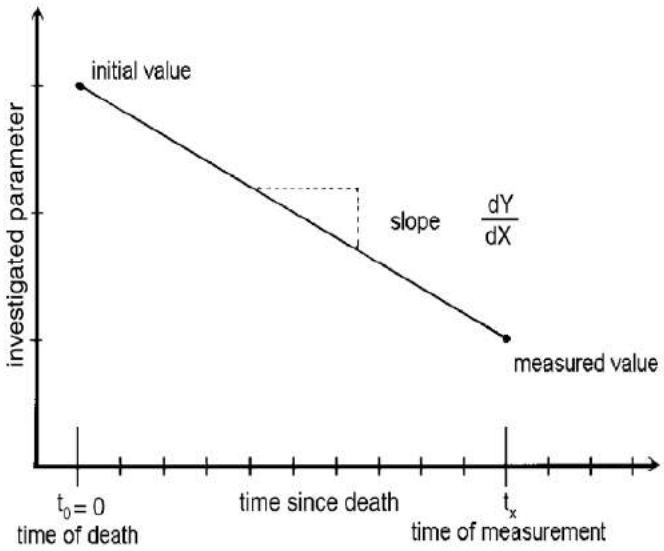
DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Time since death: rigor mortis, liver mortis, algor mortis, decomposition
Module Id	LAW/CJA/VIII/35
Objectives	Learning Outcome: • To make the learners understand about an estimation of the time elapsed since death which is a request almost invariably aimed at forensic specialists summoned to the scene of a death. • To provide an estimation of the changes occurring at different stages of time. • To make the learners understand the changes occurring in the central temperature of the body as well as the environmental.
Prerequisites	General understanding of the changes or combination/integration of different estimators like temperatue, enviornment occuring in body at early and late stages.
Key words	Rigor mortis, lividity, algor morts, Cadaveric spasm, putrefaction.

Time since death

The time passed since death which is also known as post mortem clocking is of great medico-legal importance to correlate the crime with the criminal. The estimation of time since death is one among the necessary information to be addressed after an autopsy examination. Time of death can exonerate or focus the suspect; it can also substantiate or refute suspect/witness statements hence it is one of the most important functions of the medical examiner. Usually estimation of time since death is done during the autopsy of the deceased or the pathologist/expert may also be called upon at the scene of crime to find out the actual time of death through external examinations. 1,2,3

The main principle of the determination of the time since death is the calculation of a measurable date along a time-dependent curve back to the start point. Characteristics of the curve (e.g. the slope) and the start point are influenced by internal and external, antemortem and postmortem conditions.



4 (Source: C. Henssge, B. Madea / Forensic Science International 165 (2007) 182–184)

1 Claus Henssge, Burkhard Madea, Estimation of the time since death, January 17,2007 volume 165, isues 2-3, pages 182-184.
2 Parikh
3 DiMaio VJM, DiMaio D, eds. *Forensic Pathology (Practical Aspects of Criminal and Forensic Investigations)*. 2nd ed. Boca Raton, La: CRC Press, LLC; 2001.

Obviously, exact time cannot be calculated from a single parameter therefore, these influencing factors have to be taken into consideration quantitatively in order to improve the precision of death time estimation. However, a number of cadaveric or environmental factors are there which can influence the normal rate of post mortem changes. Longer the time since death, more difficult it is to estimate the time since death with precision. Hence, apart from post mortem changes, histological, biochemical and circumstantial evidences are also considered.5 Best estimate of time since death can be offered with reasonable degree of medical and scientific knowledge and experience. Although the estimation of time since death is impossible to be 100% accurate except in case where a witness gives testimony of exact time and events happened.

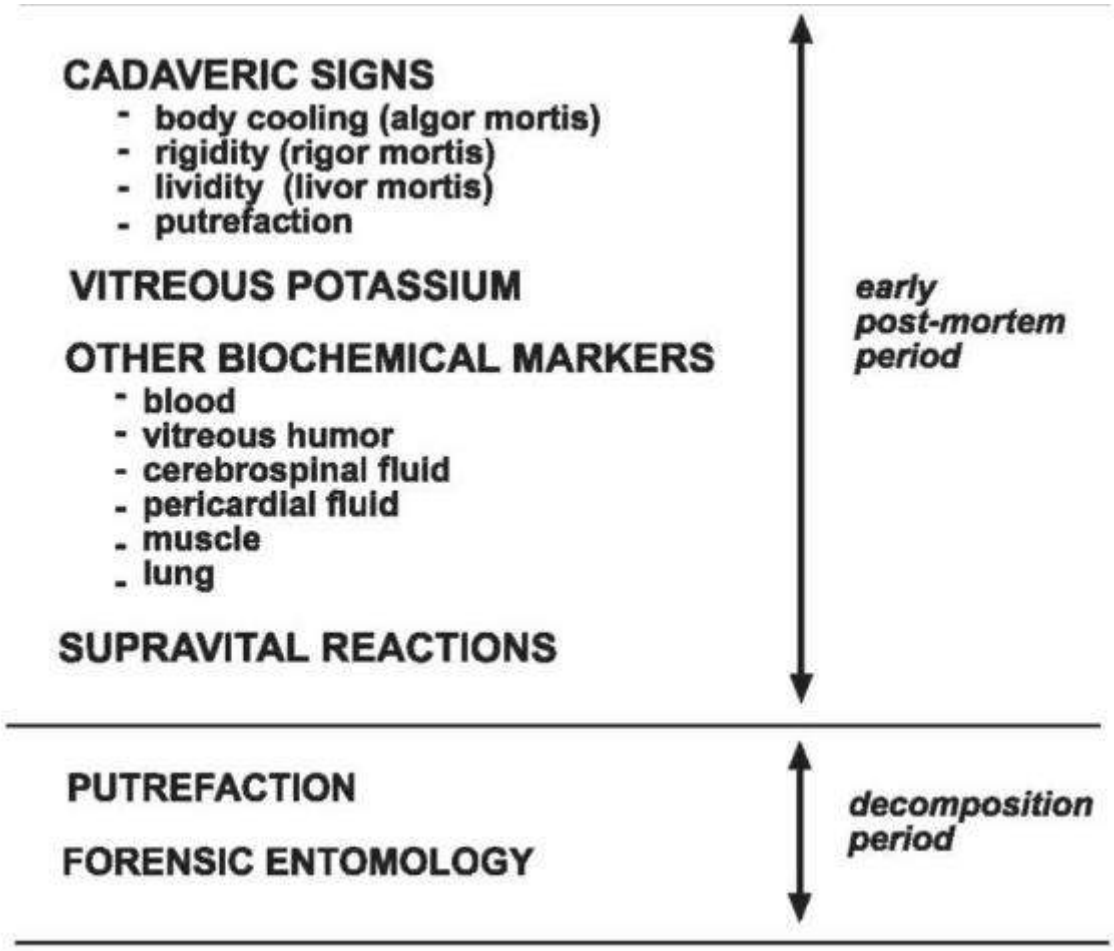
Categorising Time of Death 5

Time of death is broadly categorized in three ways:

- Physiological: when the victim's vital organs actually ceased to function.
- Estimated: A guess based on available information by the medical examiner.
- Legal: time that is shown - by law – time recorded on a death certificate.

4 (C. Henssge, B. Madea / Forensic Science International 165 (2007) 182–184).
5 (http://www.exploreforensics.co.uk/estimating-the-time-of-death.html)

Common estimator of time since death:



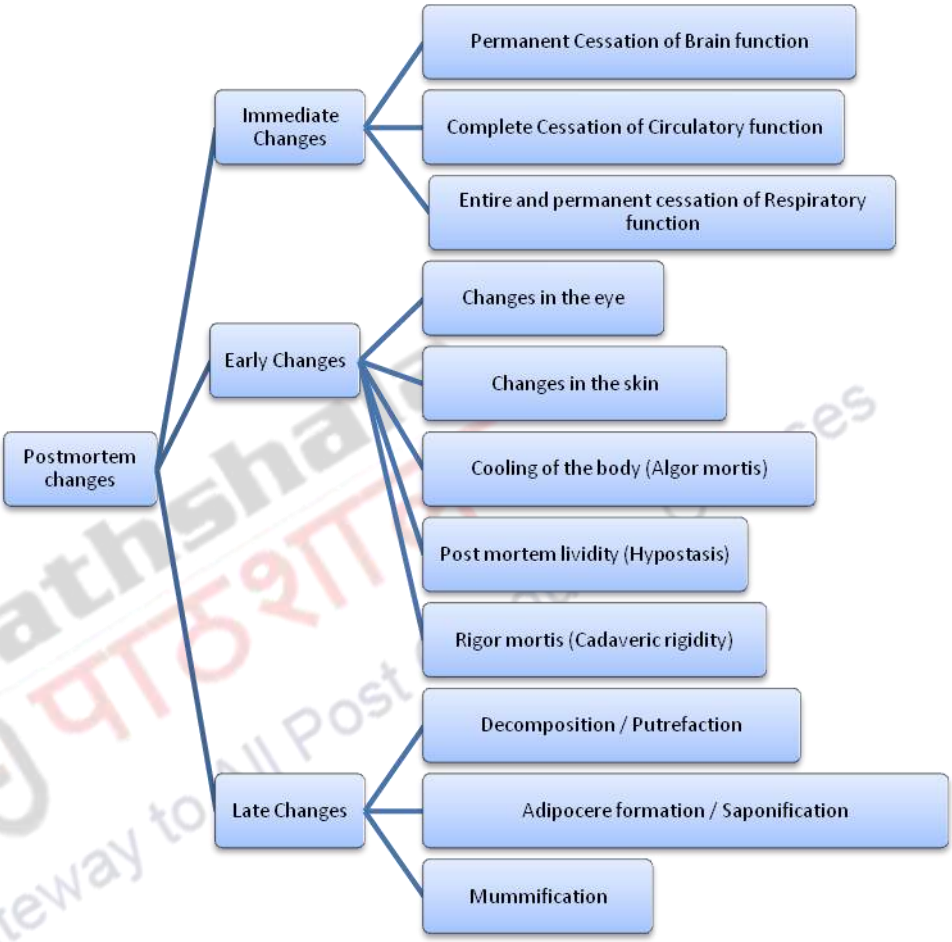
(Available at : http://what-when-how.com/forensic-sciences/time-since-death/)

Medico legal importance of determining time since death:

The fact, that most of the deaths are not witnessed. In case of natural death, it might come when person is sleeping, in accidental/suicidal cases usually the victim is alone and in cases like homicides, and the only witness is the culprit who is not likely to talk about it. That is why it becomes important for medical examiner to determine the time of death to exonerate the innocent or to apprehend the culprit. In criminal cases where it can eliminate some suspect can also focus attention on someone. But only an approximate estimate of time since

death can be made depending upon the environment surrounding the body, size of the corpse, clothing and other factors.

Postmortem changes can be broadly divided in three groups: (parikh)



5 Parikh's Text book of medical jurisprudence Forensic Medicine and Toxicology CBS publisher and distributors PVT.LTD.

6 Dikshit P C, Text book of Forensic Medicine and Toxicology, PEEPEE publisher and distributors (P) LTD.

7 Simpson's Forensic Medicine, 13th Edition, Jason Payne-James, Richard Jones, Steven B Karch, John Manlove, August 26, 2011 by CRC Press.

1- Immediate Changes; includes

- <u>Permanent Cessation of Brain function:</u>

✓ Loss of sensation (touch, pain & temperature)

✓ Absence of motor and sensory functions

✓ Loss of voluntary power to move

✓ Reflexes lost

- <u>Complete Cessation of Circulatory function (2,5,9)</u>

✓ Heart sounds are not found for continous five minutes

✓ ECG can be taken in doubtful cases

✓ Following are the tests that can be performed for stoppage of circulation/heart

➢ Icard's test

➢ Ligature test

➢ Magnus test

➢ Fingernail test

➢ Heat test

➢ Arterial spurting test

- <u>Entire and permanent cessation of Respiratory function (5)</u>

✓ Stoppage of respiration for more than 3-5 minutes (exception: yogic exercises, cheyne's stokes breathing, new born infants)

✓ Following are the tests that can be performed for stoppage of respiration

➢ Feather test

➢ Mirror test

➢ Winslow's test

2- Early Change (5, 7)

- Changes in the eye:

✓ Dilated or fixed pupils

✓ Absence of corneal and light reflex

✓ Marked decrease in intra-ocular pressure

✓ Cloudiness of cornea

✓ Increase in potassium levels

✓ Thin film observed over cornea within minutes

✓ Taché noire

✓ Absence of intraocular fluid suggests more than 4 days.

- Changes in the skin

✓ Pale/white appearance

✓ Loses elasticity

✓ Lips darken

Cooling of the body (Algor mortis)

1. Temperature fall after death is considered one of the prominent early sign of death. Extent of cooling can be used to determine the time since death given the fact that ambient temperature should be lower than the body temperature. As the time passes temperature of the body progressively decreases until it achieve the temperature of its surroundings. A body after death looses heat passively by three different mechanism namely, conduction (heat passes to any other object which comes in contact), convection (heat lost in air) and radiation (heat lost as infrared heat rays)(parikh). As far as temperate climate is concerned, the process of body cooling at the skin surface takes usually 8-10 h but the core of the body takes three times as long to cool down. Liver and brain are the organs taken for measuring core temperature. Such temperature estimates of time since death can be taken into consideration either for cold or for temperate climates. To measure the body temperature, there is a special type of chemical thermometer known as thanatometer. Temperature is measured inserting the thanotometer in the rectum ensuring there is no homosexual activity. In such cases, temperature is taken inserting the thermometer in auditory meatus or notril. Rate by which temperature falls after death is dependent on the temperature difference between the body and its surroundings. In a tropical country like India, fall in temperature is nearly 0.5-0.7 ˚C after death and body takes nearly 16-20 h to attain the ambient temperature. 8.9.10

A rough estimate of time since death can be drawn using a formula

$$\frac{\text{Normal body temperature (37.2C) - rectal temperature}}{\text{Average rate of fall of temperature per hour (0.6 C)}}$$

Or

$$\text{Time since death} = \frac{98.6°F - \text{Rectal Temp (°F)}}{1.5}$$

Factors affecting the rate of cooling: (2,6,7)

Body weight: larger the body weight, slower will be the cooling while less body weight indicates faster cooling.

Age and condition of the body: cooling of body directly depends on stature of the body. Small stature like of children and adults of small stature cools rapidly because of having large body surface as compared to their body weight. Lean or weak bodies looses haet rapidly in comparison to fat bodies as fat is bad conductor of heat.

Mode of death: heat loss from a body may start before sometime of death if the person was suffering from prolonged illness. If a healthy person dies suddenly, process of cooling will be quite low.

Surface area of the body: Larger surface area of body speeds up cooling rate.

Emaciation and clothing: also affects the rate of cooling of body.

Environmental temperature: high humidity enhances cooling rate, similarly, high air velocity also enhances cooling rate. Body looses heat rapidly if the difference in temperature between environment and body is great.

Surroundings: convection accelerates the heat loss because of air movement. Therefore, a body lying in an open area will lose heat more faster than one lying in a closed area. Naked body colls rapidlt than the body well covered with a clothes. Likewise, body found in water will lose heat rapidly than the body found on land because of convection.

8- Suzutani T, Ishibashi H, Takatori T. Studies on the estimation of the postmortem interval. 2. The postmortem lividity (author's translation). Hokkaido Igaku Zasshi 1978; 52:259-267

9- Henssge C, Knight B, Drompecher T, Madea B, Nokes L. The estimation of the time since death in the early postmortem period. London: Edward Arnold; 1995.

10 Sund-Levander M, Forsberg C, Wahren LK. Normal oral, rectal, tympanic and axillary body temperature in adult men and women: a systematic literature review. *Scand J Caring Sci*. 2002 Jun. 16(2):122-8.[Medline].

Post mortem lividity (Hypostasis)

Lividity is one of the reasonable post mortem change. It is also known as post mortem staining, livor mortis, suggilations, hypostasis or vibices. Postmortem hypostasis is defined as the intravascular pooling of blood in gravitationally dependent parts of the body after death (9). Basically lividity is the accumulation of blood in the capillaries and small veins in the dependent parts of the body due to gravitational forces and show up through the skin as livid red area of discolouration. The cessation of blood circulation at the time of death, the blood gravitates in the capillaries and venules and settles in the lowest part of the body available. Staining is same as that of colour of blood i.e. reddish-purple. (2) The lividity doesn't show where the body is in contact with something. Thus a body lying on its back will show lividity in the small of its back, its neck etc., but not parts of the body directly touching the ground. However, intense lividity can be associated with small hemorrhages in the skin, so-called postmortem hypostatic hemorrhages which is also known as Tardieu spots. 2, 9

9- Pollanen MS[1], Perera SD, Clutterbuck DJ, Hemorrhagic lividity of the neck: controlled induction of postmortem hypostatic hemorrhages. Am J Forensic Med Pathol. 2009 Dec;30(4):322-6. doi: 10.1097/PAF.0b013e3181c17ec2)

Medico-legal Importance of studying lividity:

Helps in determining-

- ✓ It is a sign of death
- ✓ Estimating the time of death
- ✓ In determining position of the body after death

- ✓ Determining Cause of death from color; generally post mortem staining colour is livid but in some cases of poisoning colour of post mortem staining will differ (in CO poisoning- cherry red colour, in HCN poisoning- bright red, in aniline dye poisoning- blue)

Appearance of lividity:

Lividity usually starts appearing within half an hour – one hour in case of a healthy individual in form of patchy area of discoloration. These blotches within 6-12 hour period gradually coalesce and manifests itself as reddish-purple discolouration. In northern India, lividity appearance starts within an hour after death and takes nearly 6-10 h to be well marked. In cases, where person is dying of narcotic poisoning, or agonal period is prolonged, before death circulation became stagnant, in a slowly dying person lividity starts appearing before death. Contrary to this, cases like death due to anaemia, acute lobar neumonia and haemorrhage its appearance is late due to intravascular clotting. 10 (basu and Krishan Vij)

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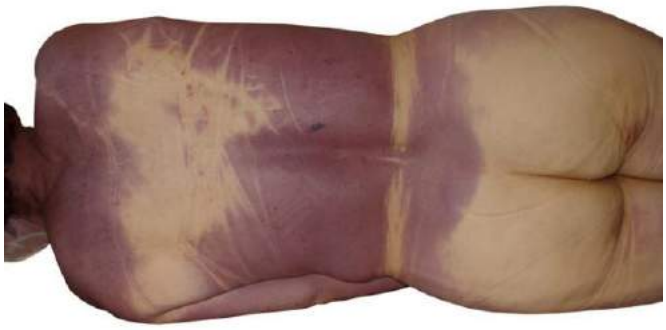
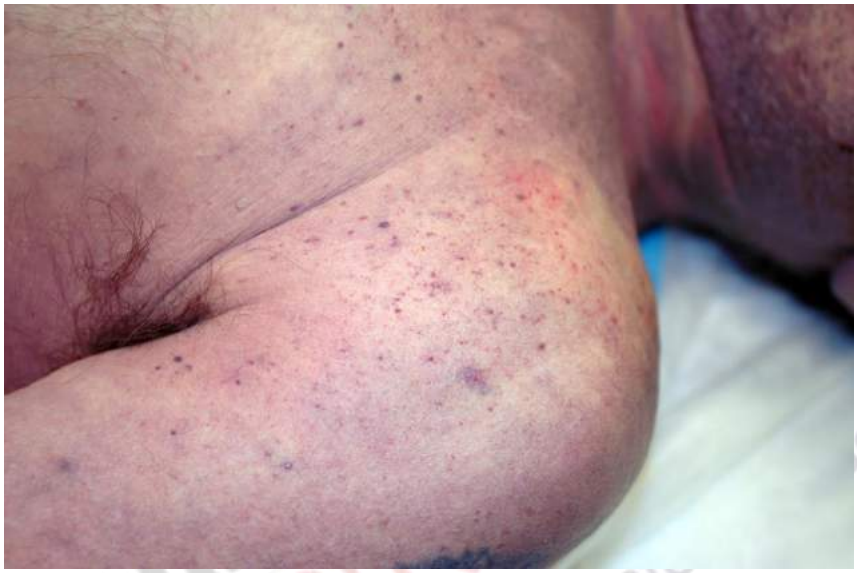
10 Vij K, Text book of Forensic Medicine and Toxicology, principle and practice, Reed Elsevier India Private Limited.



D.P.Lyle, carbon monoxide A Deadly Gas, april 4, 2013.

Livor mortis: Contact Flattening' where the pressure exerted by these areas prevents the pooling of blood in the vessels.



Tardieu spots are petechiae and purpuric hemorrhages that develop in areas of dependency secondary to the rupture of degenerating vessels under the influence of increased pressure from gravity (12)

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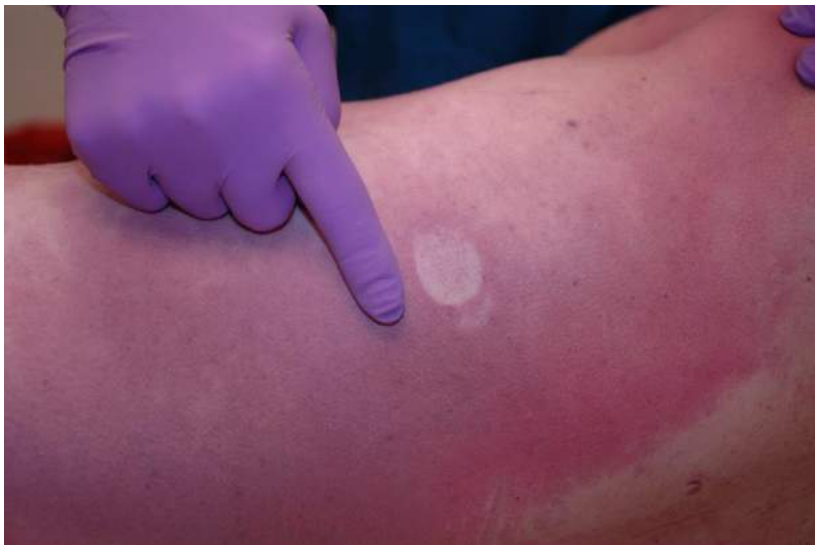
11 D.P.Lyle, carbon monoxide A Deadly Gas, april 4, 2013
12 (http://www.thepostmortempost.com/2015/10/01/stage-4-livor-mortis-2/)



Blanching: Thumb pressure indicates that the lividity is not fullyfixed.

