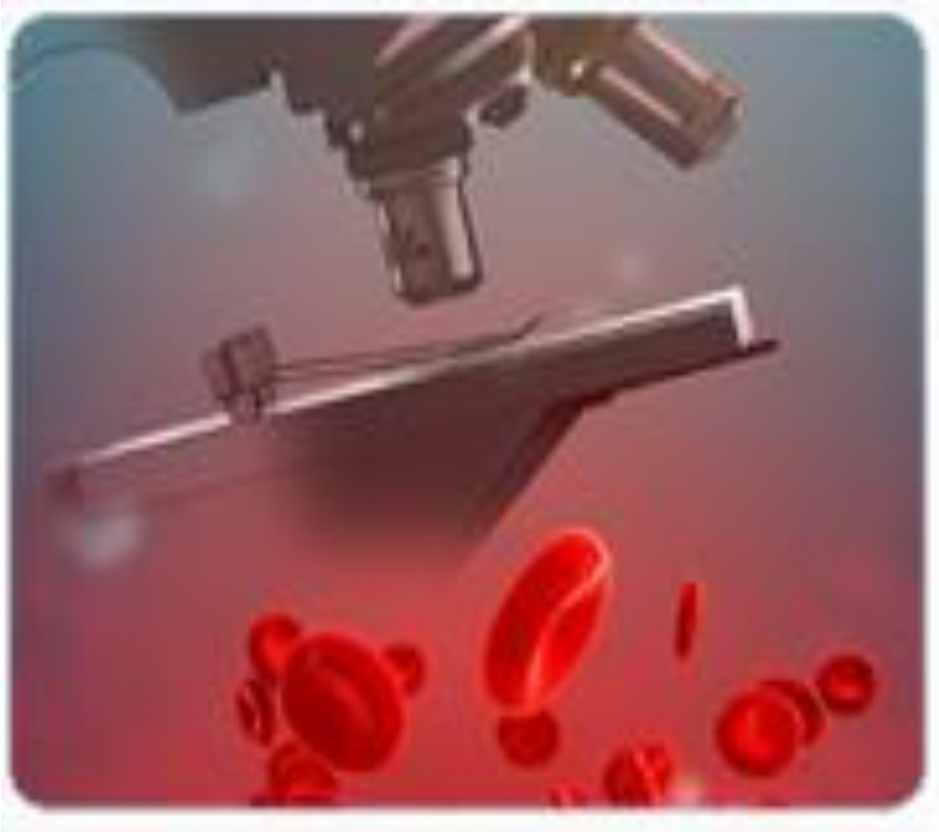
FORENSIC SEROLOGY



DR.G.V.JAGADAMBA

Forensic Serology

- “Forensic Serology is defined as a study of procedures and practices involved in the identification and examinations of blood and other body (physiological) fluids”.
- The material objects encountered in violent crimes such as murder, sexual assault etc. are received in this section for their analysis.
- The species and group (ABO) identification of biological fluid stains such as blood, semen etc. by serological methods are carried out in serology section.

The Serology section undertakes the following types of physical evidence:

- Whole blood & Blood stains
- Semen & Seminal stains
- Saliva stains
- Urine stains
- Faecal stains
- Milk stains
- Tissues
- Teeth & Bones

BLOOD

- Blood is one of the most important & most frequently encountered evidence.
- It can be found at the crime scene, on the weapon, on the victim, on the accused, in and on the vehicle or any other point of contact and provides a good investigative lead to the Police Officer. (Locard's Principle of Exchange).

BLOOD

- A complex mixture of cells, enzymes, proteins & inorganic substances
- Fluid portion of blood is called the plasma (55% of blood content)
  - primarily water
  - red cells (erythrocytes)
  - white cells (leukocytes)
  - Platelets (thrombocytes)

Composition Of Blood:

- Blood is a liquid connective tissue – a very essential part of the body.

Blood is composed of two parts:

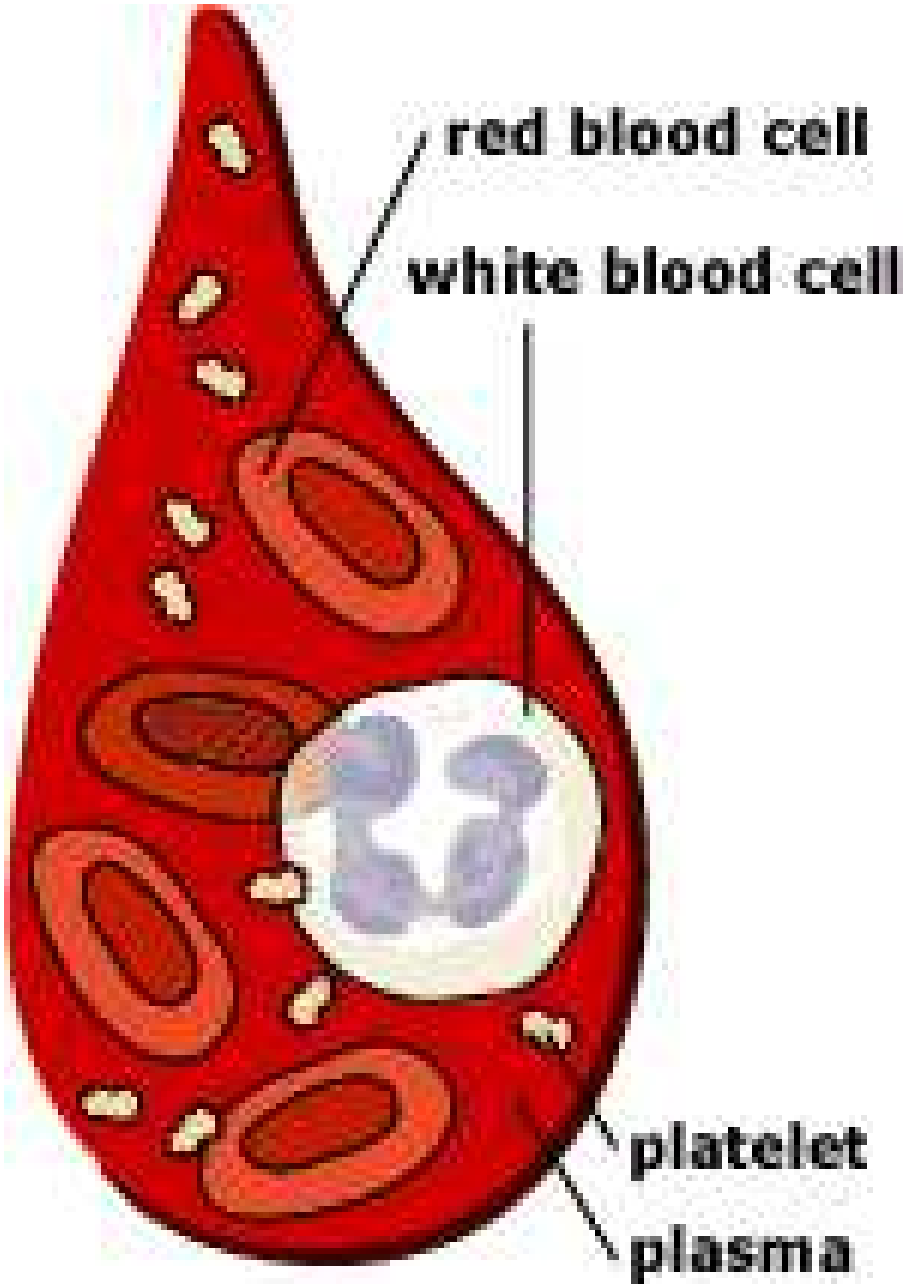
- The Cellular Portion.
- The Liquid Portion.