Extent and distribution: 13

- ✓ It depends upon amount of fibrin or fibrino-lysin in the blood.
- ✓ Amount of still fluid blood in the circulation.
- ✓ The distribution of lividity depends upon the posture of the body after death.
- ✓ Where the body is lying on the back, lividity will be found on the posterior and dependent parts like back of neck, against the lumbar region, extensor surface of the upper limbs, sparing areas that prevent pooling of blood as these areas are pressed against the ground. These areas include back of head, back of thighs and calves, back of shoulders and are known as ‘areas of contact flattening’. These areas will remain pale and blenched between the areas of lividity. The areas which are covered with tight clothing like belt, constricting terminal parts of socks will also not be having lividity, it may occur ad strips or bands.
- ✓ In case of hanging, livor mortis can be seen on dependent areas like lower limbs, genitalia and hans.

- ✓ In case of drowning, livor mortis can be seen on face, upper part of chest, hands , feets and lower legs. If the body is constantly moving with water current, hypostasis may not develop.
- ✓ In face down death, in case of epilepsy or drunken victims, whitening can be seen around nose and lips.
- ✓ On the back if the body was in a supine position or on the face and front if the body remained prone.
- ✓ Hypostasis can also be seen in viscera (in heart, lungs and intestine)

Colour of hypostasis: 13

The colour appearing in hypostasis depends on oxygenation. The Usual colour is red to purple but when the person is dying of hypoxic state due to reduced haemoglobin, color apper is of little darker while those dying of hypothermia (cold or drowning), colour is comparatively light (may be of pink color) due to presence of much oxyhaemoglobin (cherry pink – in carbon monon oxide poisoning, coffee brown by potassium chlorate, potassium bihromate, nitrobenzene and aniline, dark brown by phosphorus and bright red in case of refrigerated dead body.

13 MEDICOLEGAL SIGNIFICANCE OF POSTMORTEM LIVIDITY IN DETERMINATION OF TIME SINCE DEATH, Anand P Rayamane , M P Kumar , S D Nanandkar , G S Chavan, S S Bhise, Dayananda R, Journal of Forensic Medicine & Toxicology Vol. 31 No. 1 & 2, January - June 2014.

Disappearance of post mortem staining:

Colour appeared in hypostasis tends to disappear with the onset of decomposition as the gases produced during decomposition like H2S by the decomposed tissues acts with the haemoglobin of blood anf convert it to sulphmethhaemoglobin and takes up the usual colour of decomposition.

Hypostasis is affected by: 14, 2

Victim's age

- ✓ Deceased pre-morbid health
- ✓ Type of drug taken/administered prior to death
- ✓ Level of activity at time of death
- ✓ Environmental conditions
- ✓ In dark complexioned people: although it develops but difficult to see
- ✓ In anaemics or person dyin of severe haemorrhage
- ✓ In bodies which keep changing their position

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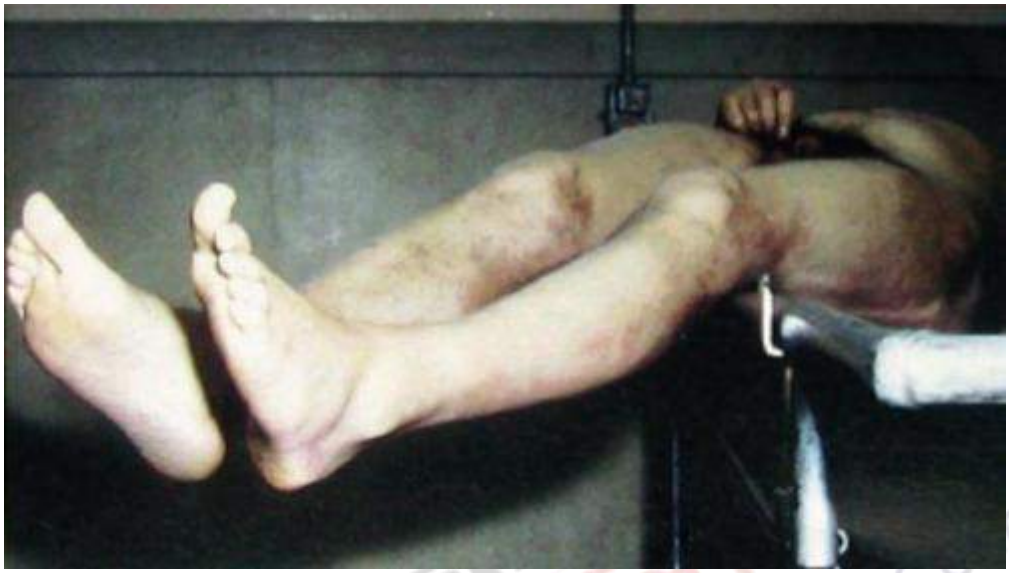
14 I Gordon and H A Shapiro, Forensic Medicine. A Guide To Principles. The Diagnosis and the Early Sign Death: the phenomena that Occur After Death, 1st ed. Churchill Livingstone, 1975. p.18 – 25. 5. 2 Dixit. P. C. Changes after Death, A Text Book of Forensic Medicine and Toxicology, 1st ed. New Delhi: Peepee Publishers; 2007. p. 91-95.

Rigor mortis (Cadaveric rigidity)

Rigor mortis (rigor = rigid, mortis = death) which is also known as cadaveric rigidity, is basically the stiffness caused in body after death. chemical changes in the body makes muscle mass to become rigid. After death muscles are initially flaccid which can be moved easily which is followed by stiffness of muscles that subcides graduall and body becomes flaccid again. This can be broadly divided in three phases of change in state of muscles where muscles pass through three different phases, i.e. primary flaccidity, rigor mortis and secondary flaccidity. 15,16,17

Primary flaccidity: where muscles are comes just able to respond to electrical or chemical stimuli. This phase comes just after somatic death. Rigor mortis: body muscles start developing rigidity and no response towards electrical or chemical stimuli.

Secondary flaccidity: rigor passes away and that is the onset of putrefaction.



18 http://www.documentingreality.com/forum/f10/rigor-mortis-lower-limbs-101806/

15 I Gordon and H A Shapiro, Forensic Medicine. A Guide To Principles. The Diagnosis and the Early Sign Death: the phenomena that Occur After Death, 1st ed. Churchill Livingstone, 1975. p.18 – 25.
16 Parikh C.K. 6 th ed. New Delhi: C B S Publishers and distributors; 1999. p. 3.10-3.13.
17 Gradwohl's Legal Medicine. Changes after death. Francis E. Camps. 3rd ed. Year Book Medical Publishers INC; 17 1976. p. 81- 88 8. Modi's Medical Jurisprudence and Toxicology. Postmortem Change and Time since Death.
18 http://www.documentingreality.com/forum/f10/rigor-mortis-lower-limbs-101806/

Medico legal importance of rigor mortis:

- ✓ Can tell Time of Death
- ✓ Can tell whether the body has been moved
- ✓ May be able to tell cause of death

Pathophysiology of rigor mortis: 19,20

The proteins, actin and myosin built sarcomere (contractile unit of muscle). Contraction in the muscle is achieved by these two filaments. Myosin heads bind the ATP and form myosin-ATP complex which has high affinity for actin, thus results in

actin-myosin complex. When the actin- myoin complex is formed, the low ATPase activity exhibited by free myosin heads is enhanced and ATP is hydrolysed and energy released is used for dissociation of the actin-myosin complex. In daily life, there is a balance between utilization and resynthesis of ATP in the muscular tissues. ATP utilized in contraction is immediately synthesized. After death, ATP is not generated and after the consumption of stored ATP, actin-myosin complex is not split, and the muscles remain inextensible giving rise to rigor mortis.

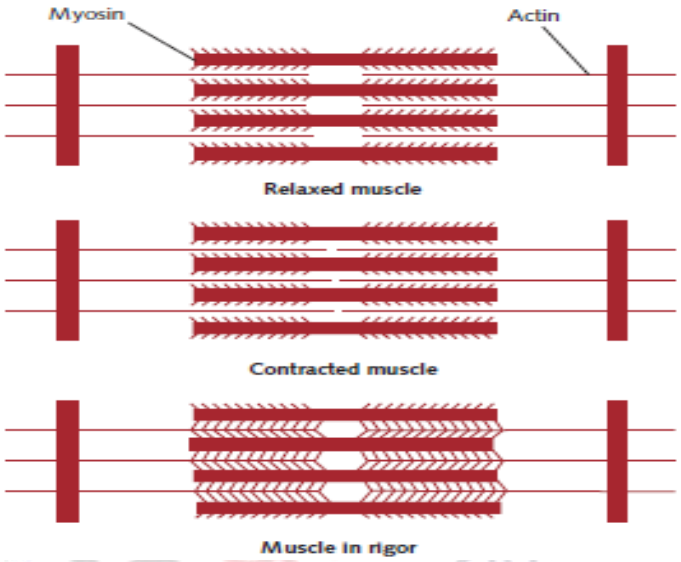


Figure: diagrammatic arrangements of actin and myosin filaments in muscle fibre

Process of development of rigor mortis:

After death, ATP is not generated hence the actin-myosin complex is not split and muscles become inextensible. This actin-myosin complex is the reason for development of rigor mortis. The process of development of rigor mortis can be studied under the following phases -

First phase: this is the phase where cellular death has not occurred and body is still able to utilizt the stored ATP(ATP already present and resynthesis from available glycogen stores).This represents onset of rigot mortis in circumstances like where depletion of glycogen due to vigorous exercise prior to death.

Second phase: this is the onset of rigor mortis when content of ATP is critically low and the muscles tend to turn into viscous, inextensible, dehydrated stiff gel.

Third phase: rigidity fully developed and is irreversible.

Fourth phase: in this phase muscles looses and rigidity disappears. This is also known as phase of resolution.

Time of onset and its duration:

- ✓ Rigor mortis can be seen within 30min- 1 hour following death.
- ✓ Gets well established in 8-12 hours
- ✓ complete rigor will Maintains for 8- 12 hours
- ✓ rigor begins to dissipate over next 12 hours.(depends on environmental temperature)
- ✓ fully flaccid by 36 hours
- ✓ in northern india, usual duration for rigor mortis during summer is 18-36 hour in summer and 24-48 hours in winter.

Order of appearance and disappearance:

It is considered to appear first in eyelids by 1-2 hour followed by muscles of face, neck , lower jaw, muscles of the chest, upper limb, abdomen and lower limbs. Since rigor mortis as a physicochemical process, it affects all the body muscles simultaneously.

Depending upon the progression of rigor mortis, corpses may be divided in three categories:

- ✓ Where the corpse is still warm, without showing any rigor indicates death within 1-2 hours previously.
- ✓ Body where the rigor is progressing but not established in full body, indicates death within 4-12 hour previously.
- ✓ Those corpses where the rigor is well developed in entire body, indicates death beyond 9-12 hours.
- ✓ The disappearance of rigor follows the same fashion as its appearance.

Factors influencing Rigor Mortis: 21

Environmental temperature: 'rigidity persists longer in cold'

- ✓ Cold and wet weather: onset will be slow, and duration will be longer
- ✓ Hot and dry weather: onset will be fast while duration is shorter

Muscular activity:

- ✓ If musles are healthy, robust and at rest before death: onset will be slow, and duration will be longer
- ✓ If muscles exhausted /fatigued: onset rapid

Nature of death:

- ✓ bodies of those who are emaciated or die of wasting diseases pass rapidly into state of rigidity which is of shorter duration.

Central nervous system:

- ✓ nerve supply or even removal of brain does not affect the rigor. Rigor mortis occur in amputated body parts too.

Age:

- ✓ Not occur in foetus less than 7 months
- ✓ May be found in stillborn infants
- ✓ In healthy adults-well marked
- ✓ Children and old people: weak and early

Cause of death:

- ✓ Asphyxia, pneumonia, muscle paralysis & dehydration: slow onset
- ✓ Septicemia & poisoning: rapid onset, may even be absent, especially in limbs affected by septicemia
- ✓ Emaciated or died of wasting disease: rapid onset, short duration

19 Perper J.A., Time of death and changes after death. Pt 1. Anatomical considerations, in Spitz W.U. (ed): Spitz and Fisher's Medicolegal Investigation of Death: Guidelines for the Application of Pathology to Crime Investigation, 3rd ed. Springfield: Charles C. Thomas, 1993, pp 26-27.
20DiMaio D.J. and DiMaio V.J.M.: Forensic Pathology. New York: Elsevier, 1989.). (Graham M.A. and Hanzlick R.: Forensic Pathology in Criminal Cases. Carlsbad: Lexis Law Publishing, 1997.
21Subrahmanayam BV. Death in its medicolegal aspects. Medical Jurisprudence and Toxicology, 22nd Ed, Butterworth's India 1999; 140-43. 2. Parikh CK. Medicolegal aspects of Death.) (Parikh's Text Book of Medical Jurisprudence and Toxicology 6th Ed; CBS Publication, Bombay 1999; 148-54.
22 Vij K. Death and its medico-legal aspects. Text book of Forensic Medicine and Toxicology, 2nd Ed.; BI Churchill Livingstone, New Delhi 2002; 159-69.) Mant AK. Postmortem changes. Taylor's Principles and Practice of Medical Jusiprudence 13th Ed.; Sydney Smith, Chicago 1965; 140-43.

Cadaveric spasm (instant rigor/ cataleptic rigidity)

Cadaveric spasm is the stiffness of the muscles that has its onset immediately after death and basis of such investigation is to find out items gripped in hand of victim before the onset of rigor state.it is quite common but rare phenomenon. Usually after death muscles become flaccid which is followed by rigor mortis but in case of cadaveric spasm, the state of primary flaccidity does not come and muscles acquire stiffness at the time of death. It is usually associated with the violent deaths. Its mechanism or nature is still obscure but the reason can be attributed to the ATP stores in the affected muscles. Most of the times cadaveric spasm is associated with the emotional or physical stress. Cases are found where bodies are recovered from rivers with weeds or twigs grasped in their hands or fingers of person committing suicide found bend tightly.23,24,25,26,27,28

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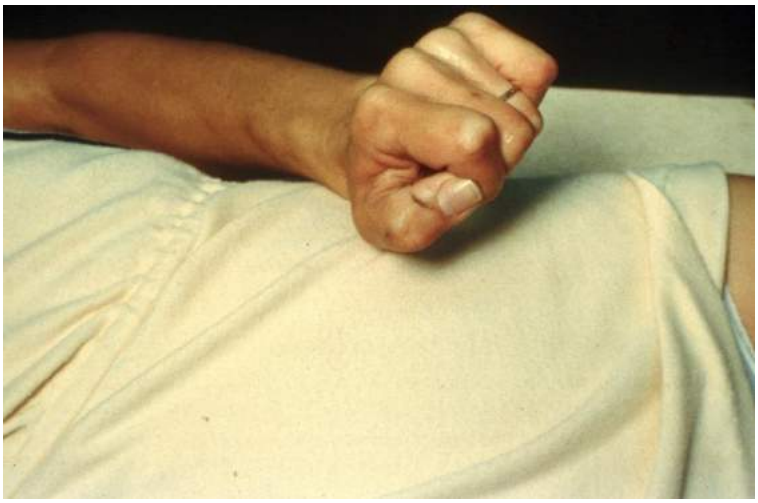
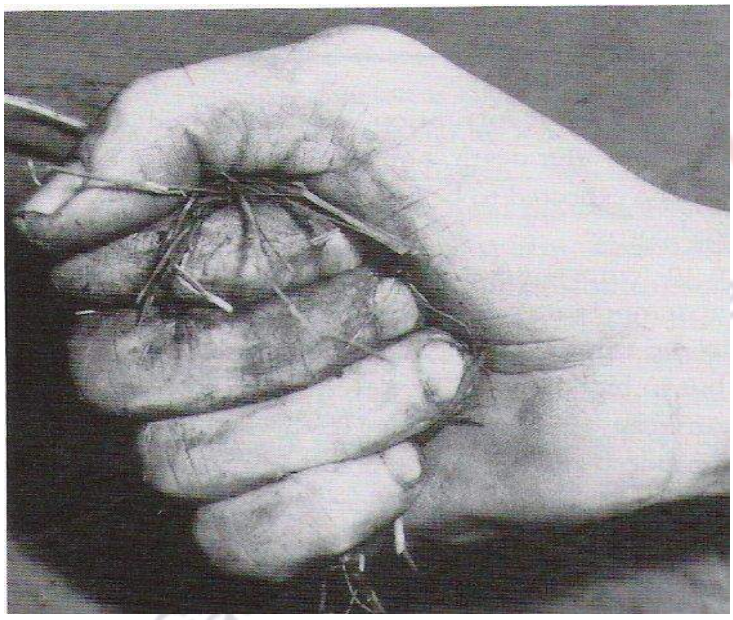
(23) Serafettin Demirci, Kamil Hakan Dogan, Zerrin Erkol, Idris Deniz Precautions Taken to Avoid Abandoning the Act of Hanging and Reducing Pain in Suicidal Hanging Cases. Am. J. Forensic Med. Pathol.2009; 30: 32–35. 2.
24 F.A. Benomran, S.E. Masood, A.I. Hassan. Masking and bondage in suicidal hanging: a case report. Med. Sci. Law.2007; 47(2): 177- 80. 3. Krill A, Griller W, Wilske J. Modern variant of hanging: use of timeprogrammed winch. Arch. Krminol.2002; 209(3-4): 110-5.
25 Kumar V. Hanging without knot in the noose. Journal of Forensic and legal medicine.2007; 14(1): 35-8.
26 Pollak S, Stellwag carion C. Deviations in findings in hanging by interposition of fingers between noose and neck. Arch. Kriminol.1986; 177(3-4); 76-84.
27 Kanchan T, Menezes RJ, Manipady S. Haemorrhoids leading to postmortem bleeding artifact. J. Clin. Forensic Med.2006; 13 (5):277-9.
28 Bharadwaj D N, Sharma SK, Gupta S. Haemorrhoids leading to postmortem artifact: a case report. Med. Sci. Law.2005; 45(3): 265- 6.





Cadaveric spasm in case of drowning: victim had grass from the river bank firmly grasped in the hand

Medico legal importance of cadaveric spasm:

- ✓ Diagnosis of cause of death as in case of weapon found in hand
- ✓ In cases like Drowning
- ✓ ID of assailant may be found in hand
- ✓ May allow one to know state of person prior to death

Difference between Rigor mortis and cadaveric spasm:

	Rigor mortis	cadaveric spasm
Onset	Onset delayed after death (1-2 hours)	Onset is immediate
Duration	Duration is approximately 12-24 hrs	Duration is a few hours, until and unless it is replaced by rigor mortis
Intensity	Intensity comparatively moderate	Intensity comparatively very strong
Mechanism	When breakdown of ATP is below critical level (less than 15%)	Mechanism of formation unknown but factors like Excitement, fear, fatigue, exhaustion, nervous tension, contraction of muscles at time of death might be the reasons.
Muscles involved	All muscles of the body are affected gradually	Selected muscles, which were in a state of contraction at the time of death, are affected.
Medico legal bearing	Mostly helps to know the time since death	It helps to suggest the manner of death, i.e. whether suicide, accident or homicide

3- Late Changes; includes

- Decomposition / Putrefaction.

There are changes in the body which takes place after 24 hour of death and is sure and certain sign of death. It basically represents the decay or decomposition of body. The process of decomposition include 29,30

1- Putrefaction
2- Adipocere formation
3- Mummification

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29 Davis JB, Goff ML (2000) Decomposition patterns in terrestrial and intertidal habitats on O'ahu Island and Coconut Island Hawai'i. J Forensic Sci 45:824–830

30 Early M, Goff ML (1986) Arthropod succession patterns in exposed carrion on the island of O"ahu, Hawaiian Islands, USA. J Med Entomol 23:520–531

Putrefaction

It is Last stage in the resolution of the body where complex organic body constituents get converted to the simple inorganic state. Putrefaction is mainly brought about by two processes: Autolysis and bacterial action. 30

- **Autolysis:**

✓ This is rise in level of enzyme in tissues after death.
✓ They soften and liquefy the dead tissues as the part of digestive action of the enzyme.
✓ The earliest autolytic changes can be seen in parenchymatous tissues or soft tissues.
✓ Autolysis Starts 3-4 hours after death and continues for 2-3 days, sometimes even longer.
✓ The process can be stopped by freezing.

- **Bacterial action:**

- ✓ Action of bacterial enzymes (aerobic and anaerobic) on tissue components like carbohydrates/fat/proteins.
- ✓ For bacterial growth – warmth, moisture are conditions favorable conditions.
- ✓ Clostridium, streptococci, E coli, Bacillus proteus are the bacteria known to decompose body tissue components.
- ✓ Clostridium welchii is the bacteria which initiates haemolysis of blood and starts the process of putrefaction.
- ✓ In warm climate putrefaction starts comparatively faster while in cold climate the process is retarded.
- ✓ Development of gases under the skin and hollow viscera takes 18-36 hrs. 24-48 hrs in case of solid viscera.
- ✓ Purefaction changes include:

Change in colour:

discolouration varies fron green to black due to formation of sulphmethaemoglobin.

Foul smelling gases:

Hydrogen sulphide ammonia phosphorated hydrogen and methane are the gases which formation creates foul smell.

Sufficient accumulation of these gases is the reason why body floats in case of drowning.

Pressure effect of putrefactive gases:

Pressure created displaces the diaphragm upwards.

Discolored fluid and liquefied tissue mixes with gases producing froth.

Shifting of the area of hypostasis.

Changes in skin, hair and wound.

Extrusion of fluid from the mouth and nose.

Emptying of the heart.

Changes in appearance of genitals.

Other sequale:

Fall of teeth

Skull sutures separation

Liquefied brain matter oozes out

Factors affecting putrefaction:

- ✓ Warmth and clothing
- ✓ Moisture
- ✓ Air
- ✓ Age
- ✓ Manner of burial
- ✓ Condition of body
- ✓ Sex
- ✓ Mode of death

Adipocere

After death, bacterial enzyme act upon body fats causing their hydrolysis and hydrogenation. Palmitic acid is the main component of adipocere. Its appearance is yellowish white with rancid smell. Adipocere can be formed at any site where fatty tissues are present.it takes nearly 3 weeks in summer while in tropics 5-15 days. 2,6,7

Medico legal importance of adipocere

- ✓ In establishing identity
- ✓ Determining cause of death
- ✓ To establish time since death
- ✓ To determine place of death

Optimal conditions for the formation of adipocere are:

- ✓ Abundant moisture
- ✓ Bacteria (*clostridium welchii*)
- ✓ Optimal temperature
- ✓ Relative air
- ✓ Abundance of adipose tissue

Mummification

It is a peculiar desiccation and modified form of putrefaction of a dead body where by its soft parts shrivel up but retain the natural appearance and the features of the body instead of liquefaction. Body attains rusty brown color, dry leathery skin which is adherent to bones while internal organs get transformed into thick brown mass. Mummification occurs in bodies buried in shallow graves, in dry sandy soils and takes time nearly 3 months to 1-2 yrs.

Medico legal importance:

- ✓ Identification
- ✓ Cause of death
- ✓ Time since death
- ✓ Place of death

The conditions necessary for its formation are:

- ✓ Warm and dry atmosphere
- ✓ Moisture deprived area so proliferation of putrefying bacteria or microorganisms can be prohibited.
- ✓ Free air circulation around the body.

Forensic entomology

Flies and *maggots* also provide an approximate time of death, very useful for cases where the body has been long dead. Only certain insects will feed and lay eggs on a dead corpse and forensic entomologists study these insects, their

larvae cycles and thereafter can determine whether a body has been dead for just one day or up to 3 or 4 weeks. 31

Time	Physical appearance of body	Insect present at that stage
0-3 days	Proteins and carbohydrates in the deceased body begin to break down.	Blowflies e.g. Bluebottle flies, Syrphidae flies
4-7 days	Body is starting to decay and causes the abdomen to inflate because of the gases inside.	Fly larvae and beetle e.g. Rove Beetles
8-18 days	Decay is well and truly setting in; the abdomen wall begins to break down.	Ants, cockroaches, beetles and flies
19-30 days	The decaying body enters a stage know as 'post-decay'; in wet, humid conditionsthe body is sticky and wet; in hot dry conditions, the body is dried out.	Beetles and mites e.g. Springtail beetle, Acari, as 'post-decay'; in wet, humid conditions, Nematocera (present only during the winter months),
31 days and onwards	The bones, skin and hair that remain no longer give off a powerful stench and smell just like the soil surrounding it.	

30 Gill-King H (1996) Chemical and ultrastructural aspects of decomposition. In: Haglund WD, Sorg MH (eds) Forensic taphonomy: the postmortem fate of human remains. CRC, New York

31 Lord WD, Goff ML (2003) Forensic entomology: application of entomological methods to the investigation of death. In: Froede RC (ed) Handbook of Forensic Pathology, 2nd Edn, College of American Pathologists, Illinois.

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e- Content for Post Graduate Courses

Paper : Forensic Science and Forensic Medicine

Module : Asphyxial death: hanging, strangulation, drowning

Role	Name	Affiliation
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Co-Principal Investigator		
Paper Coordinator	Prof. (Dr.) Sally Lukose	Dean, School of Basic and Applied Sciences, Galgotias University, Greater Noida.
Content Writer/Author	Ms. Neeharika Srivastava	Assistant Professor, Galgotias University, Greater Noida, U.P.
Content Reviewer		

DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Asphyxial death: hanging, strangulation, drowning
Module Id	LAW/CJA/VIII/36
Objectives	Learning Outcome: To make the learners understand the need of studying asphyxial deaths based on their mechanism. To make the learners understand processes to determine the various type of asphyxia operating in different case and manner of death. To make the learners understand the mechanism of oxygen supply to the blood and tissues with respect to interference with respiration.
Prerequisites	General understanding of the Obstructions to the air passages due to hanging, strangulation or other asphyxia deaths and occlusion of the air passages within as in drowning or laryngeal spasm.
Key words	Asphyxia, hanging, strangulation, drowning, entomology.

Asphyxia

Asphyxia is a common term applied to the condition where to a more or less degree interference with the respiratory exchange occurs. It is the condition where oxygen supply to blood and tissue is restricted below the normal level causing any interference with respiratory system. 1,2. It can also be considered as state of hypoxia

or the lack of oxygen below the required level. Effect of asphyxia can be divided in four stages: 3,4

- ✓ Stage of inspiratory dyspnoes where deep and forceful respiration occurs, cyanosis lasts for a minute or so.
- ✓ Stage of expiratory dyspnoea with spasmodic efforts at expiration. At this stage, consciousness is lost, pupils dialated and high blood pressure are the symptoms.
- ✓ Next is the fall in blood pressure, resulting in increased pulse rate. Sometimes defecation occurs. Erection of penis and ejaculation of semen may also occur.
- ✓ At last, respiratory movements cease except for terminal irregular occasional respiration. Heart beats for next 10-15 minutes.

Causes of asphyxia: 2

- ✓ Obstruction in air passage due to mechanical asphyxia
- ✓ Causes blockage of external respiratory orifices, as in smothering.
- ✓ In case of drowning, occlusion of the air passage
- ✓ As in case of traumatic asphyxia, pressure on chest.
- ✓ Inhaling the toxic gases like carbon monooxide.
- ✓ In case of strychnine poisoning, spasm of the respiratory muscles.
- ✓ in case of narcotics and anesthetia administered, paralysis of the respiratory centre.

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1 (Premature and Congenitally Diseased Infants, by Julius H. Hess, M.D., Chapter X, Diseases of the Respiratory Tract, parikh).

2 parikh

3 chapter 11, asphyxia, Ass. Prof.Dr. Atef Foda & Dr. Eslam Samy, 117-129). (Nandy A.; Principles of Forensic Medicine; Edition 2005; p. 319-327.

4 Dixit P.C.; Textbook of Forensic Medicine and Toxicology; Edition 2007; p. 294, 300.)

Signs of asphyxia: 5,2,6,7,8,9

1- <u>Cyanosis: (greek 'dark blue')</u>

- ✓ The quantity of oxyhaemoglobin and reduced haemoglobin in red blood cells determine the Cyanoses.

- ✓ When oxygen is lacking, the usual pink colour of well oxygenated blood might get converted to blue-purple.
- ✓ There should be at least 5gm% of reduced haemoglobin for cyanosis to become evident.

2- Congestion:

- ✓ Due to susceptibility of capillaries to hypoxia there occurs capillo-venous congestion following visceral congestion resulting in stasis of blood in the dialated capillaries and venules.
- ✓ There is redistribution of blood upto certain extrant due to gravity and to some extent by rigor mortis.
- ✓ Systemic and pulmonary congestion and dialaltion of right side of heart are the sure sign of asphaxial death.

3- Fluidity of blood:

- ✓ It has been established that fibrinolysin are found in cadaver.
- ✓ Fluidity depends upon fibrinolysin and amount of fibrinolysin depends upon the rapidity of death rather the cause.

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5 sympsom
6Ely SF and Hirsch CS, Asphyxial deaths and petechiae: a review. / Forens Sci 2000;45(6):1274-1277.)
7 Roughead W, Burke and Hare, ed 3. Edinburgh, Cited in Poison C, Gee DJ, Knight B: The Essentials of Forensic Medicine, New York, Pergamon Press, 1985.)
8 Knight BH, The significance of the postmortem discovery of gastric contents in the air passages. / Forens Sci 1975; 6:229-234.)
9Feldman EA, Traumatic asphyxia: Report of three cases./ Trauma 1969; 9:345- 353

4- Pulmonary edema:

- ✓ It is of no or less value in diagnosis of death that whether it is due to respiratory failure.
- ✓ Lungs should be weighed properly to know the extent of edema.

5- Pulmonary hemorrhages:

- ✓ Due to trauma of pharynx against the anterior surface of spine , there is larfe submucosal hemorrhages.
- ✓ Rupture of submusous venous plexus at this site is due to serious venous congestion.

6- <u>Petechial hemorrhages:</u>

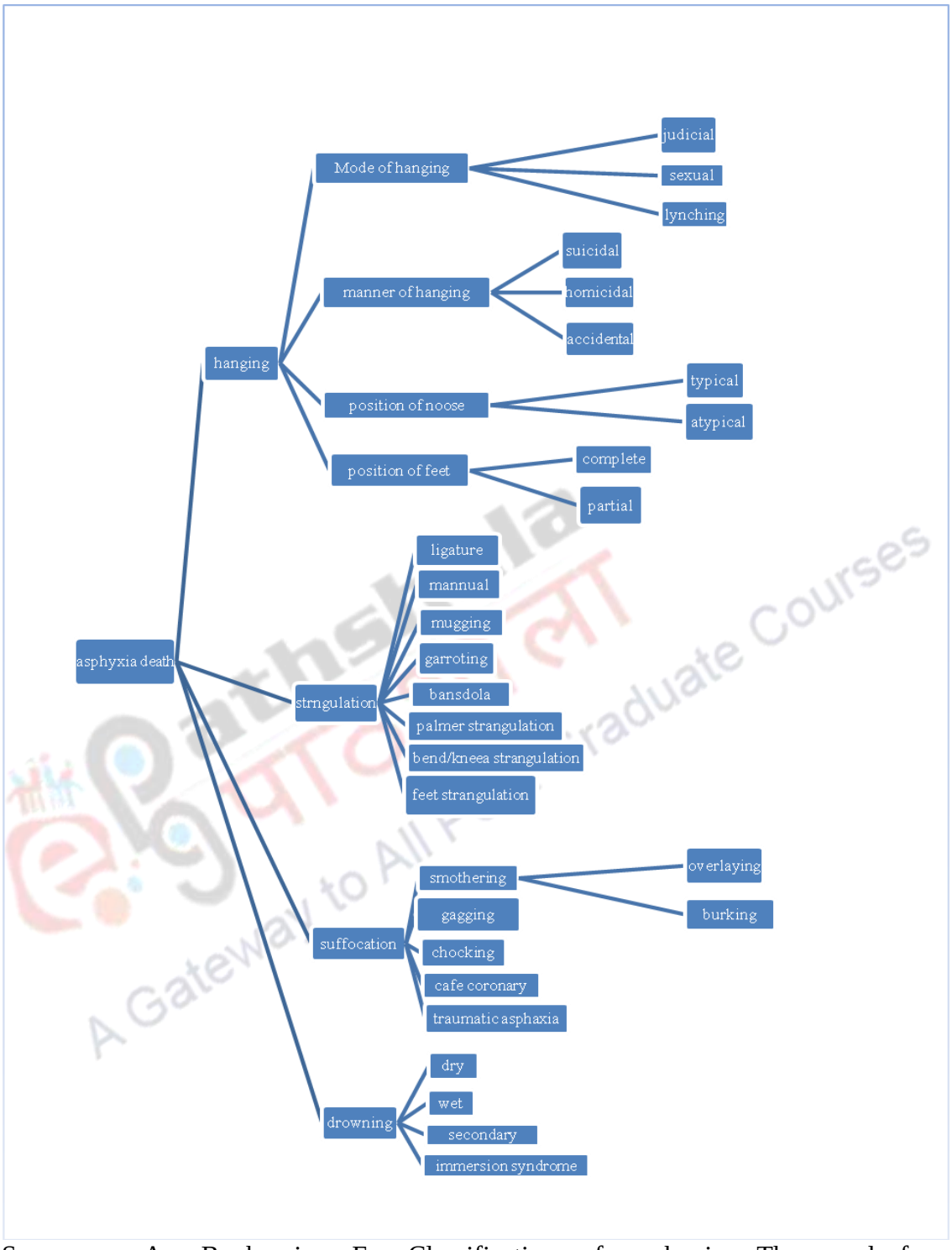
Petechial hemorrhages or tardieu spots are develop from:

- ✓ Due to Increased venous stasis causing congestion which results in increased pressure causing rupture of the vessels.
- ✓ There occurs increased permeability due to hypoxia.
- ✓ Tardieu spots are usually pinhead in appearance,but vary in size and shape.

7- <u>Stasis hemorrhages:</u>

- ✓ Found in case of homicidal strangulation
- ✓ Usually found beneath the mucosa of larynx in the subglottic space.

<u>Classification of asphyxia death 2,10</u>



Sauvageau A., Boghossian E.; Classification of asphyxia; The need for standardization; J. Forensic Sci.; 2010; 55; 1259-67.

Hanging:

Hanging is a mode of death in which death occur because of the compression of neck as a result of suspension of body through a ligature. The constricting force results from the weight of the body or a part of body weight acts as a constricting force. Virtually all the suicide cases are suicidal in nature. Diagnosis of antemortem hanging is important to acertain the death from hanging. There are few features which can ascertain death by hanging: Ligature mark with vital reaction, Saliva dribbing from mouth, Ecchymosis of larynx or epiglottis, Fracture of hyoid cartilage and hyoid bone. 2,5,11

There are chances of complete or incomplete suspension of the body:

Complete hanging:

- ✓ Here the body is completely suspended in air
- ✓ Constricting force is the weight of the body.

Partial/incomplete hanging:

- ✓ Here the constricting force is weight of the haed.
- ✓ Lower part of the body like toes, feet , knee and buttocks generate the constricting force.

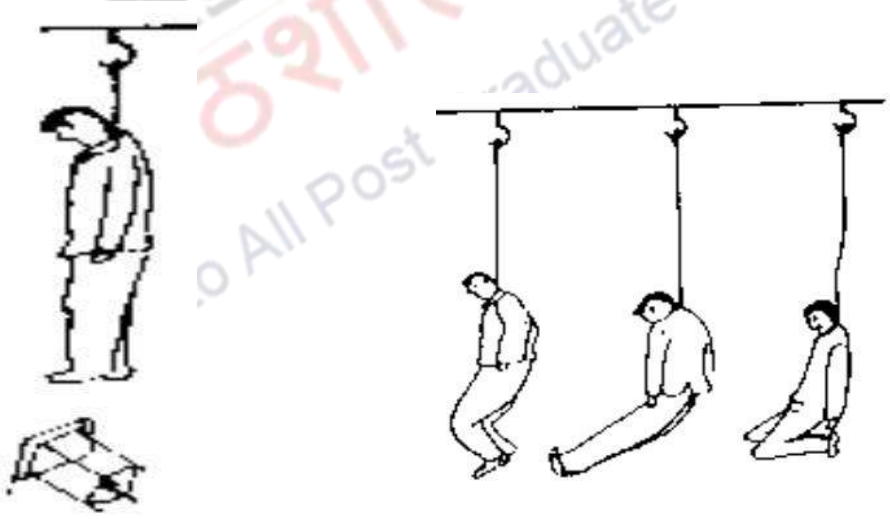


Figure: (a) complete hanging (b) partial hanging

11 A Study of Gross Postmortem Findings in Cases of Hanging and Ligature Strangulation, Mohammed Musaib M. Shaikh, H. J. Chotaliya, A.D. Modi, A. P. Parmar, S. D. Kalele, J Indian Acad Forensic Med. Jan-March 2013, Vol. 35, No. 1 ISSN 0971-0973. ,

2 Parikh's Text book of medical jurisprudence Forensic Medicine and Toxicology CBS publisher and distributors PVT.LTD.

5 Simpson's Forensic Medicine, 13th Edition, Jason Payne-James, Richard Jones, Steven B Karch, John Manlove, August 26, 2011 by CRC Press.

Cause of death in hanging:

Hanging may resulting death due to one or combination of following reasons of immidiate death: 12,13,14,5

1- Asphyxia:

- ✓ ligature forces the root of tongue aginst the pharynx and folds the epiglottis over the entrance of larynx to block the passage of air.
- ✓ A minimum weight of 15 kg is required to compee the trachea

2- Injuries to spinal cord:

- ✓ When hanging is exercised with a long drop
- ✓ Upper cervical cord is stretched
- ✓ Immediate unconsciousness
- ✓ Heart and respiration may continue for upto 10-15 minutes
- ✓ Congestive changes are absent

3- Vagal inhibition:

- ✓ By compression of the neck
- ✓ Cab be considered as a possible cause where there is no or minimal congestive changes.

4- Mechanical constrictions of the structures of the neck:

- ✓ Combined obstructive asphyxia and interfered cerebral circulation is most common cause of death

5- Cerebral anoxia:

- ✓ Carotid artery occludes with 4-5 kg tension
- ✓ Vertebral artery with 20 kgs tension

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12 **(**Ashok Kumar Samanta, Soumya Rajan Nayak. Newer trends in hanging death. Journal of Indian Academy of Forensic Medicine. 2012, Vol. 34 (1) pp 37 – 39.)

13 (Paliwal P. K, Basant Lal Sirohiwal, Vijay Pal Khanagwal, Hitesh Chawla. A drop of saliva de-codes the mystery of hanging body. Journal of Indian Academy of Forensic Medicine. July-Sep 2011, Vol. 33, No. 3.pp280-282.

14 Chormunge Patil, Mahajan S. V, Bhusari P. A. Hanging vs. strangulation a comparative study. Journal of Forensic Medicine, Science and Law. Jul-Dec 2011. Vol. 20, No.2 pp 1-5)

5 siympson

Reasons for delayed death:

- ✓ Aspiration pneumonia
- ✓ Infections
- ✓ Hypoxic encephalopathy
- ✓ Edema of lungs
- ✓ Encephalitis
- ✓ Cerebral abscess

Autopsy findings: 2,5,15,16

External:

- ✓ Neck may be stretched or elongated
- ✓ Head bend is opposite to the knot
- ✓ Face is pale usually
- ✓ Face may be swollen but swelling disappears when rope is cut down
- ✓ Petechiae present on the skin
- ✓ Dribbing of saliva
- ✓ Bloody froth may present caused by congestion of lungs
- ✓ Pulmonary edema
- ✓ In the middle ear hemorrhage may be seen
- ✓ Semen drops may come out of penis
- ✓ Lower limbs show hypostasis

Internal:

- ✓ Absence of Petechiae because of complete obstruction in the arterial system
- ✓ Saliva run from mouth down the chest
- ✓ Fracture of the hyoid bone and thyroid cartilage (considered antemortem)
- ✓ Vertebral artry may show rupture
- ✓ Thyrohyoid ligament is torn
- ✓ Trachea show Petechiae haemorrhages over the epiglottis, trachea and larynx.
- ✓ Abdominal organs are congested.

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15 Zine K. U., Tandle R. M., Varma N. M., Jambure M. P. Accidental Ligature Strangulation with Avulsion of Scalp. Journal Indian Academy Forensic Medicine. July-Sept 2011, Vol. 33, No.3, pp 267 – 268.

16 Punia R. K, Gupta B. M. A rare case of ligature strangulation with salivary staining. Journa)(Sauvageau A., LaHarpe R, Geberth VJ; Agonal sequences in eight filmed hangings: Analysis of respiratory and movement responses to asphyxia by hanging; J Forensic Sci. 2010; 55; 1278 – 81.

Strangulation

Strangulation is another form of asphaxia where death is due to constriction of neck by a ligature or other mean bvut without suspending the body. Broadly it is of two types (1) ligature strangulation and (2) manual strangulation. There also may be some more type:

- ✓ Ligature Strangulation: strangulation is by means of ligature.
- ✓ Throttling or manual strangulation: compressing the victim;s neck by the hand
- ✓ Mugging: compressing the victim's neck against the forearm
- ✓ Garroting: attacking the victim from behind, grabbing his neck or throwing a ligature over neck and tightening it.
- ✓ Bansodala: compressing the neck by means of two sticks.

Areas which are more presumptive of strangulation are head and neck and a thorough examination of these area can be used to ascertain death by strangulation.

Medico legal importance of strangulation:

In homicidal cases:

- ✓ Single turn of ligature with one or more knot
- ✓ Abrasion around the neck due to ligature movement
- ✓ Mark of struggle (absent in case of weak or frail individual)

In Accidental cases:

- ✓ Children are more prone as they can get entangled in rope while playing.
- ✓ Intoxicated person by tie, scarf or collar.
- ✓ Umbilicle cord can strangulate the foetus.

In suicide cases:

- ✓ Injuries are less marked as less force is applied.
- ✓ No sign of struggle
- ✓ Ligature is found at scene

17 (Chormunge Patil, Mahajan S. V, Bhusari P. A. Hanging vs. strangulation a comparative study. Journal of Forensic Medicine, Science and Law. Jul-Dec 2011. Vol. 20, No.2 pp 1-5)

Cause of death:

- ✓ Asphyxia
- ✓ Anoxia
- ✓ Congestion
- ✓ Vagal inhibition

Autopsy:

External:

- ✓ Ligature mark on the middle or lower part of neck
- ✓ Depending upon the compostion of the ligature it will shown regular or irregular pattern around the neck
- ✓ Mark is depressed at any level on the neck-usually at the level of thyroid cartilage or below.
- ✓ Mark may be found around the neck but is more prominent in front and sides of neck.
- ✓ Marks may be interrupted by clothing or victim's finger or ornaments.
- ✓ Mark is usually transverse but sometimes oblique as well.

Internal:

- ✓ Laceration of muscles.
- ✓ Injuries to blood vessels
- ✓ Hyoid bone fracture usually not seen.
- ✓ Fracture thyroid is more common.
- ✓ Fracture of cricoids is rare, but if pressure is used may be seen.
- ✓ Organs are congested.

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18 (Sheikh M. I. and Agarwal S. S. Medico-legal implications of hyoid bone fracture-a study paper. Journal of Indian Academy of Forensic Medicine. 2001 Vol. 23. Number 4. pp 61 - 63.)