The Cellular portion contains:

- Red Blood Corpuscles or erythrocytes,
- White Blood Corpuscles or leukocytes &
- Platelets or thrombocytes.

The Liquid Portion:

These cells are suspended in a fluid or **plasma** which contains proteins, lipids, glycoproteins, enzymes, hormones, vitamins, electrolytes, urea, etc.


red blood cell
white blood cell
platelet
plasma

- Hemoglobin makes up approximately 90% of the total volume of RBC.
- It is a complex protein rich in iron, hemoglobin has an affinity for oxygen & combines with it forming oxyhaemoglobin in the tissues from the lungs.
- The RBCs are synthesized in the bone marrow & disintegrated particularly in liver & spleen.
- The red color of the blood is due to the presence of hemoglobin.

- The total volume of blood within the human body varies from **5 to 6 liters** or about 1/12 of the body weight.

- The cellular portion of blood constitutes about 45% of the volume of blood & the plasma is about 55%.

Functions:

- Blood circulates through every tissue & participates in every major functional activity of the human body.
- It can be called an organ, because it is the body's most voluminous constituent.
- It is a body's main transport system.
- It plays a leading role in the regulation of salt & water distribution, acid – base balance & temperature.
- It is responsible for essential defense mechanism.

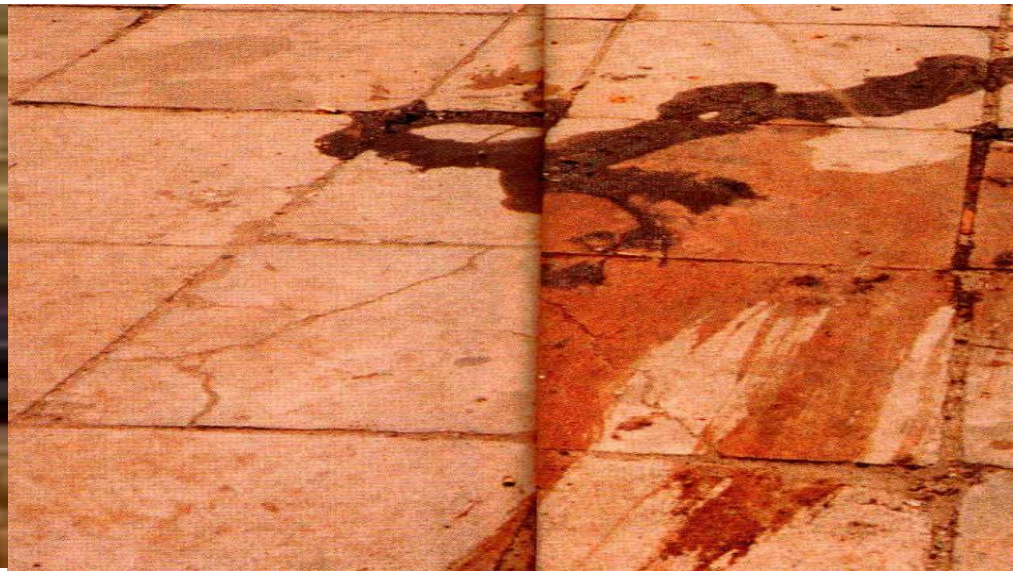
Significance of Blood Evidence:

- Blood evidence provides an important source of information for a case concerning the scene, the victim and the assailant.

Collection of blood stains:

- The blood stain evidence collected from the scene of crime, the victim, the suspect, the weapon of offence etc. may include from the movable and immovable articles, absorbent and non absorbent areas and from various other places.
- The general collection methods of blood stains are as given below:

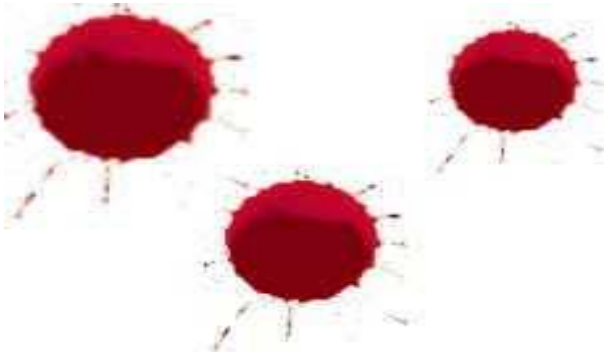
CRIME SCENE



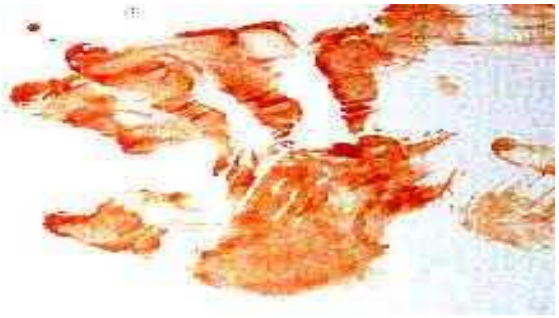
BLOOD STAINS ON KNIFE, ON FLOOR, ON CLOTHES

BLOOD STAIN PATTERNS

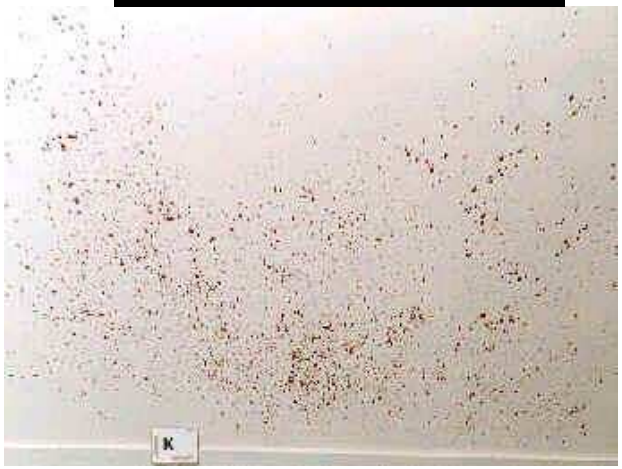
PASSIVE



TRANSFER



PROJECTED



***Location Of Blood Stains*:**

- In search for blood stain evidence at the crime scene, the investigator/IO should rely on the circumstances & any information available concerning the crime.
- The important places for the location of blood are the scene of occurrence, the culprit, the victim, the weapon of offence, the vehicle and the route the culprit has taken after the commission of crime.

- The area, articles and clothing suspected to bear blood stains are examined with strong oblique light and most of the stains become visible.
- The light is used even during the day time.
- The ultraviolet rays are very useful in the location of blood stains, preferably in the dark, when even the washed stains become visible.
- Infrared rays are also useful in locating the blood stains on colored objects, where the blood stains become invisible because of the color of the background.

- A thorough search should be made on the clothing, beddings, curtains, upholstery, carpets, papers and rags used to wipe off the blood at the scene.
- The culprit may carry blood on his hands, crevices of the nails or hair etc.
- If the culprit makes use of vehicles, he is likely to deposit some blood on the upholstery.
- In a case of rape, blood is likely to be found in the genital region of the perpetrator, on his clothing and particularly on his underwear.

- “Luminol” is a chemical reagent useful in locating small traces of blood in dark at crime scene.
- The area surrounding the victim of a homicide, or the area of violence suspect - victim contact, should be thoroughly searched for bloodstains.
- The clothes and the body of the victim should be examined.
- The investigator should not overlook the fingernails and cuticles of the victim’s hands, as these areas may contain traces of the suspect’s blood left as a result of a struggle.
- Any possible weapons discovered should be examined, like knife, sword, axe, dagger etc.
- The edges of the blade could have been wiped off the blood, by the suspect.

***Questionnaire on blood stains**:*

The blood stains are examined to answer one or more of the following questions.

- Whether the stain in question is of blood or not?
- If it is blood, is it of human or animal origin**?**
- If it is animal, what species of animal?
- If human, what is the blood group?
- If required, D.N.A. Finger Printing.

The questions can be answered by examining the blood stains in the following manner:

***EXAMINATION OF BLOOD STAINS*:**

Identification Tests:

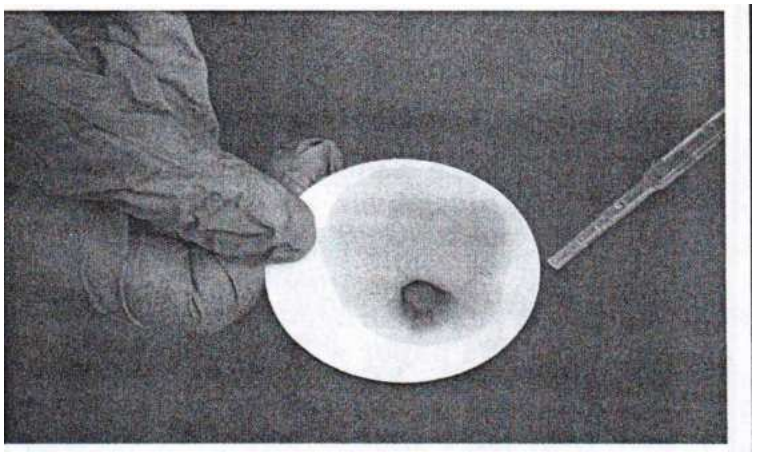
The verification that a substance or suspected stain is blood is the initial step in the identification process to rule out the possibilities of other stains appearing similar to a blood stain.