19 (Zine K. U., Tandle R. M., Varma N. M., Jambure M. P. Accidental Ligature Strangulation with Avulsion of Scalp. Journal Indian Academy Forensic Medicine. July-Sept 2011, Vol. 33, No.3, pp 267 – 268.)

Drowning

- ✓ Drowning is a form of asphyxial death due to aspiration of fluid into the air passages by submersion of the body in water or some other liquid medium.20,21
- ✓ Complete submersion not necessary, submersion of nose and mouth of a living person under water is enough. Types of drowning:

Drowning is mainly of four types:

1- Wet drowning: when more water goes to lungs.

2- Dry drowning: no water goes to lungs, death is due to laryngeal spasm.

3- Secondary drowning:

- ✓ Survival beyond 24 hours, victim may survive or die later
- ✓ Injury to CNS is reported
- ✓ Hypothermia and low oxygen delivery to vital tissues are the main factors towards morbidity and mortality.

4- Immersion drowning: Death is due to vagal inhibition following cardiac arrest. In drowning this may be brought about by

- ✓ A sudden water entry to larynx.
- ✓ Falling in water in a way such that it strikes the abdomen suddenly, especially the epigastric region.
- ✓ Sudden entry of cold water into the ears.

Medico legal importance of drowning:

- ✓ Sure signs of drowning,
- ✓ Could still be identified in putrefied bodies,
- ✓ Could give an evidence of the site of drowning (fresh or salt water species).
- ✓ Whether the death was due to drowning or other cause?
- ✓ Length of time the body was in water.
- ✓ Whether it was accidental/suicidal/homicide

20(Auer A, Möttönen M (1988). Diatoms and drowning. Z Rechtsmed 101: 87-98.)

21Davis J (1986). Bodies found in the water: an investigative approach. Am. J. Forensic Med Pathol 7: 281-287

The change occur in body simply tells about the duration of submersion of body in water. Changes are result of imbibition of water in outer layer of body. Changes start to develop first in finger tips (3-4 hours) later spreading to entire hand (24 hours). By careful examination of these changes duration of submersion can be determined.

- ✓ In a couple of hours only, skin starts developing wrinkles
- ✓ In about 12 hours of submersion, cuticle becomes bleached.
- ✓ In 24 hours saddening of skin can be seen.

- ✓ In about 48 hours of submersion, cuticle of skin starts separating from palm and foot and can be peeled off by 3-4 days.
- ✓ Usually body starts to float in about 24 hours of submersion in summer in 2- 3 days in winter.

Autopsy/ diagnosis of death by drowning can be ascertained by (a) External sign (b) internal sign (c) biochemical test and (d) analysis through diatoms. 22,23,24,25

External sign:

- ✓ Clothing and skin is wet, cold and pale
- ✓ Hypostasis is pink in color due to oxygenation or may be cyanotic
- ✓ Upper parts of body show postmortem staining
- ✓ Petechial haemorrhage may be present
- ✓ Pupil dialated
- ✓ Cyanosis may be present
- ✓ Rigor mortis takes place early
- ✓ White and leathery froth sometimes with blood is present over the mouth and nostril. When chest is pressed more froth comes out.
- ✓ Cutis anserine (Due to spasm of the erector pilae muscles and due to exposure to cold water at the time of death) or goose skin is present
- ✓ Cadaveris spasm: presence of weeds in grass in hands.
- ✓ Washerwomen's hand: saddening of the skin due to absorption of water.

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22 DiMaio DJ, DiMaio VJM (1989) Drowning. In: DiMaio DJ, DiMaio VJM, eds. Forensic pathology. Elsevier, Amsterdam pp. 357-365.)(Hendey NI (1973).
23 The diagnosis value of diatoms in the cases of drowning. Med Sci Law 13(1): 23-34.)
24(Knight B (1991). Immersion deaths. In: Knight B, ed. Forensic Pathology, E.Arnold, London pp. 360-374.
25 Ludes B, Fornes P. (2003). Drowning in : Forensic Medicine : Clinical and Pathological Aspects. Payne-James J, Busuttil A, Smock W eds, Greenwich Medical Media, pp 247-257)

Internal signs:

Paltauff's haemorrhages:

- ✓ Present in the lower lobes of lungs
- ✓ Red or grey patchy appearance
- ✓ This condition of lung is also known as emphysema aquosum and trockenes oedema.

Microscopic findings of drowning lungs:
Following stages are encountered

- ✓ Thickness of the alveolar wall is reduced to capillary width
- ✓ Alveolar are more distended and capillaries lie separately.
- ✓ Capillaries appearance is thread like, lumina is observed occasionally.
- ✓ Involve only scattered alveoli.

Water in stomach and duodenum:

- ✓ When water is taken in excess, it passes to the duodenum.

Froth in air passage:

- ✓ In case of fresh drowned bodies, froth comes out from mouth and nostril.
- ✓ Froth is odema fluid from lungs
- ✓ Froth consist of proteinaceous exudates and surfactant mixed with the drowning medium water.

Over-inflation of lungs:

- ✓ Lungs may be over-inflated filling the thoracic cavity.

Biochemical tests:

Many workers have worked on the biochemical and biophysical tests on drowning related cases including calcium, magnesium or specific gravity of plasma but the results are not rewarding. The rapid onset of post mortem changes in case of drowning may be considered as one of the reason which is obscuring the reliability of biochemical tests. 26

- ✓ Diatoms (bacillariophyceae) is a photosynthetic unicellular algae with silicaceous exoskeleton is found in water.
- ✓ There are nearly 15,000 species of diatom found in fresh and sea water.
- ✓ A broad classification of diatom can be (1) oligohalophilic: live in fresh water (2) mesohalophilic: in sea water with salinity more than 0.05%.

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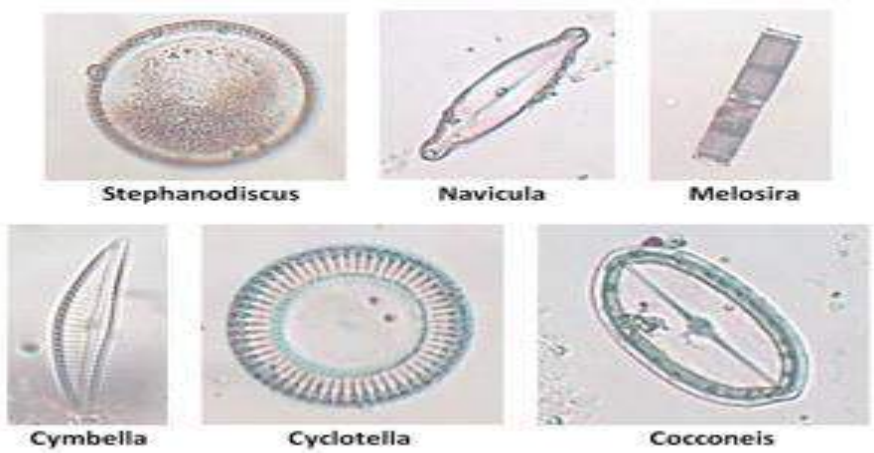
26 Analysis of diatoms: (Ludes B, Coste M, North N, Doray S, Tracqui A, Kintz P (1999). Diatom analysis in victim's tissues as an indicator of the site of drowning. Int J Legal Med 112: 163-166.)



Different types of diatoms27

- ✓ When a person drowns in water containing diatoms, many diatoms reaches to pulmonary parenchyma. From there they enter into blood stream through the alveolar walls during forceful inspiratory or expiratory efforts. Once they enter in blood , are distributed in whole body through blood stream. This presence of diatom makes the basis of diatom test in drowned individuals.
- ✓ When person is not drowned oe a body is thrown in water after death, diatom are though able to reach lungs by passive perlocation but cannot reach to distant organs.
- ✓ Hence organs examined routinely for the presence of diatoms are lung, liver, brain and bone marrow. 28

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27 Forensic diatomology, ANU SASIDHARAN*, RESMI S, HEALTH SCIENCES, 2014; Vol.3,No.1 January –March, ISSN 2319 – 4154.

28 (Ludes B, Quantin S, Coste M, Mangin P (1994). Application of a simple enzymatic digestion method for diatom detection in the diagnosis of drowning in putrefied corpses by diatom analysis. Int J Med 107: 37-41.)

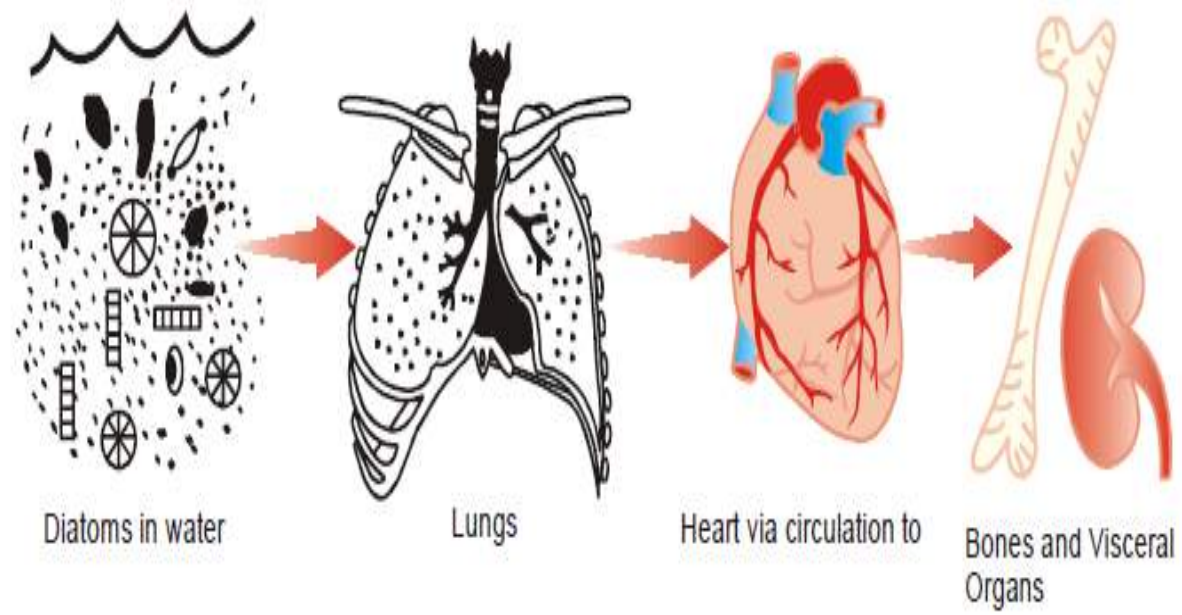

Figure: Diagrammatic representation of transmission of diatoms

There may be cases where the person was not drowned but diatoms were present or may be absent when person was drowned. Such conditions can arise due to:

- ✓ Seasonal variation
- ✓ Due to havinf raw fruits or vegetables which have been in contact of soil diatoms
- ✓ Having their ubiquitous nature, they are present in soil, water and in air.
- ✓ Sometimes they can penetrate the intestinal lining and can directly get in the blood stream.
- ✓ Certain food like selfish contain diatoms.

In such conditions, following are the requirements which should be fulfilled:

- ✓ Diatoms species recovered from body organs and from water of submersion should be same.
- ✓ They must be present in approximate same proportion. 29, 30,31

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29 Neidhart DA, Greedyke RM (1967). The significance of diatom demonstration in the diagnosis of death by drowning. Am J Clin Pathol 48(4): 377-382.
30 Pollanen MS (1997). The diagnosis value of the diatom test for drowning, II. Validity: analysis of diatoms in bone marrow and drowning medium. J Forensic Sci 42(2): 286-290.
31Pollanen MS (1998). Forensic diatomology and drowning. Elsevier (Amsterdam) ed.

DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Injuries and their medico legal aspects: Abrasion, bruise, laceration, Incised, stab wounds
Module Id	37
Objectives	Learning Outcome: • To make the learners understand the various types of injuries sustained by individuals and the medico-legal aspects associated with such injuries. • To make the learners understand the nature of different injuries and the estimation of age of injuries. • To understand the importance of assessing the ante-mortem and post-mortem injuries.
Prerequisites	General understanding of the human anatomy.
Key words	Forensic Medicine, Medico-legal aspects, injuries

1. Introduction:

An injury or a wound means a solution or disruption of the anatomical continuity of any of the tissues of the body.

Section 44 IPC : An injury is defined as any harm whatever illegally caused to any person in body, mind, reputation or property.

The Mechanism of Injuries:

The routine movements of our body are a resultant of elasticity and flexibility of our soft tissues and rigid skeletal framework, subsequently; injuries result when the forces acting on the human body crosses its limits of this elasticity or resistance. The factors responsible for the mechanism of injuries are:

1. Force
2. Area over which it acts
3. Specific effect of the force
4. Time taken over which the kinetic energy is transferred

Within a forensic context, the interpretation and classification of injuries are important in helping to gain an insight into how they were caused. The classification of injuries can be made based on the influencing factors and on the legal basis.

Classification of Injuries based on influencing factors:

1. Mechanical Injuries
    - Abrasion
    - Contusion
    - Laceration
    - Incised
    - Stab
    - Fire Arms
    - Fractures and Dislocations

2. Thermal Injuries
    - Due to Cold
        - Frost Bite
        - Trench Foot
        - Immersion Foot
    - Due to Heat
        - Burns
        - Scalds

3. Chemical Injuries
    - Corrosive Acids
    - Corrosive Alkalis

4. Miscellaneous
    - Injuries due to electricity
    - Injuries due to lightning
    - X-Rays
    - Radioactive Substances

Legal Classification of Injuries:

1. Simple Injuries
2. Grievous Injuries
3. Others
    - Self-inflicted Injuries
    - Defense Injuries
    - Unintentional Injuries

In the following sections we will discuss few commonly encountered injuries:

1. **Abrasions:** It is a superficial injury involving only the superficial layers of the skin. Caused by friction or pressure between the skin and some rough object or surface. It is sub-classified as:

a) **Scratch**: caused by a sharp object and carries the epithelium in front of it: indicates the direction

b) **Graze:** Broad surface of skin slides against a rough surface: Found in traffic accidents.

c) **Imprint, pressure, or contact abrasion**: Caused as a result of direct impact or pressure of or contact with some object which crushes the cuticle and stamps the reproduction of its shape upon the skin.

Fig1: Showing an abrasion
Source: www.slideshare.net

Determining the age of an Abrasion:

Time after Injury	Appearance
Fresh	bright red colour
12-24 hours	Lymph and blood dries up forming bright red scab
2 days	Reddish brown Scab
4-7 days	Epithelium starts to come under the scab
After 7 days	Scab dries and falls off

Ante-mortem and Post-Mortem Abrasion:

Ante-mortem Abrasion	Post-Mortem Abrasion
It is seen anywhere on the body	It is seen usually on the bony prominences
It is Reddish brown in colour	It is yellowish and translucent
Scab is slightly raised	Scab if seen is slightly depressed
Vital reactions are visible	No vital reactions are visible

Medicolegal Aspects of Abrasions:

a) Abrasions are usually seen in accidental and assault cases. Suicidal abrasions are very rare.
b) The nature of injury can be identified.
c) Site of impact can be determined
d) Direction of force can be explained
e) Patterned abrasion helps in the identification of the object.
f) Age of the abrasion can be known.
g) Nature of the crime can be identified from the site of abrasion, like around the neck indicates throttling
h) Presence of mud, grass, dirt can also indicate site of crime

2. **Bruise or Contusions:** A bruise or contusion signifies haemorrhage in to the skin, the subcutaneous tissue or deeper tissues. These are caused due to infiltration of blood in to the tissues when the blood vessels break due to application of blunt force trauma and the blood leaks in to areas under the skin, resulting in pain, swelling, and skin discoloration. A bruise may not appear at the site of injury but may appear at a place remote from the place of injury due to gravity shifting of the extravasated blood.
   Blunt objects like Lathi, Bamboo stick, iron rod, stone or by a blow from fist or boot or by a fall or by compression or crushing etc, may cause a bruise. Bruises are also found on different organs of the body especially in case of vehicular accidents.

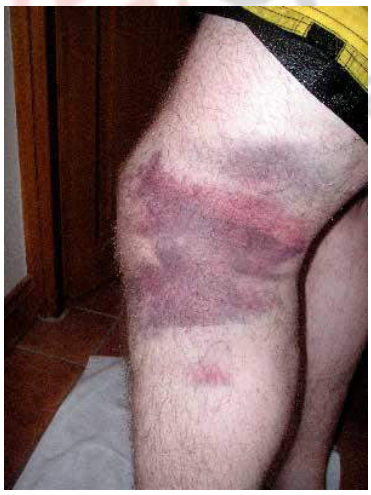


Figure2: Showing bruise
Source: http://thesurvivaldoctor.com

Age determination of bruises:

Time after Injury	Appearance
In fresh bruise	Red
Few hours to 3 days	Swollen, tender and blue
4 days	Bluish black to brown colour
5-6 days	Greenish colour
7-12 days	Yellow colour
2 weeks	Normal

Ante-mortem and post –mortem Bruise:

Ante-mortem bruise	Post Mortem Bruise
The site is swollen in recent bruises	Absent
If the person survives for some time colour changes signifying vital reactions are noted	Skin discolouration can be seen due to post mortem staining but with no vital reactions
Coagulation of extravasated blood in the subcutaneous tissues and muscle fibers are evident.	Presence of coagulated blood in the subcutaneous tissues and muscle fibers are absent.

Medico-legal Aspects of Bruise:

1. Bruises are resultants of either assaults or accidents. Self-inflicted assaults are rare as they are extremely painful.
2. Self-inflicted bruises are though known to be made by application of some plant parts such as "Bhilawan"(Marking nut) or the root of Chitra"(Plumbago Rosae).
3. These self-inflicted bruises can be differentiated by the following characters -
    - They are present on the accessible parts of the body.
    - These are dark brown in colour.
    - Their margins are covered with tiny vesicles.
    - The surrounding skin is red and inflamed.
    - The scrapings of the area give positive test, on chemical analysis.
4. Age of the injury can be determined
5. Degree of violence can be known.
6. Type of weapon used can also be determined especially when the entire length of the object used as a weapon is applied on the body as in case of a rod, chain or stick.

Lacerations:

These are the wounds caused by the blunt force resulting in the tearing of the skin and the underlying tissue, with a minimal bleeding.

Characteristic Features of Lacerated Injuries:

- Edges or margins of the wound are ragged, irregular and contused.
- These margins are abraded due to impact of blunt force.
- The underlying deep tissues are crushed and the damage is gross and extensive.
- Hair bulbs present in the deeper tissues are crushed.
- Less bleeding is as a result of crushing of underneath vessels.
- Presence of foreign materials like dust, mud, gravel at the injury site is a common feature.
- The shape of the injury is usually irregular devoid of any definite shape.
- The size of the injury may or may not correspond to the size or shape of the weapon used
- The healing process is delayed due to gross damage and infection at the injury site.
- Scars are formed due to the gross damage to underlying skin and tissue.

Types of Lacerated Injuries:

1. ***Split laceration:***

https://med.pdn.ac.lk/departments/forensic/

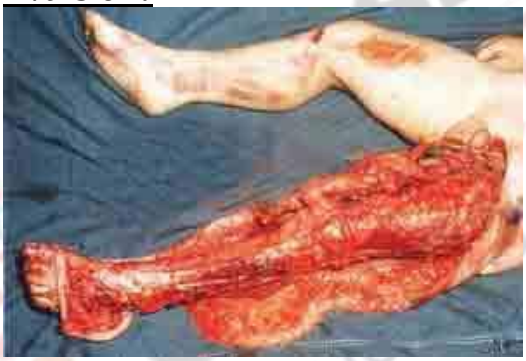
- This kind of laceration is usually found on parts overlying bones such as the scalp, face, hands and lower limbs.
- Split lacerations occur due to perpendicular impact by a blunt object.
- The resulting injury is due to crushing of skin between two hard objects.
- This injury in some instances simulates an incised injury.

2. ***Stretch laceration:***

https://med.pdn.ac.lk/departments/forensic/

- Stretch lacerations, as the name suggests is due to over stretching of skin as a result of which it produces a flap.
- A blunt tangential impact creates a stretch laceration. For example, when head strikes on the wind screen of the vehicle, stretch laceration is created.

3. ***Avulsion:***

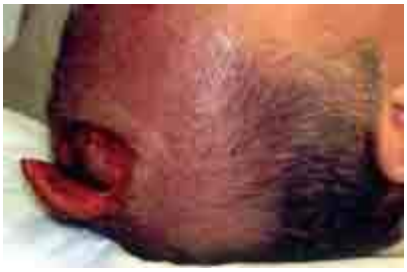


https://med.pdn.ac.lk/departments/forensic/

- Avulsion is de-gloving of skin over the impacted area due to compression and grinding of underlying tissue.
- It is commonly seen in road traffic accidents or by impact of machinery in heavy industries.

4. ***Tears:***
   - Tears are a result of friction with irregular or pointed end of a weapon or an object on the surface of the body.
   - Such lacerations are deeper at the starting point than at the terminal end.

5. ***Cut laceration:***



https://med.pdn.ac.lk/departments/forensic/

- This type of lacerated wound is produced by "blunt-sharp" edge of a weapon like an ice pick.
- Margins are not clear cut as would be seen with a sharp weapon.
- Abrasions or contusions are seen on the margins.

Medico-Legal importance

- Lacerations can been seen most often in homicidal and accidental cases. It may occur on any part of the body and are produced by blows with hard and blunt weapon.
- Lacerations in suicidal cases are known to be **v**ery rare.
- In accidental cases, lacerations are more prominent in **r**oad traffic accident cases and accidental fall from height.
- The location of the accident or crime can be determined by assessing the foreign bodies present in the injured site such as mud, gravel, oil etc.
- A split laceration may mimic an incision.

Incised Wounds

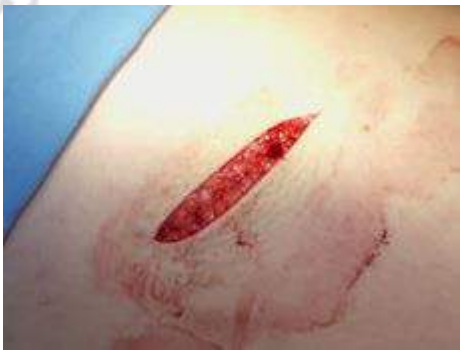


Fig: Showing an incised wound
Source: http://etmcourse.com/

- It is produced by any sharp cutting instrument such as knife, razor, blade, sword, chopper, axe, etc.
- The edges are clear cut, retracted and averted. An exception to this is found in the neck and scrotum where the edges are inverted. The edges may be

irregular when the skin is loose in the affected site or if the cutting edge of the knife is blunt.

- The wound is spindle shaped due to retraction of the tissue.
- The length of the wound is greater than its breadth. Additionally, the breadth of the wound may be greater than the thickness of the cutting blade.
- Wound gaping is greater if underlying muscles are cut obliquely.
- Excessive Bleeding or Hemorrhage is imminent due to the clear incision of blood vessels.
- The cuts are deeper at the beginning and gradually become shallow towards the end when only skin is cut. This is called as "Tailing of the wound".

Determination of Age of the Incised Wound:

Time after Injury	**Appearance**
When fresh	Haematoma formation
12 hrs	Blood clot and lymph dry up, margins are red and swollen. Histologically there is infiltration of leucocytes.
24 hrs	Proliferation of connective tissue cells and vascular endothelium for neo-vascularization.
36 hrs	Fibroblastic infiltration and capillary
2-3 days	Capillary network is completed. Fibroblasts run across the new vessels.
3-5days	Definite Fibrils are seen. Vessels are obliterated and thickened
1-2 weeks	Scar formation is completed.

Medico-legal Importance:

- The injury gives an indication of the nature of the weapon.
- It gives an idea about the site of impact and direction of force.
- Age of the injury can be estimated.
- Position and characteristics of the wound can give an insight in assessing whether it is a suicidal, homicidal or accidental injury.

Stab Injuries

- These are also called as punctured injuries.
- These injuries are generally caused by sharp and pointed weapons such as knives, dagger, arrow, pick-axe, broken glass pieces, etc.
- A stab wound caused by a sharp pointed and cutting instrument has clean cut edges and sharp angles at the two extremities.
- These are deeper than its length on the skin. Perforating wounds can also be seen in stab wounds.
- The shape of the wound will vary as per the type of piercing weapon used:

Type of Piercing Weapon	**Shape of injury Produced**
Weapon with only one cutting edge	Triangular or wedge shaped
Double edged weapon	Elliptical
Round sharp pointed end (Spear)	Circular injury with clean cut edges
Round blunt pointed end	Circular injury with ragged and bruised edges
Tapering Blades	Perforating injury (entry wounds are larger with inverted edges as compared to exit wounds which are smaller and with inverted edges)

Medicolegal Importance :

- Shape of the injury will idicate the type of weapon used.
- Depth of the injury will indicate the force of penetration.
- Direction of the wound can indicate the relative position between the victim and the assailant.
- Age of the injury can be determined.
- Stab wounds are mostly suicidal or homicidal.
- Accidental stab wounds are rare.

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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Ante-mortem and Post-mortem injuries, Burns, scalds and electrocution
Module Id	38
Objectives	Learning Outcome: • To make the learners understand the various medico-legal aspects associated with Burns, scalds and electrocution injuries. • To make the learners understand the nature of different injuries • To understand the importance of assessing the ante-mortem and post-mortem injuries.
Prerequisites	General understanding of the human anatomy.
Key words	Forensic Medicine, Medico-legal aspects, injuries

1. Introduction:

The distinction between ante-mortem and post-mortem injuries are probably one of the most prime problem faced by the Forensic Medicine Experts and the officials who seek answers to the time of injury sustained by the victim. The correct interpretation not only helps the conviction of the guilty but also the acquittal of the innocent. Hence it is important for the Forensic Medicine Expert to make detailed observations which should ideally include the following points:

1. External appearance of the injuries: It is the naked eye appearances of the injuries.
2. Histological timings of the injuries: it is based on the morphology of various stages of wound healing.
3. Histochemical timings of the injuries: it involves the study of enzymes such as adenosine triphosphatase, aminopeptidase, acid phosphatase, and alkaline phosphatase in the wound region.
4. Biochemical timings of the injuries: It is the measurement of histamine and serotonin contents of the injured skin as compared to the intact skin of the same individual

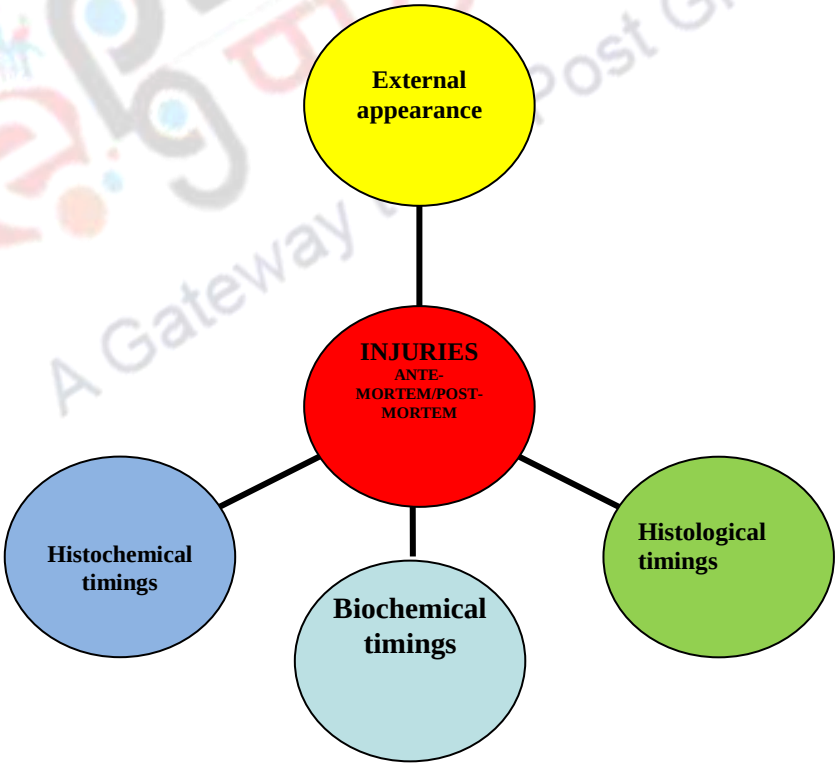


Fig1: Showing the Examinations done to distinguish between Ante-Mortem and Post Mortem Injuries.

1.2 Difference between Ante-mortem and Post-mortem injuries:

The salient distinguishing features of Ante-mortem and Post-mortem injuries are as follows:

S.No.	Characteristics	Ante-mortem Injuries	Post-mortem injuries
1.	Haemorrhage	• Profuse and arterial • Arterial spurting of blood • Clotting of Blood • Blood clot when found is laminated • Clot firmly adheres to endothelium lining • Due to deep infiltration the edges of wound are stained which cannot be washed away.	• Slight and venous • Venous oozing of blood • Blood clotting absent • Blood clot if found non-laminated • Clot weakly adheres to endothelium lining. • No infiltration and hence the edges are not stained and the stains if present can be washed away.
2.	Wound edges	Gaping, everted and swollen	Apposed and not swollen
3.	Vital Reaction	• Inflammation present • Granulation present	• Inflammation absent • Granulation absent
4.	Microscopy	• Leucocyte and RBC infiltration between muscle fibers • Clot composed of fibrin, RBC and platelets	• Vessels distended with postmortem clot • Clot composed of fibrin and RBC
5.	Enzyme Histo-chemistry	• Negative and positive vital reactions seen	• Vital Reactions absent
6.	Serotonin and Histamine biochemistry	• Increase in Serotonin and Histamine content	• No increase in Serotonin and Histamine content

2. BURNS

A burn is defined as a traumatic injury to the skin or other organic tissue primarily caused by thermal or other acute exposures namely heat, cold,

electricity, radiation, or chemicals. Burns may be classified in to three degrees:

1. **Epidermal Burns:**
    - Effected part is red
    - Blister Formation
    - Inflammation
    - Singeing of hair
    - Very painful
    - Repair without Scar

2. **Dermo-epidermal Burns:**
    - Whole thickness of skin destroyed
    - Coagulation necrosis of epidermis and dermis
    - Lesions have a dry white leathery appearance.
    - Scar formation
    - Scars contact causing disfigurement
    - Considerable pain and shock

3. **Deep Burns:**
    - Complete charring
    - Gross destruction of subcutaneous tissue, muscles, and bones
    - Nerve endings destroyed. Burns therefore less painless

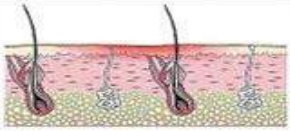
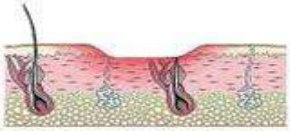
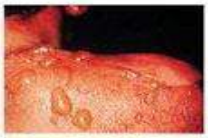
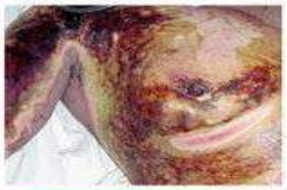
Degree	Anatomic correlate	Schematic aspect	Clinical aspect
I	Reddening, swelling, pain (epidermis)		
IIa	Reddening, blistering, pain (superficial dermis)		
IIb	Pallor, blister, pain (partial dermis)		
III	Greyish white or black necrosis, analgesia (complete dermis)		
IV	Carbonization (may extend to the bones and joints)		

Fig2: Showing the different degree of Burns
Source: https://s-media-cache-ak0.pinimg.com/originals/

The estimation of burnt surface area can be worked out by the “Rule of 9”.

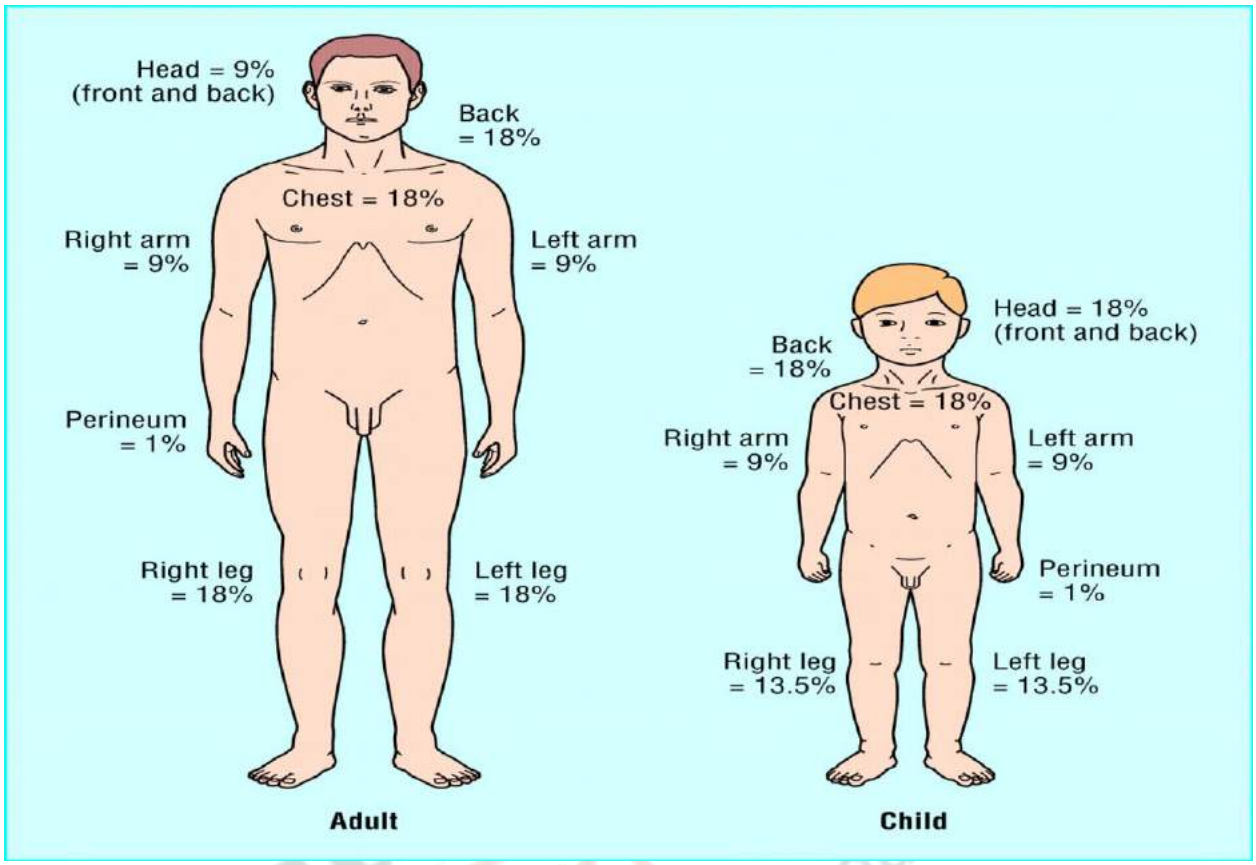


Fig 3: Showing Rule of 9 in an adult and a child

Medicolegal Significance:

- Due to heat stiffening and coagulation of proteins the body presents a pugilistic attitude. This condition is present in both dead and alive and hence has no medicolegal significance.
- Presence of soot in esophagus or stomach depicts that the victim was alive when the fire was in progress.
- Mucosa and trachea necrosed due to inhalation of hot air.
- Blood thick due to haemo-concentration and cherry red in colour due to due to carboxy-haemoglobin.
- Suicidal burning is common.
- Homicidal is rare but have known to occur with criminal intent.
- Accidental burns are also common

3. **SCALDS:** A scald is an injury sustained due to application of liquid at or near the boiling point or from steam. The injury is limited to skin, mouth, throat when hot liquids are drunk. Moist heat usually causes bleaching effect and soddening of the skin.

Classification of Scalds:

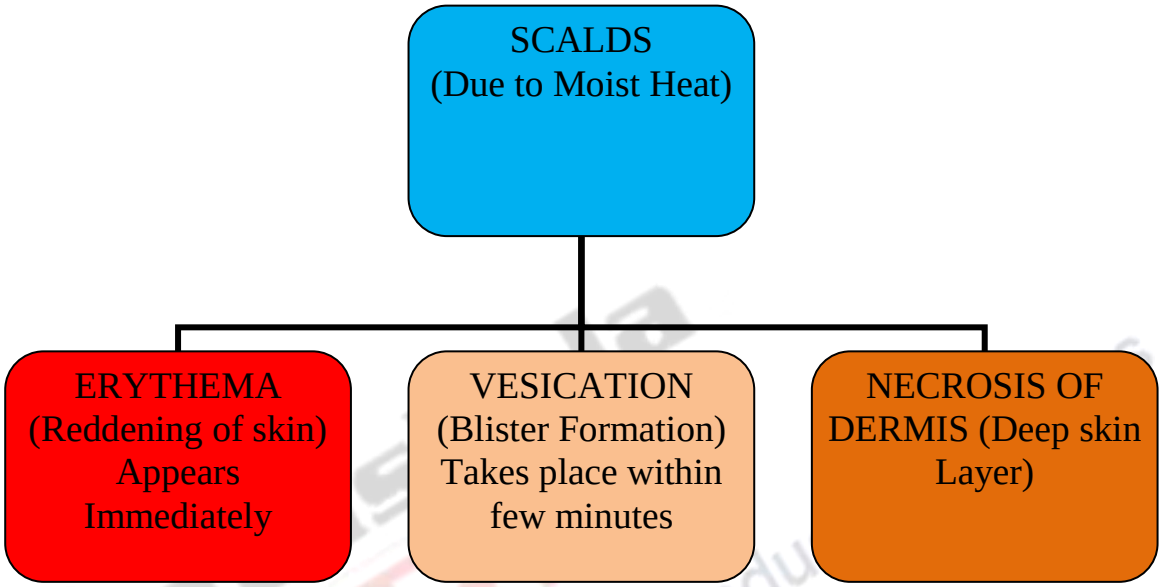


Fig: Classification of Scalds

Medicolegal Significance:

- Scalding is usually accidental.
- Severe scalds of the mouth and throat when hot liquid is taken orally.
- Deliberate scalding is common in child abuse cases.
- Forceful immersion is also common.

4. **ELECTROCUTION:**

3.1 Introduction

Electricity is the flow of electrons from atom to atom. Electrons, which comprise the current, are passed along from atom to atom. Every time 6.242 x 1015 electrons pass a given point in 1 second, 1 ampere of current has passed. Electric voltage of 380 volts or less is considered low voltage and above 380 volts, high voltage.

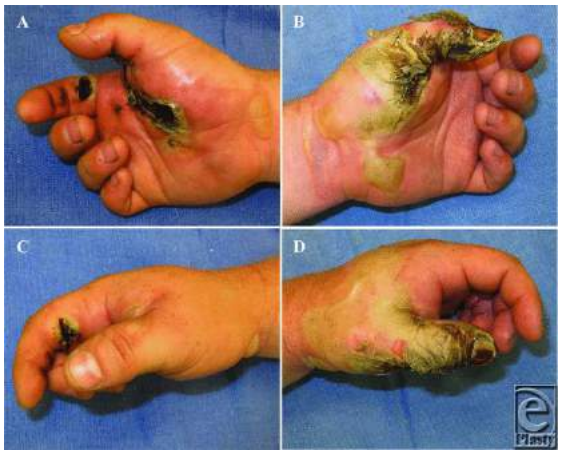


Fig.4: Showing Injury by Electrocution
Source: http://www.eplasty.com/article_images

3.2 Injury by Electrocution:

- Resistance offered by the callused palm may reach 1,000,000 ohms/cm2, while the average resistance of dry normal skin is 5000 ohms/cm2.
- This resistance may decrease to 1000 ohms/cm2 if hands are wet.
- Skin resistance is encountered primarily in the stratum corneum that serves as an insulator for the body.
- Exposure of the skin to 50 volts for 6-7 seconds results in blisters that have a considerably diminished resistance.

3.3 Classification of Electric Burns:

4.3.1 Contact Burns:

- Caused due to close contact with a live electric object.
- The injury may vary from small to charring depending on the length of contact
- The point of entry is a raised blister containing gas or fluid.
- The lesion is often seen on the pads of fingers or thumb.
- Point of exit injury looks like lacerated of punctured wounds.

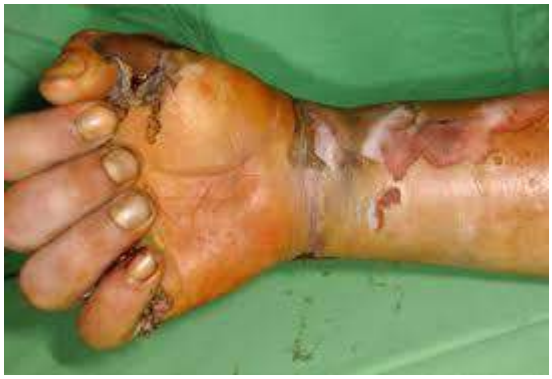


Image 5: Showing contact Burns
Source: https://encrypted-tbn0.gstatic.com/images

4.3.2 Spark Burns

- These are due to poor or intermittent contact with electrical equipment and resistance of dry skin.
- Yellowish parchment like scab formation is seen with a pale halo around it due to capillary contraction.
- These lesions may be multiple.

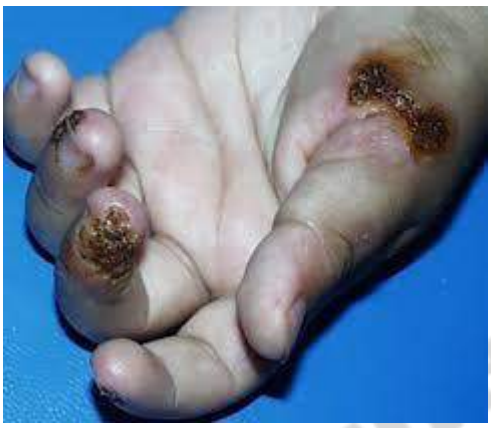


Image 6: Showing spark Burns
Source: https://encrypted-tbn0.gstatic.com/images

4.3.3 Flash Burns

- This is due to contact with very high voltage lines (more than 1000 Volts).
- Commonly seen in lines-men working on grid system.
- Charring of tissues with carbonization is common.
- Arborescent pattern of lightening burn is seen.
- "Crocodile skin effect" is commonly seen

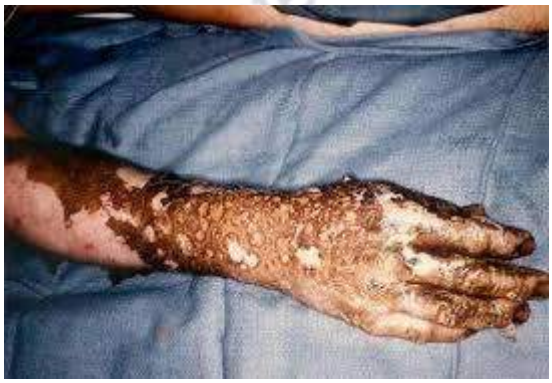


Image 7: Showing Flash burn symptom
Source: https://encrypted-tbn0.gstatic.com/image

3.4 Medicolegal Aspects:

Death by electric currents is usually accidental in nature caused due to defective electric appliances or negligence in the use of equipment. Suicide is rare.