-Preliminary or *Chemical Tests (color tests):*

- Benzidine test
- Phenolphthalein test

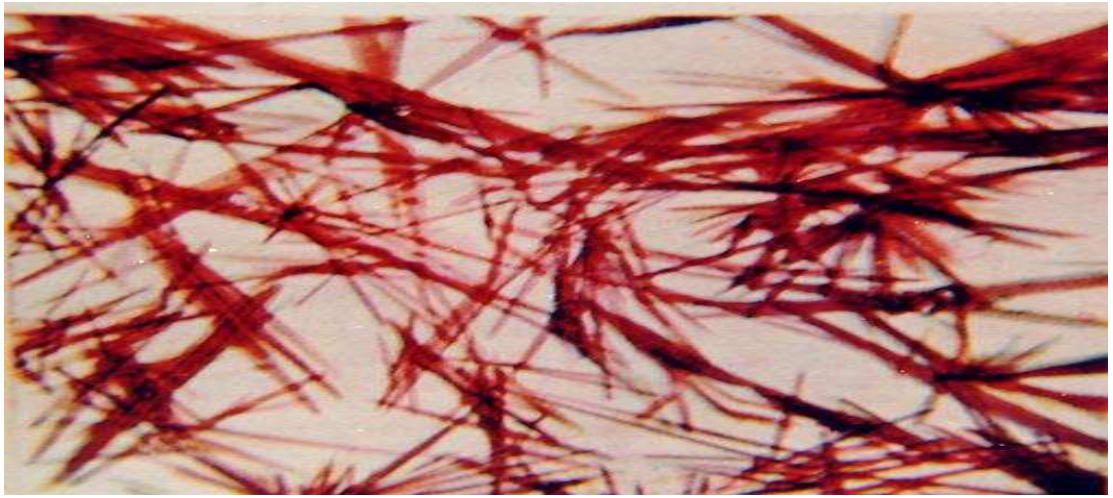
- Identification of blood can be made more specific by confirmatory tests.
- The test is based on the presence of hemoglobin in blood.
- The most popular test is hemochromogen.

Benzidine test for blood



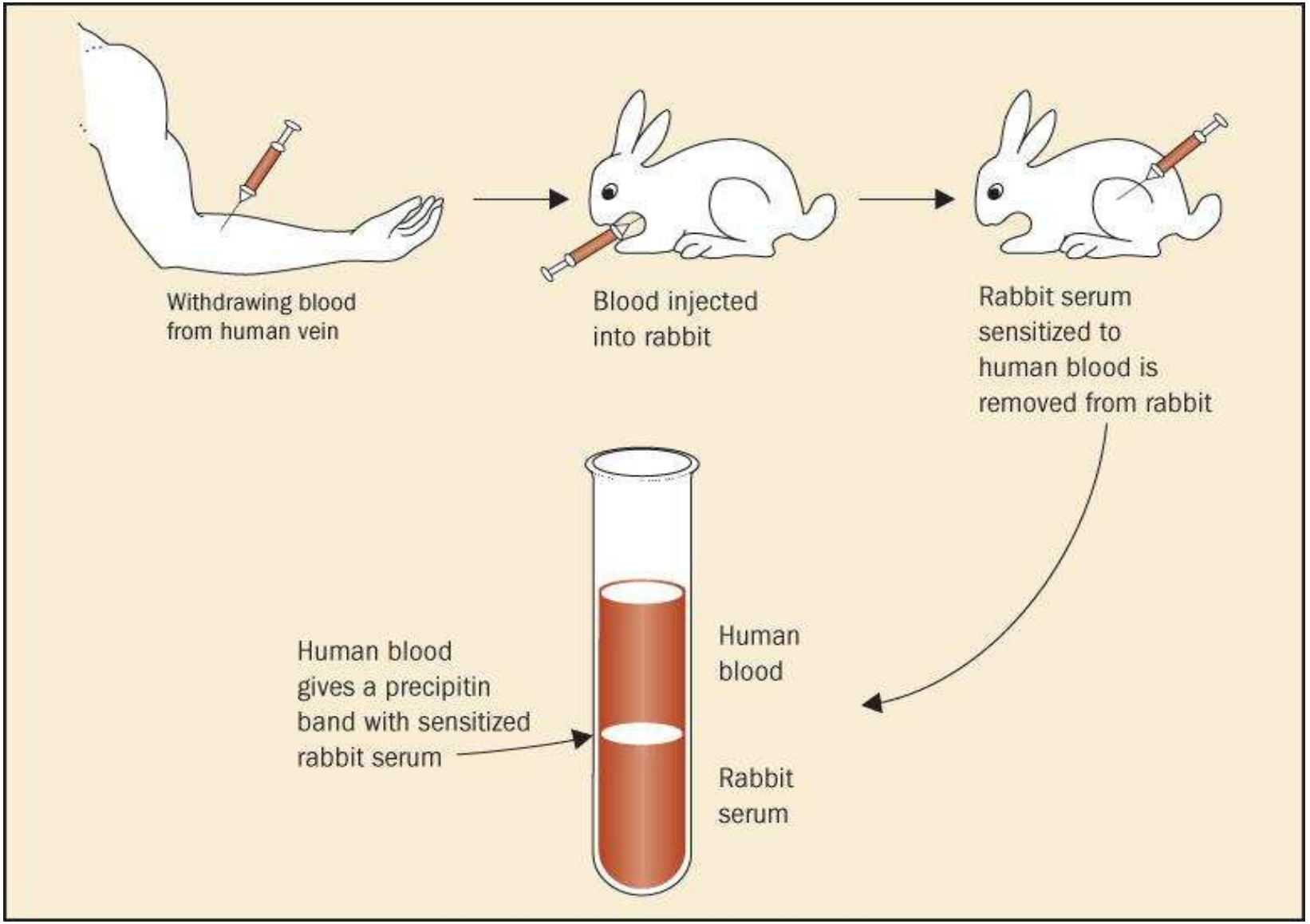
CONFIRMATORY OR CRYSTAL TESTS:

Hemochromogen crystals



Human or Animal Blood?– (*Origin of Species):*

- Once the stain has been confirmed as blood, it is necessary to determine whether it is human or of any other origin.
- The tests are based on the principle that blood proteins (or blood globulins) are specific to each species.
- In other words the blood proteins of one species will not be similar with other species.
- Thus in experimental animals (like rabbits) by injecting blood proteins, different antibodies can be raised for different species.