References:

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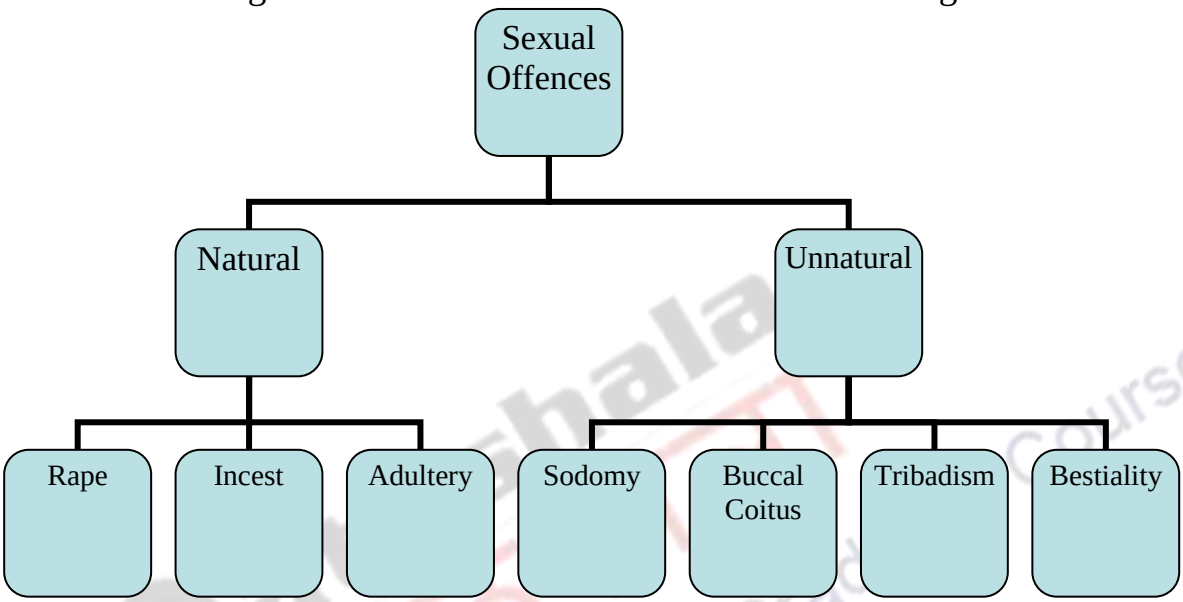
DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Sexual Offences: Natural and unnatural, examination of victim and accused.
Module Id	39
Objectives	Learning Outcome: • To make the learners understand the various types of sexual offences, medico-legal aspects associated with these offences. • To make the learners understand the procedure to examine the victim and accused of these sexual offences. • To understand the Medicolegal aspects of associated with sexual offences.
Prerequisites	General understanding of the human anatomy.
Key words	Forensic Medicine, Medico-legal aspects, Sexual Offences

1. Introduction:

Sexual offences are acts of illegal sexual intercourse with another person or animal to obtain sexual gratification. Sexual offenses are classified as given below:



Rape: As per Section 375 IPC the definition of Rape constitute the following points:

- A man is said to commit rape, when he has sexual intercourse with a woman against her will,
- without her consent,
- with her consent, when her consent has been obtained by putting her in fear of death, or of hurt,
- with her consent when the man knows that he is not her husband and that her consent is given because she believes that he is another man to whom she is or believes herself to be lawfully married (as unsoundness of mind or intoxication),
- with or without her consent, when she is under 16 years of age.

Punishment for Rape: As per Section 376 IPC the punishment for rape is as follows:

- May extend from 7 years to life imprisonment and also fine.
- For custodial rape/gang rape: minimum ten years rigorous imprisonment and also fine.

- Sec 228 IPC prohibits disclosure of identity of victim of rape.

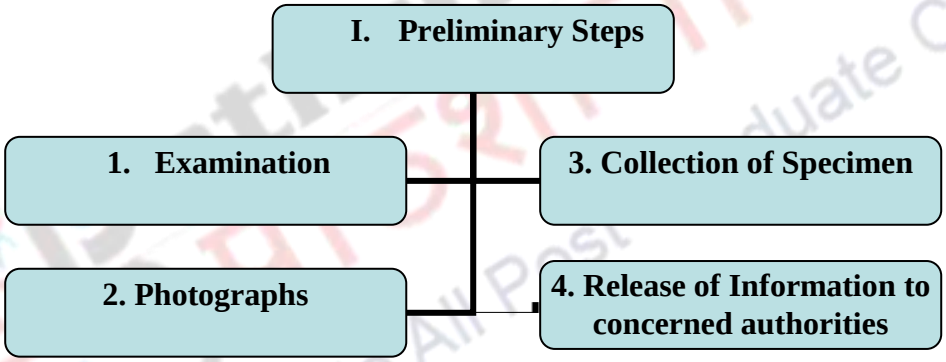
Examination of Victim

The Objective for examination of a rape victim covers the following points:

1. To search for physical signs that will corroborate the history given by the victim.
2. To search for, collect and preserve all trace evidence for laboratory examination.
3. To treat the victim for any injuries and any venereal disease or pregnancy.

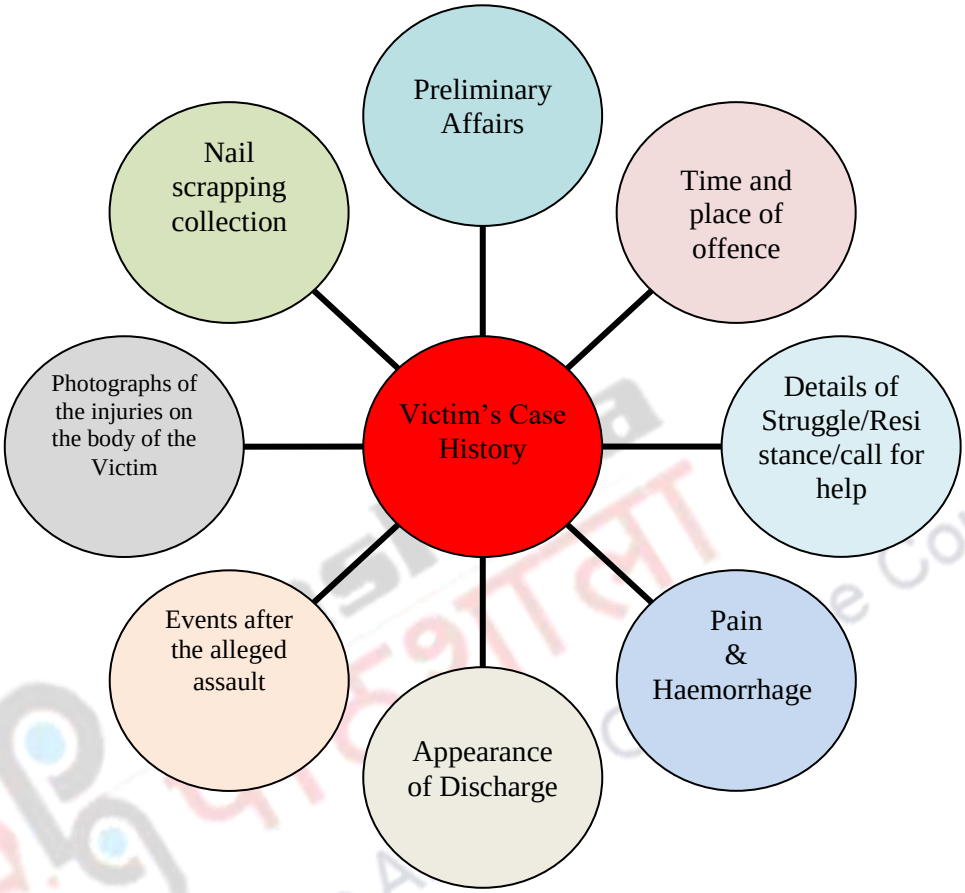
Preliminary steps:
The Examination process of the victim should proceed only when asked by the Police Officer or the Magistrate.

1. The first step is to obtain a written consent from the victim for the following:



NOTE: If the victim is under 12 years, or is insane, written consent has to be obtained from her parents or guardians.

3. Obtain and write history in the victim's words which should include the following:



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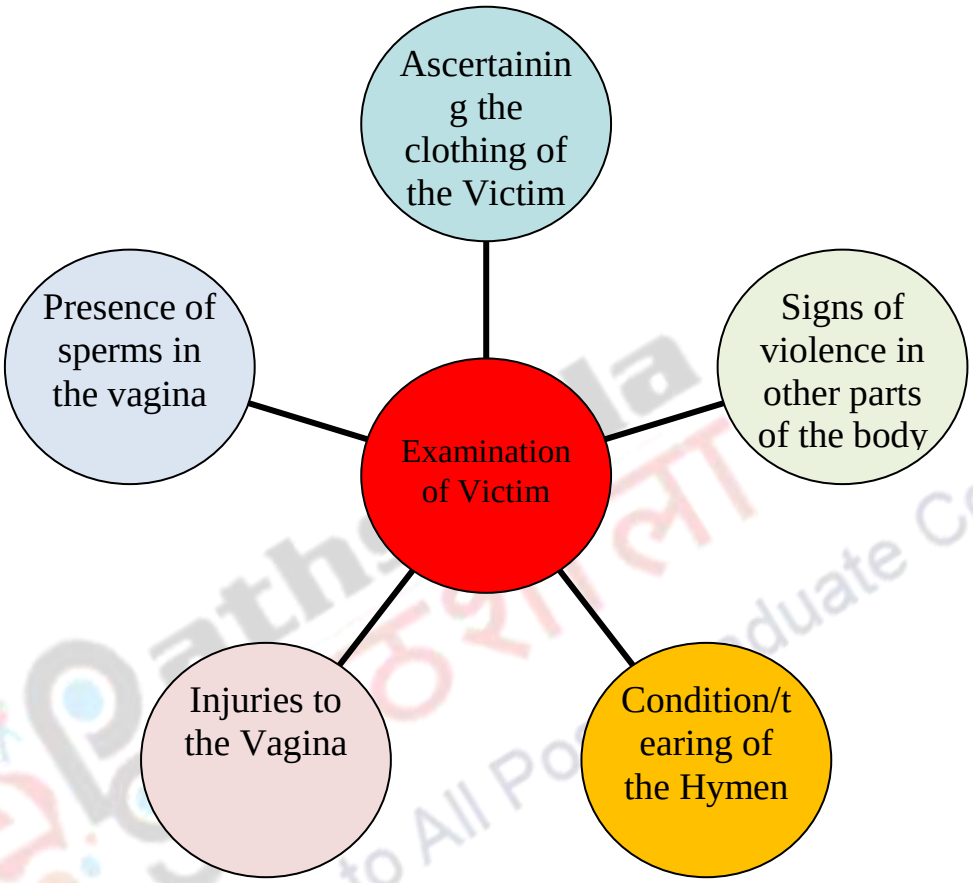
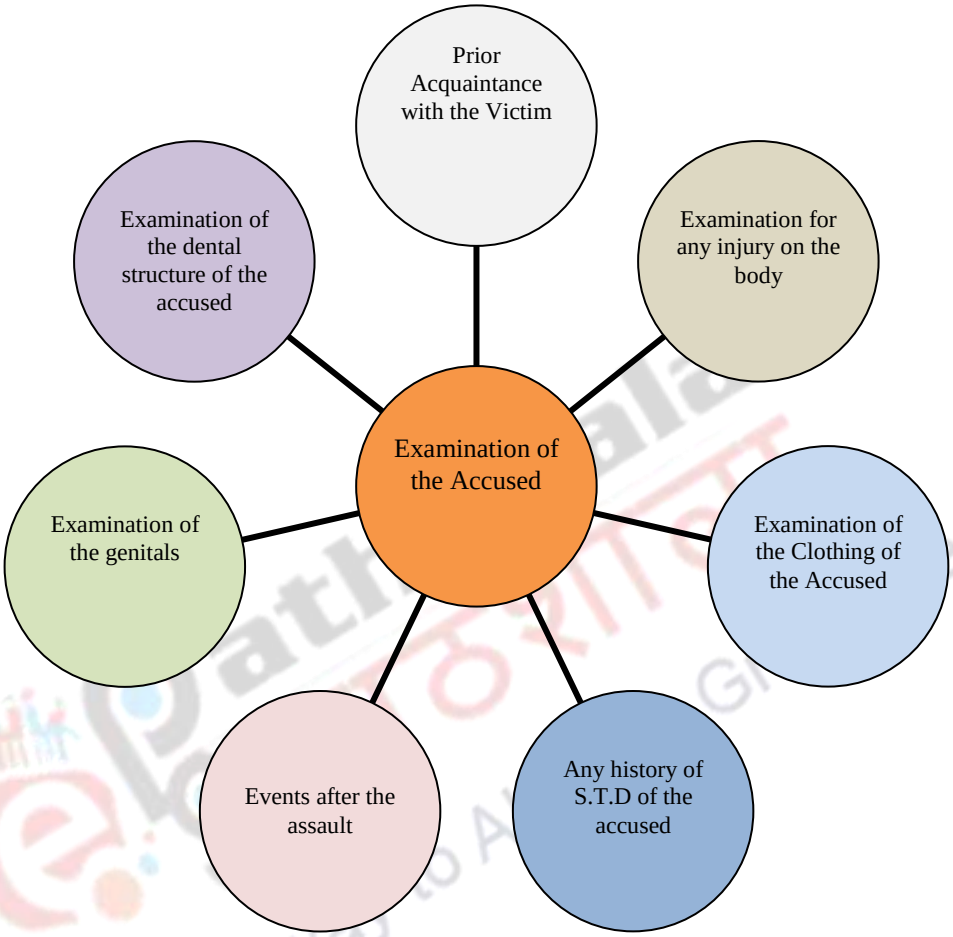
4. **Examination of Clothes**

- Ascertain whether the clothes are those worn at the time of attack.
- The clothing should be retained if possible and labelled and handed over to police.
- Foreign hair, fibers, etc., must be preserved.

5. Examination of the Victim: This aspect should broadly include the followings points:



6. Examination of the Accused:



7. Samples collected for lab examination:

Samples Collected	Purpose
Urethral swabs and smears	For detection of semen, spermatozoa, gonococci, etc
Loose foreign pubic hair or fiber present on the body of accused.	For correlation with the event and the victim
Stains of semen, blood, mud, grass or other foreign materials on the body of the accused.	For correlation with the event and the place of occurrence.
Penile washings	For examining the presence of vaginal epithelia

Nail Scrapings	For examination of tissues embedded in them during struggle
Buccal mucosa swabs	Collected for saliva examination
Urethral swabs	Collected for examination of any venereal disease
Blood	Collected for grouping/serological examinations
X-ray	For age estimation especially in case of delinquency plea

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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Criminology
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Forensic psychiatry: definition, classification, McNaugtens rule
Module Id	40
Objectives	Learning Outcome: • To make the learners understand the various aspects associated with Forensic Psychiatry • To make the learners understand the various types of mental disorders • To understand the importance of legal aspects associated with mental disorders
Prerequisites	General understanding of the human psychology, behaviours and psychiatric disorders.
Key words	Forensic Psychiatry, mental disorders, McNaugtens Rule

1. **Introduction:**

Forensic psychiatry is a branch of medicine which focuses on the interface of law and mental health. It includes psychiatric consultation in a wide variety of legal matters (including expert testimony), as well as clinical work with perpetrators and victims.

A **Psychiatrist** is a medical doctor who has completed several years of additional training in the understanding, diagnosis, and treatment of mental disorders.

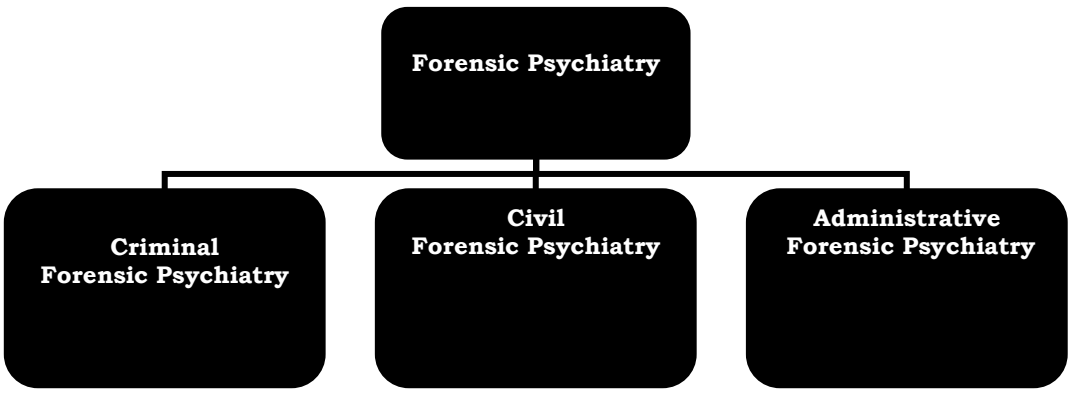
A **Forensic Psychiatrist** is a psychiatrist who has additional training and/or experience related to the interface of mental health (or mental illness) and the law.

The Mental Health Act of 1987 was introduced to consolidate and amend the law relating to the treatment and care of mentally ill persons, to make better provisions with respect to their property and affairs and for matters connected therewith or incidental thereto.

A mentally ill person needs to be restrained for his own safety or for the safety of others. If the lawful guardian of such a patient is unable to keep him under control for any reason, or if there be no guardian at all, the State is legally justified to take charge of such a patient and to put him under restraint.

Restraint may be (1) immediate, or (2) by admission to a psychiatric hospital or registered psychiatric nursing home after certain conditions have been complied with.

Scope of Forensic Psychiatry



- **Competency to Stand Trial**
- **Legal Insanity**
- **Expert Witness/Testifying**
- **Treatment of the mentally ill offender**

- **Personal Injury Cases**
- **Domestic relations matters**
- **Testamentary capacity**
- **Testimonial capacity**
- **Competency to vote**

- **Confidentiality**
- **Privileged Communications**
- **Privacy issues**
- **Right to treatment**
- **Commitment or Involuntary hospitalization**

Classification of Mental Disorders

- Mental Retardation (mental sub normality, mental handicap)
- Organic Psychoses
  - Dementia
  - Drug induced psychoses
  - Confusional states and psychoses following epilepsy, pregnancy and child birth, trauma, and general diseases.
- Functional Psychoses
  - Schizophrenia
  - Paranoid States
  - Affective disorders (mania, depression)
- Neurotic Disorders
- Personality disorders (e.g., sociopathic personality)
- Sexual deviations

Classification and Diagnosis of Mental Illnesses

- In 1952, the American Psychiatric Association first published the Diagnostic and Statistical Manual of Mental disorders (DSM-I). The latest edition, DSM-IV was published in 1994.
- The International Classification of Disease, 10th Revision, Clinical Modification (ICD-10-CM), published by World Health Organization.
- Diagnostic methods:
  - Computed Tomography (CT)
  - Magnetic Resonance Imaging (MRI)
  - Positron Emission Tomography (PET)

1. Dementia

- Dementia is described as a deterioration of intellectual function and other cognitive skills, leading to a decline in the ability to perform activities of daily living.
- Prevalence increases rapidly with age; it doubles every 5 years after age 60.
- Alzheimer's disease and vascular dementias are the two most common types, accounting for up to 90% of cases of established dementia in about a 2:1 ratio.

Signs and Symptoms

- Steady, inexorable decline in intellectual function over 2 to 10 years, culminating in total dependence and death, often due to infection.
- Most common symptom is diminished short memory.
- Other symptoms include personality changes, emotional liability, and poor judgment.
- Occurrence of mood swings, depression and euphoria.

Diagnosis

Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) criteria for dementia:

- Impairment of memory
- Impairment of at least one other domain of cognition.
- The key to diagnosis is a thorough history.
- Detailed drug review (over-the-counter drugs & ophthalmic preparations).
- History of alcohol to be obtained.
- Screening set of laboratory tests (e.g. CBC, electrolytes, albumin, renal function, liver function, thyroid function, vitamin B12 levels).
- Dynamic imaging of cerebral blood flow by single photon emission computed tomography (SPECT).
- Neuropsychological testing.

Psychosis

- Psychosis is a generic term for mental states in which the components of rational thought and perception are severely impaired.
- Particularly associated with schizophrenia, bipolar disorder and severe clinical depression.
- It should be distinguished from the concept of insanity and psychopathy.
- Also to be distinguished from the state of delirium and mental illness.

Causes

- Physical Circumstances (Electrolyte disorder, urinary tract infections).
- Mental Illness (Bipolar disorder and schizophrenia).
- Drug Use (Amphetamines, LSD, PCP, Cocaine or scopolamine).
- Chronic psychological stress.
- Withdrawal from CNS depressant drugs (Alcohol and Benzodiazepines).

Signs and Symptoms

- Hallucinations
- Delusions and paranoia
- Thought disorder
- Lack of insight

Diagnosis

- Pneumoencephalography in 1935 to obtain the first brain image of person with psychosis.
- Grey matter reduction in cortex of people with psychosis.
- Sensory perceptions active during psychosis.
- Increased activation in the right hemisphere of the brain.

2. Delirium

- Delirium is not a disease, but it develops as the result of a medical condition.
- Acute means that it happens suddenly.
- Change in thinking or consciousness develops over a few hours or days.
- Patient may die from exhaustion in a week or two.

Signs and Symptoms

- Patient seems less aware of the environment.
- Memory may be affected.
- Trouble speaking or understanding.
- Delusions and hallucinations common.
- Restlessness and irritability.
- Mood swings and sleeplessness.

Causes

- Severe infections and high fevers.
- Dehydration.
- Diseases of the kidney or liver.
- Lack of certain vitamins.
- Hormonal imbalances.
- Lack of oxygen.
- Head injury.
- Reaction to drugs, alcohol, or prescription medications.
- After surgery effects.

3. Schizophrenia

- Schizophrenia is derived from the Greek words ‘schizo’ (split) and ‘phren’ (mind) and was coined by Eugene Bleuler to refer to the lack of interaction between thought processes and perception.
- Severe mental illness characterized by persistent defects in the perception or expression of reality.
- Schizophrenia does not involve a person changing among distinct multiple personalities.
- Onset of schizophrenia typically occurs in late adolescence or early adulthood, with males tending to show symptoms earlier than females.