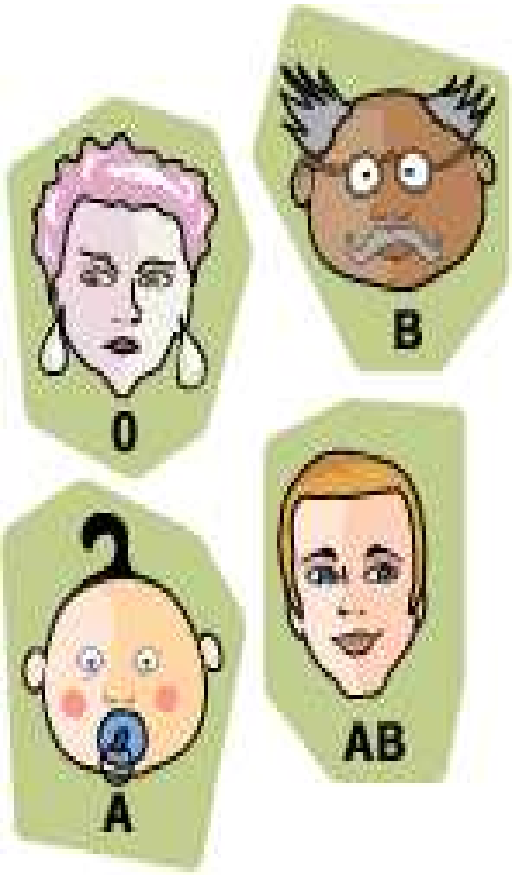


Preparation of Human Anti serum

- If the blood stain is not of human, it could be tested separately against the anti-sera of various animals like sheep, goat, dog, cat, horse, cow, deer etc. and also against the domestic birds like fowl etc., to know the origin of the blood stain.
- After determination of the origin of blood as human, the stain is further examined to find the **blood group** to associate it with a particular individual.

What are the different blood groups?

- The differences in human blood are due to the presence or absence of certain protein molecules called antigens and antibodies.
- The antigens are located on the surface of the red blood cells and the antibodies are in the blood plasma.
- Individuals have different types and combinations of these molecules.
- The blood group you belong to depends on what you have inherited from your parents.



There are more than 20 genetically determined blood group systems known today, but the AB0 and Rh systems are the most common and important ones.

***AB0 blood grouping system*:**

- According to the AB0 blood typing system there are four different kinds of blood groups: **A, B, AB & O.**

SUMMARY OF ANTIGEN, ANTIBODY COMPONENTS IN BLOOD

BLOOD GROUP	ANTIGEN IN RED CELLS	ANTIBODIES IN SERUM	APPROXIMATE % OF INDIAN POPULATION
A	A	Anti-B	22
B	B	Anti-A	33
AB	A&B	--	5
O	--	Anti-A & anti-B	40

BLOOD GROUP NOTATION:

According to above blood grouping systems, you can belong to any of following 8 blood groups:

A Rh+	B Rh+	AB Rh+	0 Rh+
A Rh-	B Rh-	AB Rh-	0 Rh-

BLOOD GROUPS AND PATERNITY

PARENTS' BLOOD GROUP	POSSIBLE BLOOD GROUP OF THE CHILD	IMPOSSIBLE BLOOD GROUP OF THE CHILD
A X A	A and O	B and AB
A X B	A, B, O and AB	NONE
A X AB	A, B and AB	O
A X O	A and O	B and AB
B X B	B and O	A and AB
B X AB	A, B and AB	O
B X O	B and O	A and AB
AB XAB	A, B and AB	O
AB X O	A and B	AB and O
O X O	O	A, B and AB

BLOOD GROUPING OF BLOOD STAINS

- In dried blood stains as the red blood cells are all broken, it is not possible to under take direct agglutination tests for the purpose of grouping.

- However the blood group antigens in the broken cells especially the ABO antigens retain their property of combining with specific antibodies for a considerable period.

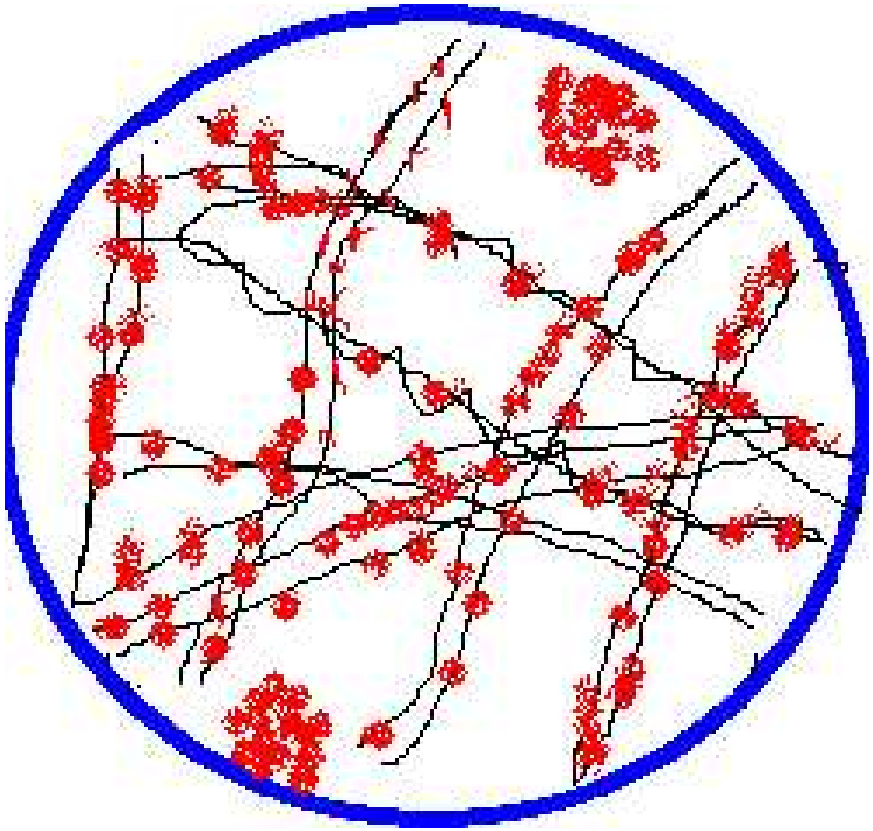
- Hence, by different indirect methods, blood groups of the blood stains can be determined.

BLOOD GROUPING OF BLOOD STAINS

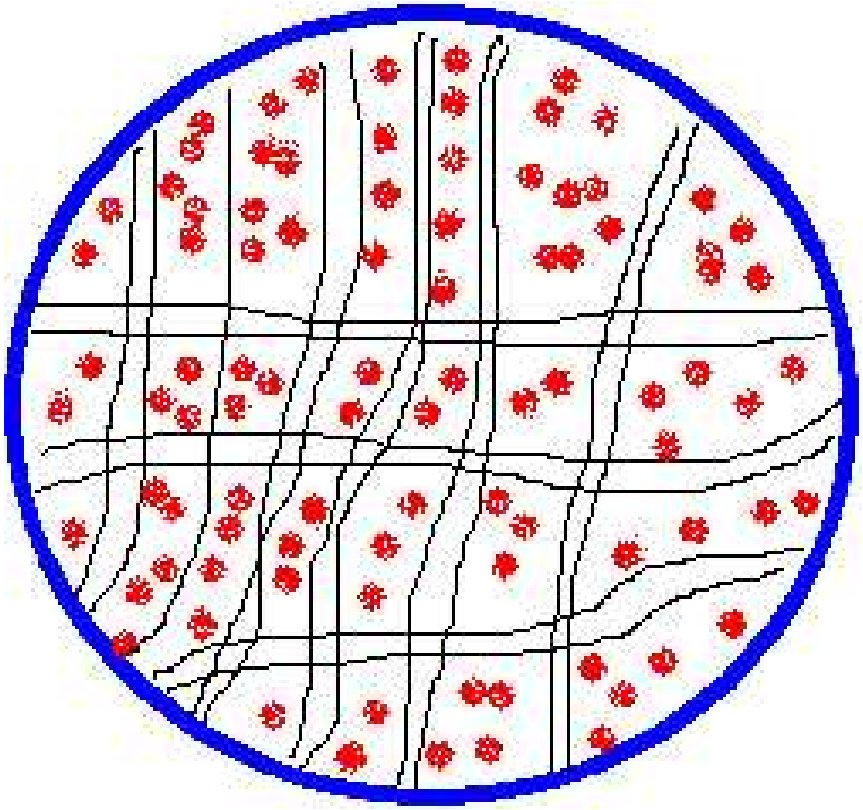
- Mixed Agglutination Method.
- Absorption Elution Method.
- Absorption Inhibition Method.

Principle:– Antigen & Antibody Reaction.

BLOOD GROUPING OF BLOOD STAINS – ABSORPTION – ELUTION METHOD



Positive agglutination



Negative agglutination

***Other blood group systems*:**

- There are blood groups other than ABO system. They are Rh, MN types, DUFFY, LUTHRAN, LEWIS etc., which divide the blood group into hundreds of groups.
- Polymorphic enzymes like Gm, Gc, Haptoglobins-serum groups and red cell enzyme groups like PGM, AK,EAP,GLO 1, ESD etc., and white cell antigen-HLA system etc. exist in variable forms although they have the same function to play.