Causes

- Stressful life events
- Drug usage
- Use of stimulant or hallucinogenic drugs
- Cannabis use
- Smoking tobacco

Diagnosis

- Significant Loss of Brain Gray Matter

- Coronal MR scans
- Decreased Prefrontal Brain Function
- Enlarged Ventricles in the Brain
- Decreased brain activity

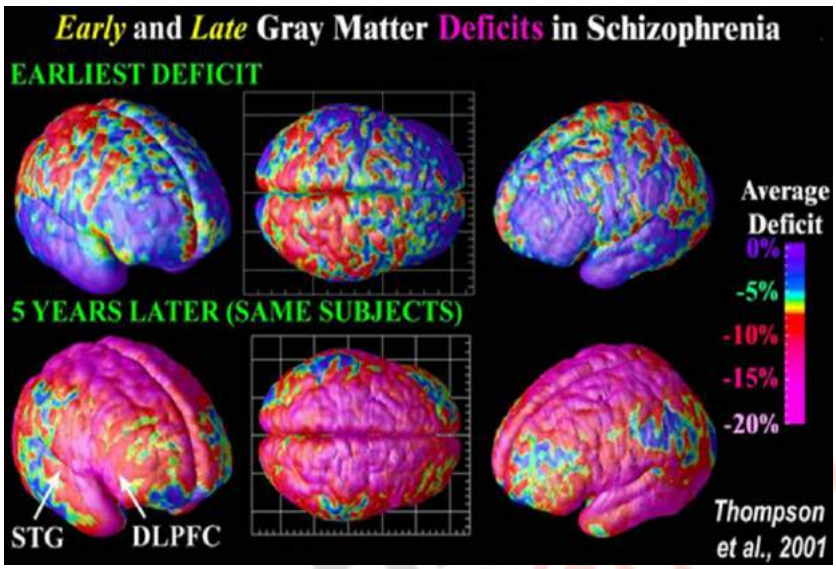


Figure 1: Showing Significant loss of brain gray matter

McNaghten's Rules

Daniel McNaghten killed the Prime Minister's Secretary by mistake for the Prime Minister under an insane belief that the Government was persecuting him. He was tried and acquitted on the ground of insanity and committed to Bethlehem Hospital. The House of Lords then sent a number of questions to the judges of England, who returned answers in the form of rules which are reported in 10 C. & F. 200. The salient points covered under the McNaughten's Rules are as follows:

- Persons acting under the influence of an insane delusion are punishable if they knew at the time of committing the crime that they were acting contrary to law.
- Every man is presumed sane and to have sufficient reason to be held responsible for his crimes.
- To establish a defense on the ground of insanity it must be clearly proved that, at the time of committing the act, the accused was laboring under such a defect of reason, from disease of the mind, as not to know the nature and quality of the act he was doing or, if he did know it, that he did not know he was doing what was wrong. If the accused was conscious that the act was

one that he ought not to do, and if the act was at the same time contrary to the law of the land, he is punishable.

- A person under a partial delusion is to be considered as if the facts with respect to which the delusion exists were real.

Legal Test of Insanity

Section 84 IPC: Nothing is an offence which is done by a person who at the time of doing it is by reason of unsoundness of mind, incapable of knowing the nature of the act, or that he is doing what is either wrong or contrary to law.

References :

1. Davidson, A.H., Forensic Psychiatry, 2nd ed., Ronald Press, New York, 1965
2. Heilbrun, K., The role of psychological testing in forensic assessment, Law Human Behav., 16, aa257, 1992
3. Hess, A.K. and Weiner, I.B., Handbook of forensic Psychology, 2nd Ed., John Wiley & Sons, New York, 1999.
4. APA, Issues in Forensic Psychiatry, American Psychiatric Association Press, Washignton, D.C., 1984.
5. Simon, R.I., Clinical Psychoiatry and the Law. 2d ed., American Psychiatric Press, Washignton, D.C., 1992
6. Stone, A.A., Mental Health and Law. A System in Transition, Crime and Delindquency Series, NIMH, Rockville, MD., 1975.

GALGOTIAS UNIVERSITY
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CREATING KNOWLEDGE

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Uttar Pradesh 203201, India

Sr no	Name of the teacher	Name of the module developed	Platform on which module is developed	Date of launching e content	Link to the relevant document and facility available in the institution
1.	Dr. A Ram Pandey	Society and Media	SWAYAM	2019-20	https://swayam. gov. in/nd2_cec20_ge36/preview
2.	Dr. Harish Kumar	Gender & Contemporary Issues	SWAYAM	2019-20	https://youtu. be/_vKTyr4x1Eg

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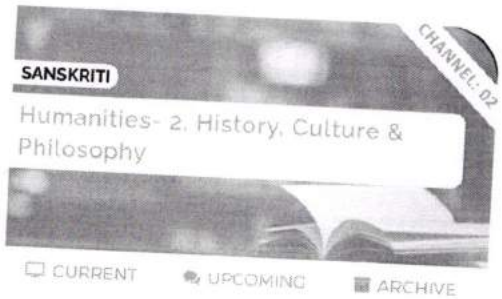

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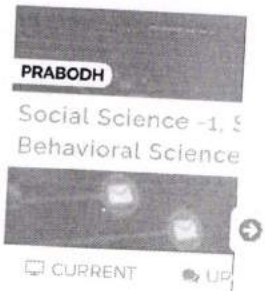

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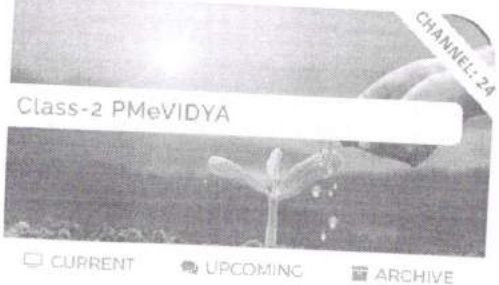

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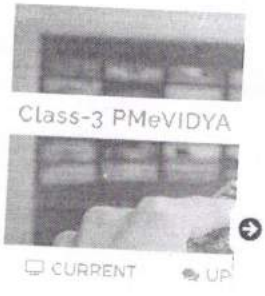

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GAUTAM BUDDHA UNIVERSITY
Uttar Pradesh

Gmail

Dr.Shrikant Dwivedi <shree280@gmail.com>

(no subject)

5 messages

Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>
Reply-To: Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>
To: "Dr.Shrikant Dwivedi" <shree280@gmail.com>

Mon, Feb 4, 2019 at 2:24 PM

F-90-1.63/2018/NIOS/Acad./TE/
December 31, 2018

Sir,

As you may be aware that NIOS has started a **Live Telecast for the D.El.Ed Programme** which is being transmitted on the **SWAYAM Prabha** DTH Channel no 32. The timing of the telecast is Monday to Friday 3:00 pm to 5:00 pm (two hours).

Being an experienced person in the field of Teacher Education, we request for your expertise in this Live Telecast of D.El.Ed. Programme on **February 05-06, 2019** in the Media Unit, 6th Floor, NIOS HQ, NOIDA at 3:00 pm to 5:00 pm. Kindly be present by 2:00 pm for the preparation of this Programme. Please prepare PPTs for your topic following the prescribed format as mentioned under Note.

We look forward to your cooperation in the matter.

Needless to say, NIOS will reimburse local conveyance and provide a token honorarium.

With Regards,

Yours
sincerely,

(Sanjay Kumar Sinha)

GALGOTIAS UNIVERSITY
Uttar Pradesh

Dr.Sreekant Dwivedi
Professor
Faculty of Education,
Galgotia University
NOIDA

Note: Please ensure that PPTs have Font Heading size 24-30 pnts; Subheading size 22-26 pnts; Body size 20-24 pnts; Frame size full screen 4:3 and fonts must be clear, legible against a soft coloured background with only 4-5 lines in each slide. Also include pictures and visuals to support the content. Mail the final PPTs 1 day prior to your telecast date on vagda@nios.ac.in

With regards
Dr. Kanchan Kachroo

Training Officer(Edu)
NIOS HQs
Kanchankachroo7@gmail.com
M-9654366679

Kanchan Kachroo <kanchan_kachroo@yahoo.co.in> Mon, Feb 4, 2019 at 2:26 PM
Reply-To: Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>
To: "Dr.Shrikant Dwivedi" <shree280@gmail.com>

Sir,
Any person is accompany you plz send the name.
With regards
Dr. Kanchan Kachroo
Training Officer(Edu)
NIOS HQs
Kanchankachroo7@gmail.com
M-9654366679

[Quoted text hidden]

Dr.Shrikant Dwivedi <shree280@gmail.com> Mon, Feb 4, 2019 at 2:27 PM
To: Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>

Co presenter

MD FIROZ ALAM Designation Assistant Education officer NCPUL , Dept ofHigher Education , Ministry of Human Resource Govt. of India Email firozmimt@rediffmail.com Mobile No 9911130633
[Quoted text hidden]

Dr.Shrikant Dwivedi <shree280@gmail.com> Mon, Feb 4, 2019 at 11:05 PM
To: Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>, vagda@nios.ac.in

Plz find attached PPT for Live Telecast 3 to 5 pm slot.
Topic: Learning Resources in Social Sciences
Thanks
[Quoted text hidden]
--
Regards,
Dr. Shri Kant Dwivedi
Associate Professor
School of Education, Galgotias University,
Room No. A-017A, Sec 17 A, Yamuna Expressway,
Greater Noida, G. B. Nagar, (U.P.) - 201308
E Mail: shrikant.dwivedi@galgotiasuniversity.edu.in
Web: *http://www.galgotiasuniversity.edu.in*
Mobile No.- 9911481737

Dr. Shri Kant Dwivedi 05.02.2019.pptx
80K

Dr.Shrikant Dwivedi <shree280@gmail.com> Wed, Feb 6, 2019 at 12:38 PM
To: vagda@nios.ac.in

Plz find attached PPT for Live Telecast 3 to 5 pm slot (06.02.2019).
Topic: Learning Resources and Assessment in Social Sciences
Thanks

[Quoted text hidden]

Dr. Shri Kant Dwivedi 06.02.2019.pptx
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Gmail

Dr.Shrikant Dwivedi <shree280@gmail.com>

LIVE

2 messages

Kanchan Kachroo <kanchan_kachroo@yahoo.co.in> Tue, Jan 8, 2019 at 1:05 PM
Reply-To: Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>
To: "Dr.Shrikant Dwivedi" <shree280@gmail.com>, "firozmimt@rediffmail.com" <firozmimt@rediffmail.com>

Sir,

As per our discussion, I will book a slot for your LIVE Telecast scheduled to be held on **January 09, 2019 (Wednesday).**

The topic for the Telecast will be - **Course Code 509 Assessment in Social Sciences**

Please include the following subtopics in your preparation:

Lecture42 509 Unit 9
Continuous Comprehensive Evaluation

Lecture43 509 Unit 9
Method of evaluation in social sciences based on information recall; understanding, applications and synthesizing

Lecture44 509 Unit 9
Alternative ways to evaluate learning (Port Folio)

Lecture45 509 Unit 9
Basis of evaluation, types of objective based questions, importance of grading and marking system

Kindly prepare your PPTs following the format:
Please ensure that PPTs have Font Heading size 24-30 pnts; Subheading size 22-26 pnts; Body size 20-24 pnts; Frame size full screen 4:3 and fonts must be clear, legible against a soft coloured background with only 4-5 lines in each slide. Also include pictures and visuals to support the content. Mail the final PPTs 1 day prior to your telecast date on vagda@nios.ac.in

Shall mail your Invitation Letters shortly.

With regards
Dr. Kanchan Kachroo
Training Officer(Edu)
NIOS HQs
Kanchankachroo7@gmail.com
M-9654366679

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Dr.Shrikant Dwivedi <shree280@gmail.com> Tue, Jan 8, 2019 at 2:09 PM
To: firozmimt <firozmimt@rediffmail.com>

[Quoted text hidden]

--

Regards,

Dr. Shri Kant Dwivedi
Programme Chair (B.Ed.)
School of Education,Galgotias University
Plot No.2, Sector 17-A
Yamuna Expressway, Greater Noida, Gautam Buddh Nagar,
Uttar Pradesh Pin 201310
Mob.: 9911481737

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Dr.Shrikant Dwivedi <shree280@gmail.com>

LIVE

1 message

Kanchan Kachroo <kanchan_kachroo@yahoo.co.in> Thu, Feb 28, 2019 at 11:20 AM
Reply-To: Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>
To: SATYENDRA GUPTA <satyendra.edn@gmail.com>, "Dr.Shrikant Dwivedi" <shree280@gmail.com>

Sir,

As per our discussion, I will book a slot for your LIVE Telecast scheduled to be held on **March 13, 2019 (Wednesday) from 3:00 pm to 5:00 pm.** You are requested to kindly be present by 2:00 pm for the preparation of the Programme.

The topic for the Telecast will be - **Course Code 507 Unit 12 MANAGEMENT APPROACHES OF SCHOOL AND COMMUNITY PARTNERSHIP**

Please include the following subtopics in your preparation:

Lecture 31 507 Unit 12
Management Approaches – Meaning, nature and scope

Lecture 32 507 Unit 12
Types of approaches man power,
- Cost benefit,
- Social demand,
- Social justice

Lecture 33 507 Unit 12
Relevance of each approach to strengthen school & Community Partnership

Lecture 34 507 Unit 12
Differentiating management and organisation of School-Community Partnership and process of strengthening relationship between the two agencies

Lecture 35 507 Unit 12
Supplementary Material: Video on Cases of Community Mobilisation across states

Kindly prepare your PPTs following the format:
Please ensure that PPTs have Font Heading size 24-30 pnts; Subheading size 22-26 pnts; Body size 20-24 pnts; Frame size full screen 4:3 and fonts must be clear, legible against a soft coloured background with only 4-5 lines in each slide. Also include pictures and visuals to support the content. Mail the final PPTs 1 day prior to your telecast date on vagda@nios.ac.in

With regards
Dr. Kanchan Kachroo
Training Officer(Edu)
NIOS HQs
Kanchankachroo7@gmail.com
M-9654366679

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Dr.Shrikant Dwivedi <shree280@gmail.com>

Invitation for Live Programme on SWAYAM PRABHA DTH CHANNEL

3 messages

manojthakur@nios.ac.in <manojthakur@nios.ac.in>
To: shree280@gmail.com, shrikant.dwivedi@galgotiasuniversity.edu.in
Wed, Mar 18, 2020 at 11:50 AM

Dear Sir,
This is in continuation to our telephonic conversation and your consent,you are invited for live discussion for NIOS SWAYAM PRABHA DTH CHANNEL on 20.03.2020 from 3 PM to 4 PM. You are requested to reach NIOS studio,6th floor, A 24/25, Sector 62, NOIDA by 2.30 PM. Kindly, send ppts by 20.03.2020 (by 11.30 AM) for our media unit for preparation of live programme.

Regards,

Dr. Manoj Thakur
Asst. Director (CBC)

Dr.Shrikant Dwivedi <shree280@gmail.com>
To: manojthakur@nios.ac.in
Cc: shrikant.dwivedi@galgotiasuniversity.edu.in
Wed, Mar 18, 2020 at 1:48 PM

I accept the invitation and will be there on time.
[Quoted text hidden]

Dr.Shrikant Dwivedi <shree280@gmail.com>
To: manojthakur@nios.ac.in
Thu, Mar 19, 2020 at 7:04 PM

Dear Sir
Kindly find Attached PPT for live telecast (3:00 to 4:00 pm)
Topic: Assessment in Education
[Quoted text hidden]
--
Regards,
Dr. Shri Kant Dwivedi
Associate Professor
School of Education, Galgotias University,
Room No. A-017A, Sec 17 A, Yamuna Expressway,
Greater Noida, G. B. Nagar, (U.P.) - 201308
E Mail: shrikant.dwivedi@galgotiasuniversity.edu.in
Web: *http://www.galgotiasuniversity.edu.in*
Mobile No.- 9911481737

Assessment in Education.pptx
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GALGOTIAS UNIVERSITY
Uttar Pradesh

Gmail

Dr.Shrikant Dwivedi <shree280@gmail.com>

LIVE

4 messages

Kanchan Kachroo <kanchan_kachroo@yahoo.co.in> Tue, Feb 19, 2019 at 3:46 PM
Reply-To: Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>
To: "Dr.Shrikant Dwivedi" <shree280@gmail.com>, SATYENDRA GUPTA <satyendra.edn@gmail.com>, SATYENDRA GUPTA <satyendra.gupta@gmail.com>

Sir,

As per our discussion, I will book a slot for your LIVE Telecast scheduled to be held on **February 21, 2019 (Thursday) from 3:00 pm to 5:00 pm.** You are requested to kindly be present by 2:00 pm for the preparation of the Programme.

The topic for the Telecast will be - **Course Code 509 Assessment in Social Sciences**

Please include the following subtopics in your preparation:

Lecture42 509 Unit 9 Continuous Comprehensive Evaluation

Lecture43 509 Unit 9 Method of evaluation in social sciences based on information recall; understanding, applications and synthesizing

Lecture44 509 Unit 9 alternative ways to evaluate learning (Port Folio)

Lecture45 509 Unit 9 basis of evaluation, types of objective based questions, importance of grading and marking system

Kindly prepare your PPTs following the format:
Please ensure that PPTs have Font Heading size 24-30 pnts; Subheading size 22-26 pnts; Body size 20-24 pnts; Frame size full screen 4:3 and fonts must be clear, legible against a soft coloured background with only 4-5 lines in each slide. Also include pictures and visuals to support the content. Mail the final PPTs 1 day prior to your telecast date on vagda@nios.ac.in

With regards
Dr. Kanchan Kachroo
Training Officer(Edu)
NIOS HQs
Kanchankachroo7@gmail.com
M-9654366679

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Dr.Shrikant Dwivedi <shree280@gmail.com> Tue, Feb 19, 2019 at 4:31 PM
To: Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>
Cc: SATYENDRA GUPTA <satyendra.edn@gmail.com>, SATYENDRA GUPTA <satyendra.gupta@gmail.com>

Thanks, I will be there.
[Quoted text hidden]
--
Regards,
Dr. Shri Kant Dwivedi
Associate Professor
School of Education, Galgotias University,
Room No. A-017A, Sec 17 A, Yamuna Expressway,
Greater Noida, G. B. Nagar, (U.P.) - 201308
E Mail: shrikant.dwivedi@galgotiasuniversity.edu.in
Web: *http://www.galgotiasuniversity.edu.in*
Mobile No.- 9911481737

Dr.Shrikant Dwivedi <shree280@gmail.com>
To: firozmimt <firozmimt@rediffmail.com>
Wed, Feb 20, 2019 at 10:31 AM

Please include the following subtopics in your preparation:

Lecture42 509 Unit 9 Continuous Comprehensive Evaluation

Lecture43 509 Unit 9 Method of evaluation in social sciences based on information recall; understanding, applications and synthesizing

Lecture44 509 Unit 9 alternative ways to evaluate learning (Port Folio)

Lecture45 509 Unit 9 basis of evaluation, types of objective based questions, importance of grading and marking system

[Quoted text hidden]

Dr.Shrikant Dwivedi <shree280@gmail.com>
To: Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>, vagda@nios.ac.in
Thu, Feb 21, 2019 at 9:52 AM

Plz find attached PPT for Live Telecast 3 to 5 pm slot (21.02.2019).
Thanks & Regards

On Tue, Feb 19, 2019 at 3:46 PM Kanchan Kachroo <kanchan_kachroo@yahoo.co.in> wrote:
[Quoted text hidden]

[Quoted text hidden]

Dr. Shri Kant Dwivedi 21.02.2019.pptx
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Dr.Shrikant Dwivedi <shree280@gmail.com>

LIVE dated July 11, 2019

2 messages

Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>
Reply-To: Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>
To: "Dr.Shrikant Dwivedi" <shree280@gmail.com>

Wed, Jul 10, 2019 at 1:43 PM

Sir,

As per our discussion, we extend our invitation for your LIVE Telecast scheduled to be held on **July 11, 2019 from 3:00 pm to 5:00 pm.** You are requested to kindly be present by 2:00 pm for the preparation of the Programme.

1) Dr. Shrikant Dwivedi
2) Md. Firoz Alam

The topic for the Telecast will be from Course Code 507 Unit 4 **PROVISIONS FOR COMMUNITY PARTICIPATION UNDER SSA AND RTE**

Please ensure the following subtopics are covered in your presentation:

Lecture 7 507 Unit 4
Policy provision, Role of parent teacher association/ mother teacher association, School Management Committee; Self help group

Lecture 8 507 Unit 4
Main objectives of Panchayati Raj and their role as an institution in EE

Lecture 9 507 Unit 4
EE and partnership with community (pros and cons), Experiences and research studies

Kindly prepare your PPTs following the format:
Please ensure that PPTs have Font Heading size 24-30 pnts; Subheading size 22-26 pnts; Body size 20-24 pnts; Frame size full screen 4:3 and fonts must be clear, legible against a soft coloured background with only 4-5 lines in each slide. Also include pictures and visuals to support the content. Mail the final PPTs 1 day prior to your telecast date on vagda@nios.ac.in

With regards
Dr. Kanchan Kachroo
Training Officer(Edu)
NIOS HQs
Kanchankachroo7@gmail.com
M-9654366679

GALGOTIAS UNIVERSITY Uttar Pradesh

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Dr.Shrikant Dwivedi <shree280@gmail.com>
To: Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>, vagda@nios.ac.in

Thu, Jul 11, 2019 at 11:43 AM

PFA

[Quoted text hidden]

--

Regards,
Dr. Shri Kant Dwivedi
Associate Professor
School of Education, Galgotias University,
Room No. A-017A, Sec 17 A, Yamuna Expressway,
Greater Noida, G. B. Nagar, (U.P.) - 201308
E Mail: shrikant.dwivedi@galgotiasuniversity.edu.in
Web: *http://www.galgotiasuniversity.edu.in*
Mobile No.- 9911481737

Dr. Shri Kant Dwivedi 11.07.2019 Provisions for Community Participation Under SSA and RTE.pptx
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Uttar Pradesh

Gmail

Dr.Shrikant Dwivedi <shree280@gmail.com>

LIVE dated October 14, 2019

3 messages

Kanchan Kachroo <kanchan_kachroo@yahoo.co.in> Thu, Oct 10, 2019 at 5:04 PM
Reply-To: Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>
To: SATYENDRA GUPTA <satyendra.edn@gmail.com>, "Dr.Shrikant Dwivedi" <shree280@gmail.com>, SATYENDRA GUPTA <satyendra.gupta@gmail.com>

Sir,

As per our discussion, we extend our invitation for your LIVE Telecast scheduled to be held on **October 14, 2019 (Monday) from 3:00 pm to 5:00 pm.** You are requested to kindly be present by 2:00 pm for the preparation of the Programme.

1) Dr. Satyendra Gupta
2) Dr. Shrikant Dwivedi

Kindly confirm the Topic selected.

Kindly prepare your PPTs following the format:
Please ensure that PPTs have Font Heading size 24-30 pnts; Subheading size 22-26 pnts; Body size 20-24 pnts; Frame size full screen 4:3 and fonts must be clear, legible against a soft coloured background with only 4-5 lines in each slide. Also include pictures and visuals to support the content. Mail the final PPTs 1 day prior to your telecast date on vagda@nios.ac.in

With regards
Dr. Kanchan Kachroo
Training Officer(Edu)
NIOS HQs
Kanchankachroo7@gmail.com
M-9654366679

Dr.Shrikant Dwivedi <shree280@gmail.com> Fri, Oct 11, 2019 at 11:19 AM
To: Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>

Thanks mam for your invitation. I am selecting topic from **block 502** for LIVE Telecast scheduled to be held on **October 14, 2019 (Monday) from 3:00 pm to 5:00 pm.**

Topic: Integrated Learning and Teaching Process.

Thanks again for giving this opportunity.

[Quoted text hidden]

--

Regards,
Dr. Shri Kant Dwivedi
Associate Professor
School of Education, Galgotias University,
Room No. A-017A, Sec 17 A, Yamuna Expressway,

GALGOTIAS UNIVERSITY
Uttar Pradesh

Greater Noida, G. B. Nagar, (U.P.) - 201308
E Mail: shrikant.dwivedi@galgotiasuniversity.edu.in
Web: *http://www.galgotiasuniversity.edu.in*
Mobile No.- 9911481737

Dr.Shrikant Dwivedi <shree280@gmail.com> Sun, Oct 13, 2019 at 9:34 PM
To: Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>, vagda@nios.ac.in
Cc: SATYENDRA GUPTA <satyendra.edn@gmail.com>
Bcc: shrikant.dwivedi@galgotiasuniversity.edu.in

Dear Sir/Mam
Please find attached PPT for Live Telecast 3 to 5 pm slot (14.10.2019).
Topic:Integrated Learning and Teaching Process
Thanks
[Quoted text hidden]

14.10.2019 Integrated Learning and Teaching Process.pptx
90K

GALGOTIAS UNIVERSITY
Uttar Pradesh

Gmail

Dr.Shrikant Dwivedi <shree280@gmail.com>

LIVE dated October 21, 2019

3 messages

Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>
Reply-To: "kanchan_kachroo@yahoo.co.in" <kanchan_kachroo@yahoo.co.in>
To: "Dr.Shrikant Dwivedi" <shree280@gmail.com>

Fri, Oct 18, 2019 at 1:20 PM

Sent from Yahoo Mail

Sir,

As per our discussion, we extend our invitation for your LIVE Telecast scheduled to be held on **October 21,2019 (Monday) from 3:00 pm to 5:00 pm.** You are requested to kindly be present by 2:00 pm for the preparation of the Programme.

1) Dr. Shrikant Dwivedi
2)Ms. Deepa Bisht

Kindly confirm the Topic selected.
Topic Contextualising learning processes of disadvantaged learners
Block 2

Kindly prepare your PPTs following the format:
Please ensure that PPTs have Font Heading size 24-30 pnts; Subheading size 22-26 pnts; Body size 20-24 pnts; Frame size full screen 4:3 and fonts must be clear, legible against a soft coloured background with only 4-5 lines in each slide. Also include pictures and visuals to support the content. Mail the final PPTs 1 day prior to your telecast date on vagda@nios.ac.in

With regards
Dr. Kanchan Kachroo
Training Officer(Edu)
NIOS HQs
Kanchankachroo7@gmail.com
M-9654366679

GALGOTIAS UNIVERSITY
Uttar Pradesh

Dr.Shrikant Dwivedi <shree280@gmail.com>
To: Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>

Fri, Oct 18, 2019 at 1:31 PM

Thanks for the mail.
[Quoted text hidden]

Dr.Shrikant Dwivedi <shree280@gmail.com>
To: depabist@gmail.com

Fri, Oct 18, 2019 at 1:34 PM

[Quoted text hidden]

Gmail

Dr.Shrikant Dwivedi <shree280@gmail.com>

LIVE dated Sep 30, 2019

2 messages

Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>
Reply-To: Kanchan Kachroo <kanchan_kachroo@yahoo.co.in>
To: "Dr.Shrikant Dwivedi" <shree280@gmail.com>
Mon, Sep 30, 2019 at 12:48 PM

Sir,

As per our discussion, we extend our invitation for your LIVE Telecast scheduled to be held on **September 30, 2019 (Monday) from 3:00 pm to 5:00 pm.** You are requested to kindly be present by 2:00 pm for the preparation of the Programme.

1) Dr. Shrikant Dwivedi
2) Ms. Deepa Bisht

The topic for the Telecast will be from **Course Code 507 Community and School**

Kindly prepare your PPTs following the format:
Please ensure that PPTs have Font Heading size 24-30 pnts; Subheading size 22-26 pnts; Body size 20-24 pnts; Frame size full screen 4:3 and fonts must be clear, legible against a soft coloured background with only 4-5 lines in each slide. Also include pictures and visuals to support the content. Mail the final PPTs 1 day prior to your telecast date on vagda@nios.ac.in

With regards
Dr. Kanchan Kachroo
Training Officer(Edu)
NIOS HQs
Kanchankachroo7@gmail.com
M-9654366679

Dr.Shrikant Dwivedi <shree280@gmail.com>
To: depabist@gmail.com
Mon, Sep 30, 2019 at 12:56 PM

[Quoted text hidden]

GALGOTIAS UNIVERSITY Uttar Pradesh

दूरभाष: 0120-4089899 • फैक्स: 0120-4626902
राष्ट्रीय मुक्त विद्यालयी शिक्षा संस्थान
आईएसओ 9001:2008 प्रमाणित
(मा.सं.वि.मं., भारत सरकार के अधीन एक स्वायत्त संस्था)
ए-24-25, इंस्टीट्यूशनल एरिया, एन. एच. - 24
सेक्टर-62, नोएडा, जिला गौतम बुद्ध नगर (उ.प्र.)

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ISO 9001:2008 Certified
(An autonomous Institution Under MHRD, Govt. of India)
A-24-25, Institutional Area, NH-24, Sector-62
NOIDA, Distt. - Gautam Buddha Nagar (U.P.)

संजय कुमार सिन्हा
निदेशक (शैक्षिक)
Sanjay Kumar Sinha
Director (Academic)

Web Site: www.nios.ac.in
E-mail: diracad@nios.ac.in

F-90-1.41/2016/NIOS/Acad./TE/
May 25, 2018

Sir,

As you may be aware, NIOS is developing Video Lectures for Diploma in Elementary Education (D.El.Ed.) Programme which are being telecast on the DTH Channel No. 32, **Swayam Prabha.**

Being an experienced person in the field of Teacher Education, we would request you to record the Video Lectures of D.El.Ed. Programme Course no-507 Titled "**Community and Elementary Education**" on **June 14-15, 2018** in the Media Unit, 6th Floor, NIOS HQs, Noida at 10:00 am. It is requested that you please bring PPTs and some related videos of the topic assigned to you. Please prepare PPTs for your topic following the prescribed format as mentioned under Note.

We look forward to your cooperation in the matter.

Needless to mention, NIOS will reimburse local conveyance and provide a token honorarium.

With regards,

Yours sincerely,

(Sanjay Kumar Sinha)

Dr. Srikant Dwivedi
Asst, Professor
Galgotia University
NOIDA

Note: Please ensure that PPTs have Font Heading size 24-30 pnts; Subheading size 22-26 pnts; Body size 20-24 pnts; Frame size full screen 4:3 and fonts must be clear, legible against a soft coloured background with only 4-5 lines in each slide. Also include pictures and visuals to support the content. Ensure that the Hindi Font Kruti Dev (010) is used for PPTs. Kindly mail the final PPTs 1 day prior to your telecast date on vagda@nios.ac.in.

GALGOTIAS UNIVERSITY Uttar Pradesh

दूरभाष: 0120-4089899 • फैक्स: 0120-4626902
राष्ट्रीय मुक्त विद्यालयी शिक्षा संस्थान
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ए-24-25, इंस्टीट्यूशनल एरिया, एन. एच. - 24
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Sanjay Kumar Sinha
Director (Academic)

Web Site: www.nios.ac.in
E-mail: diracad@nios.ac.in

F-90-1.63/2018/NIOS/Acad./TE
November 30, 2018

Sir,

As you may be aware that NIOS has started a **LIVE Radio Counselling for the D.El.Ed Programme** which is being transmitted on **Radio Vahini** FM Channel station 91.2 MHz. The timing of the Radio Programme is Monday to Friday 2:45 pm to 3:30 pm (45 minutes).

Being an experienced person in the field of Teacher Education, we request for your expertise in this Live Radio Counselling of D.El.Ed. Programme on **December 06, 2018** in the Media Unit, 6th Floor, NIOS HQ, NOIDA at 2:45 pm to 3:30 pm. Kindly be present by 2:00 pm for the preparation of this Programme.

We look forward to your cooperation in the matter.

Needless to say, NIOS will reimburse local conveyance and provide a token honorarium.

With Regards,

Yours sincerely,

(Sanjay Kumar Sinha)

Dr. Shri Kant Dwivedi
Program Chair (B.Ed)
School of Education
Galgotias University, Greater Noida

GALGOTIAS UNIVERSITY ★ Uttar Pradesh ★

Note: The Radio Counselling Programme is also available on NIOS web radio portal www.nios.iradiondia.

GALGOTIAS UNIVERSITY

Uttar Pradesh

CREATING KNOWLEDGE

E-content developed by Teachers

3. For other MOOCs platforms (NIOS)

Galgotias University

Plot No. 2, Yamuna Expressway,
Opposite, Buddha International Circuit,
Sector 17A, Greater Noida,
Uttar Pradesh 203201, India

Sr no	Name of the teacher	Name of the module developed	Platform on which module is developed	Date of launching e content	Link to the relevant document and facility available in the institution
1.	Dr. Satyendra Gupta	D. El. Ed. 503 Learning- The Concept and Process	National Institute of Open Schooling (NIOS)	5-Nov-18	https://youtu. be/7JsY0AxTHzc
2.	Dr. Satyendra Gupta	D. El. Ed. 501 Universalization of Elementary Education	National Institute of Open Schooling (NIOS)	17-May-18	https://youtu. be/-dbn5UL1Iew
3.	Dr. Satyendra Gupta	D. El. Ed. 504 Learner and Learning Centered Methodologies- I	National Institute of Open Schooling (NIOS)	18-Jun-18	https://youtu. be/sB6W9eW-Hcc
4.	Dr. Satyendra Gupta	D. El. Ed. 504 Learner and Learning Methodologies	National Institute of Open Schooling (NIOS)	7-Jun-18	https://youtu. be/lWpHAtYpE9M
5.	Dr. Satyendra Gupta	D. El. Ed. 504 Pedagogy of Mathematics	National Institute of Open Schooling (NIOS)	13-Jul-18	https://youtu. be/_nT5rpLlvCg
6.	Dr. Satyendra Gupta	D. El. Ed. 504 Data Handling	National Institute of Open Schooling (NIOS)	27-Aug-18	https://youtu. be/L1q5MRb5rww
7.	Dr. Satyendra Gupta	D. El. Ed. Data Handling and Measures of Central Tedency	National Institute of Open Schooling (NIOS)	9-Oct-18	https://youtu. be/AOADulLOQ0M
8.	Dr. Satyendra Gupta	D. El. Ed. 506 Development of Personality and Assessment	National Institute of Open Schooling (NIOS)	19-Nov-18	https://youtu. be/tE2Rs7ep-QY
9.	Dr. Satyendra Gupta	D. El. Ed. 509 Nature of Social Science	National Institute of Open Schooling (NIOS)	26-Dec-18	https://youtu. be/c1neGi4kooU
10.	Dr. Satyendra Gupta	D. El. Ed. Teaching Learning Strategies	National Institute of Open Schooling (NIOS)	2-Nov-19	https://youtu. be/gfDtoe1dhWc
11.	Dr. Satyendra Gupta	D. El. Ed. 510 Different Approaches to Teaching of Science	National Institute of Open Schooling (NIOS)	25-Feb-19	https://youtu. be/84WhQHov71s
12.	Dr. Satyendra Gupta	D. El. Ed. 501 Strategies for UEE-I	National Institute of Open Schooling (NIOS)	4-Mar-19	https://youtu. be/znDIXSLPsbQ
13.	Dr. Satyendra Gupta	D. El. Ed. 504 Learner Assessment in Mathematics	National Institute of Open Schooling (NIOS)	25-Apr-19	https://youtu. be/gcuB8kGaYD8
14.	Dr. Satyendra Gupta	D. El. Ed. 504 Characteristics of Learning Centred Approach	National Institute of Open Schooling (NIOS)	30-Apr-19	https://youtu. be/_UaEJmfnlao

15.	Dr. Satyendra Gupta	D. El. Ed. 504 Follow up of Assessment of Learning Mathematics	National Institute of Open Schooling (NIOS)	7-Jan-20	https://youtu. be/-GnRI0YcLsA
16.	Dr. Satyendra Gupta	D. El. Ed. Teacher's Training, Emerging Trends in Assessment	National Institute of Open Schooling (NIOS)	14-Feb-20	https://youtu. be/JKWSr2Ik7Hs
17.	Dr. Satyendra Gupta, Dr Navita Malik	D. El. Ed. 506 Introduction of Inclusive Education	National Institute of Open Schooling (NIOS)	14-Jun-19	https://youtu. be/7c0rZrJx4Vo
18.	Dr. Satyendra Gupta, Dr. Shri Kant Dwivedi	D. El. Ed. Management Approaches of School & Community Partnership	National Institute of Open Schooling (NIOS)	13-Mar-19	https://youtu. be/TIY_QwGut2M
19.	Dr. Shri Kant Dwivedi	D. El. Ed. Course-507 विभिन्न राज्यों में सामुदायिक भागीदारी के प्रयास	National Institute of Open Schooling (NIOS)	14-Jun-18	https://youtu. be/MC6Bm4IrlT8
20.	Dr. Shri Kant Dwivedi	D. El. Ed. Course-507 शिक्षा का अधिकार आधारित उपागम	National Institute of Open Schooling (NIOS)	14-Jun-18	https://youtu. be/h0jss75hGpg
21.	Dr. Shri Kant Dwivedi	D. El. Ed. Course-507 शिक्षार्थियों के भाषा विकास पर समुदाय का प्रभाव	National Institute of Open Schooling (NIOS)	14-Jun-18	https://youtu. be/mX--SaStXwo
22.	Dr. Shri Kant Dwivedi	D. El. Ed. Course-507 सूक्ष्म नियोजन में समुदाय की भूमिका	National Institute of Open Schooling (NIOS)	15-Jun-18	https://youtu. be/PwHU4tL5SnE
23.	Dr. Shri Kant Dwivedi	D. El. Ed. Course-507 स्थानीय संसाधनों की पहचान और प्रचलन में समुदाय की भूमिका	National Institute of Open Schooling (NIOS)	15-Jun-18	https://youtu. be/I0nxX9h5Uig
24.	Dr. Shri Kant Dwivedi	D. El. Ed. Assessment in Social Sciences	National Institute of Open Schooling (NIOS)	9-Jan-19	https://youtu. be/2_Oo-n5-EJI
25.	Dr. Shri Kant Dwivedi	D. El. Ed. Learning Resources in Social Sciences	National Institute of Open Schooling (NIOS)	5-Feb-19	https://youtu. be/bdaVxzgIy-0
26.	Dr. Shri Kant Dwivedi	D. El. Ed. Learning Resources and Assessment in Social Sciences	National Institute of Open Schooling (NIOS)	2-Jun-19	https://youtu. be/tJjI-6dE150
27.	Dr. Shri Kant Dwivedi	D. El. Ed. Assessment in Social Sciences	National Institute of Open Schooling (NIOS)	21-Feb-19	https://youtu. be/hsdXES4bGlg

28.	Dr. Shri Kant Dwivedi	D. El. Ed. Contextualizing Learning Processes of Disadvantaged Learners	National Institute of Open Schooling (NIOS)	21-Oct-19	https://youtu.be/BEr5mqOknIQ
29.	Dr. Shri Kant Dwivedi	D. El. Ed. Teacher's Training, Assessment in Education	National Institute of Open Schooling (NIOS)	20-Mar-20	https://youtu.be/IGScqZNHY-Q

4. For other MOOCs platforms

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24.07.2019

CERTIFICATE

This is to certify that Dr. Agya Ram Pandey has contributed the following modules as the First Author in the Unit "Media, Society and Social Change" under Massive Open Online Courses (MOOCs) programme "Society and Media", sponsored by University Grants Commission (UGC), SWAYAM, Ministry of Human Resource Development, Govt. of India.

The title of the module is as follows:

1. Media and the Alternate Paradigms of Change (With 4 Quadrants)

Dr. Durgesh Tripathi
Assistant Professor
University School of Mass Communication
Guru Gobind Singh Indraprastha University
and Course Coordinator
Society and Media, MOOCs, UGC-SWAYAM

Dean
School of Media & Communication studies
Galgotias University

University School of Mass Communication (USMC)
Guru Gobind Singh Indraprastha University (GGSIPU)
Sector 16-C, Dwarka, New Delhi-110078.

Consortium For Educational Communication

onlinecourses.swayam2.ac.in/ugc19_hs49/unit?unit=101&lesson=109

Course outline

Week 1-Unit 1:Society and Media: A Conceptual Understanding

Week 2-Unit 1: Society and Media: A Conceptual Understanding

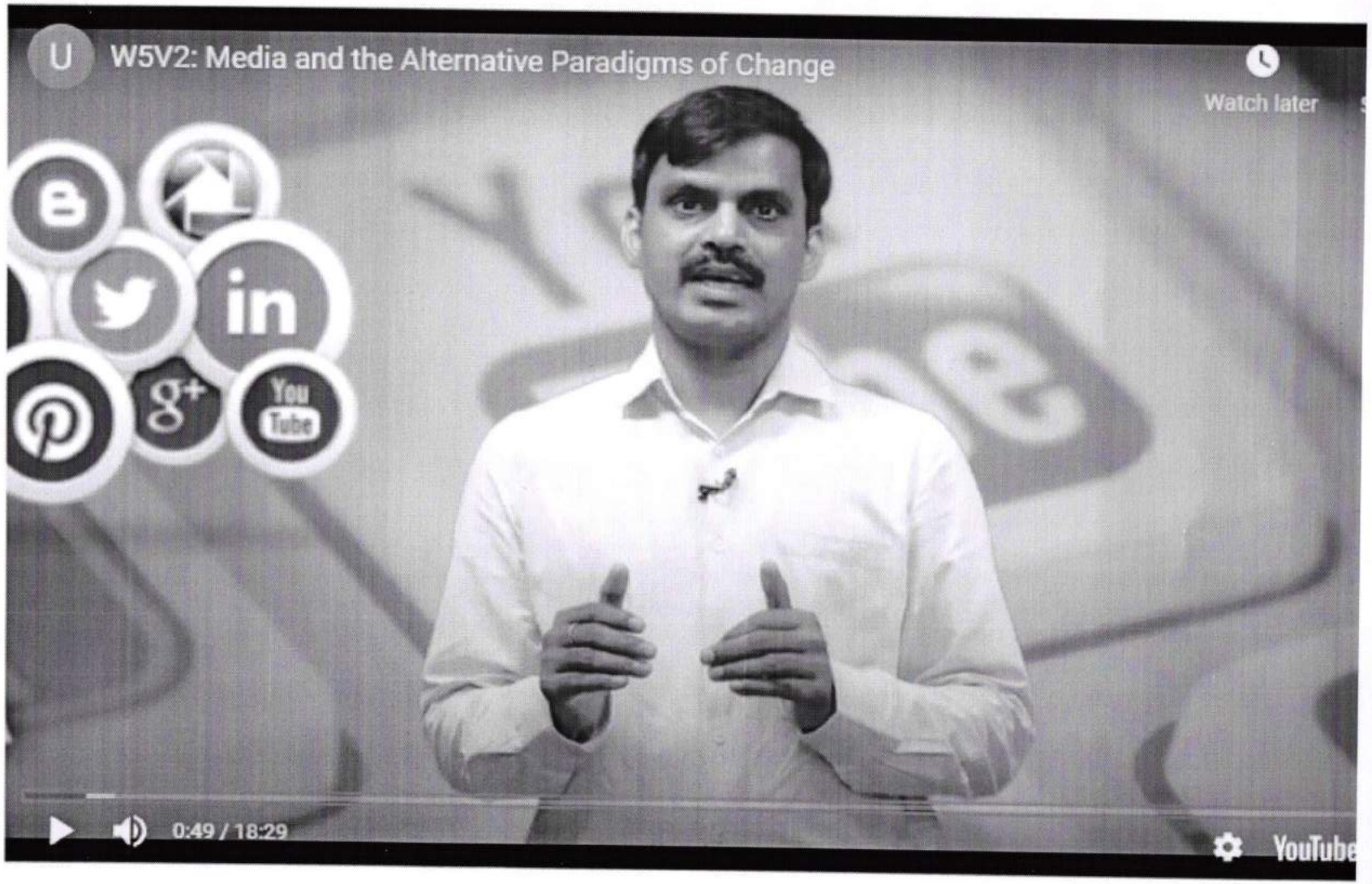
Week 3-Unit 1:Society and Media: A Conceptual Understanding

Week 4-Unit 2: Media, Society and Social Change

Week 5-Unit 2: Media, Society and Social Change

- Week 5_Introduction
- Week 5_Module 1_Video: Media and the Dominant Paradigms of Change
- Week 5_Module 1_E-Text: Media and the Dominant Paradigms of Change
- Week 5_Module 1_Learn More: Media and the Dominant Paradigms of

Week 5_Module 2_Video: Media and the Alternative Paradigms of Change



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Galgotias University