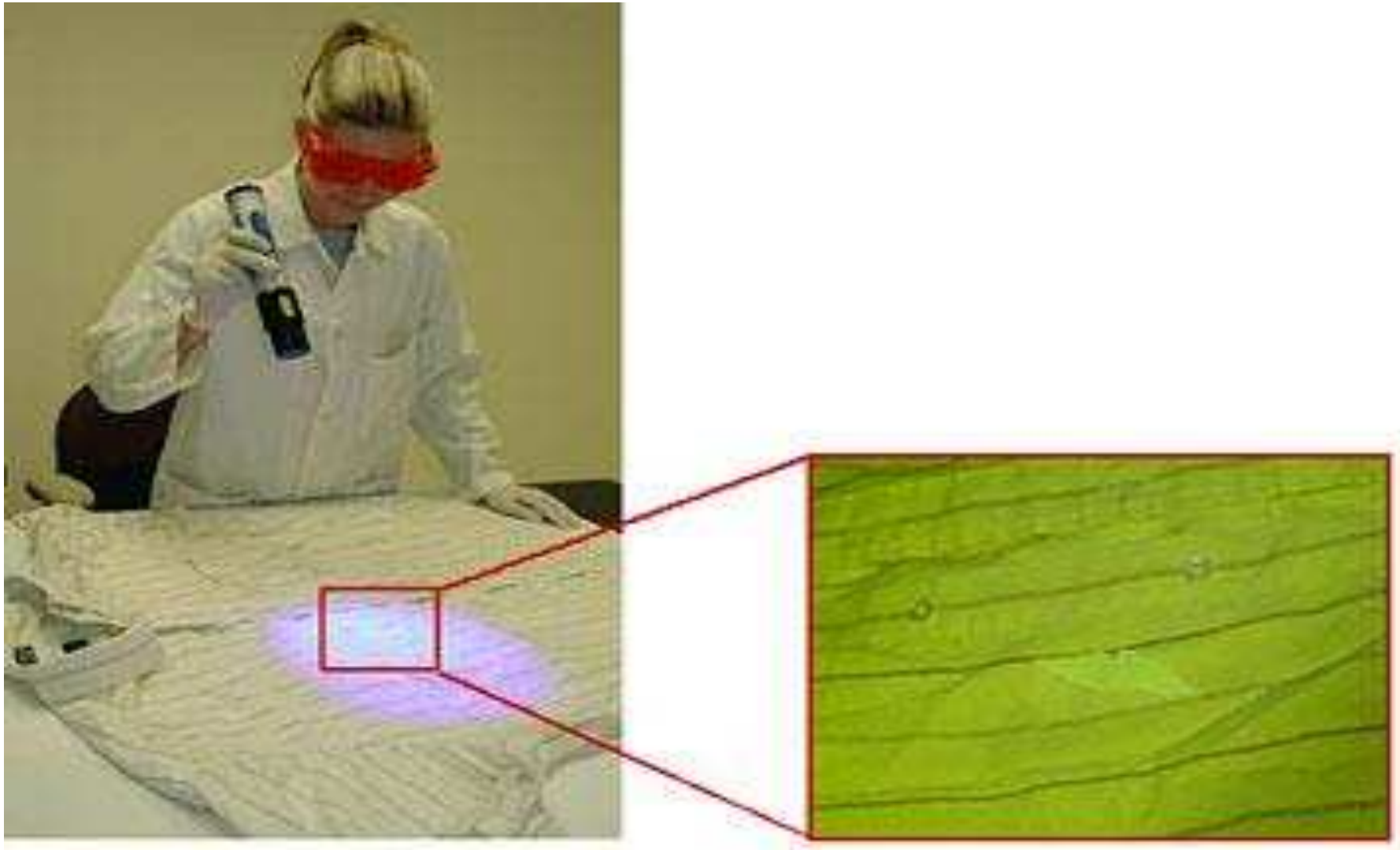
Examination of other (Body) physiological fluids:

- Semen, saliva, urine, sweat, milk, vaginal secretions, vomit stains, and faecal stains are commonly encountered during the investigation of crime – in case of homicides, suicides, sexual offences etc.
- These stains could be identified based on their physico - chemical properties.
- In a secretor individual which is a inherited character the blood group substances are secreted in his glandular secretions like semen, saliva etc.
- Thus blood group could be determined in saliva, semen, gastric juice etc, by any of the techniques used for blood.

***SEMINAL STAINS*:**

- Seminal stain is an important biological stain which requires identification and characterization in the investigation of sexual offences.
- The stains are usually found on the clothing of the victims and the suspects especially on their undergarments.
- They may be found on bed sheets, on pillow cases, carpets, floor etc.

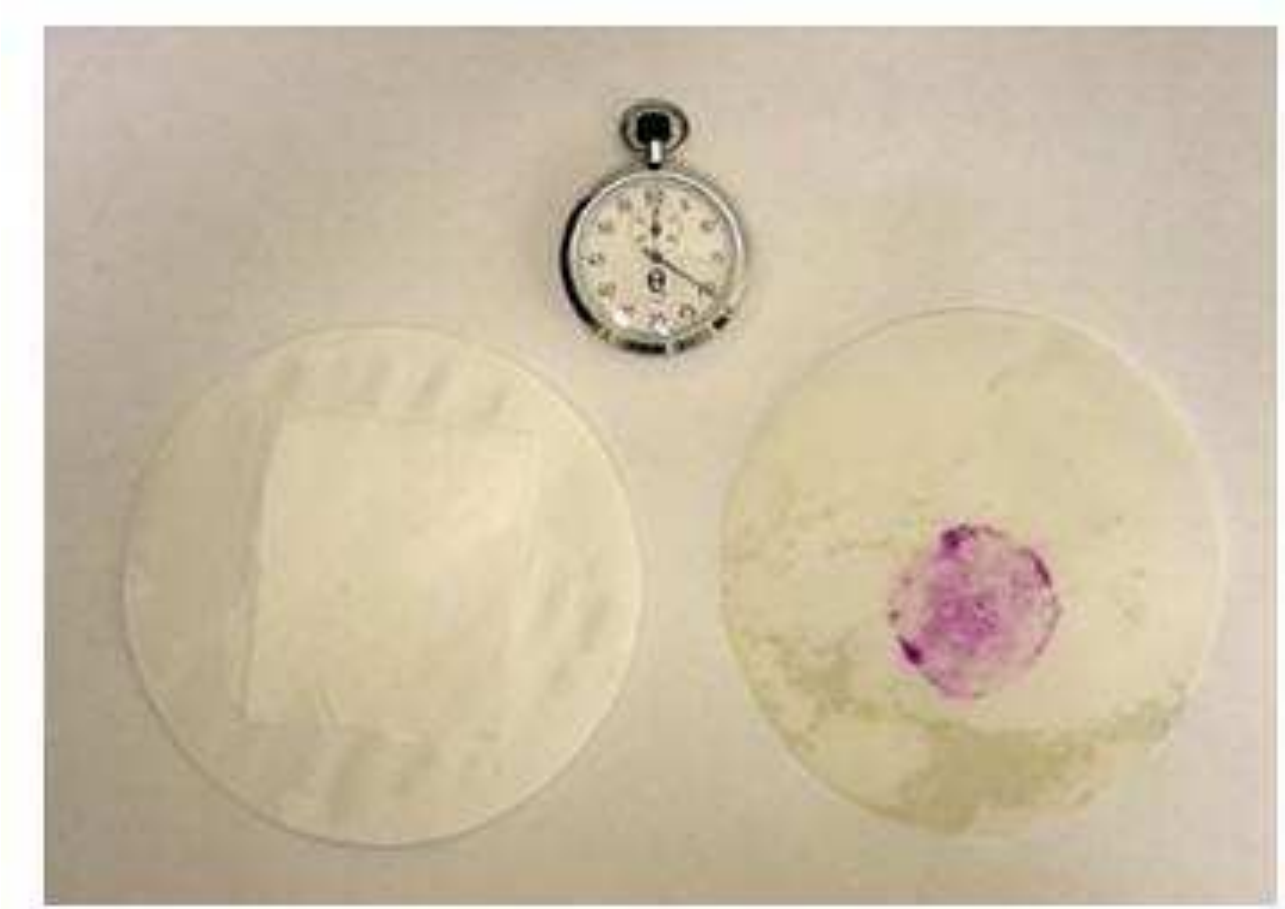
Physical Examination:



Chemical Test (color test) :

Stain portion + Acid Phosphatase Reagent = *Purplish Pink Color*

Acid Phosphatase Test



***Microscopic Examination*:**

- The identification of one or more spermatozoa in the questioned stain confirms the stain to be a seminal stain.
- The stain made as a smear on a glass slide, stained and to be viewed under a microscope.
- The spermatozoa measures about 50 microns in length and contains the flat, oval shaped sperm head, the middle piece or neck and a tail.

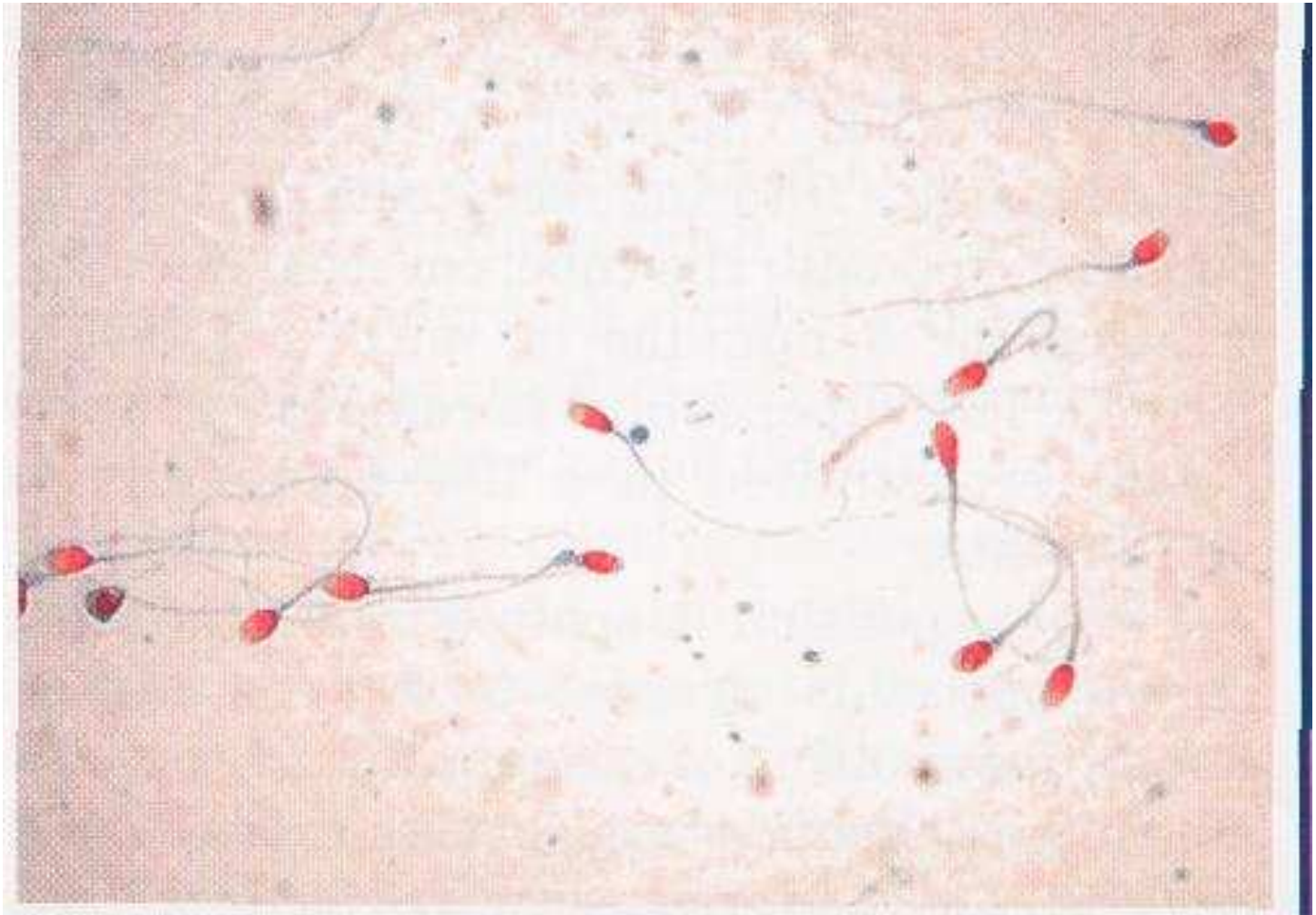


Figure 12.2 Human spermatozoa stained with

***Serological examination of semen*:**

- This serological examination may be used for the detection of semen, identification of species, and the identification of blood group in a secretor individual.
- Group specific substances like A, B and H can be determined in seminal stains derived from secretor individuals by using absorption inhibition, absorption-elution and mixed agglutination techniques.

EXAMINATION OF SALIVA STAINS:

- Stains of saliva are sometimes encountered in the investigation of criminal cases and it becomes necessary to detect such stains and characterize them.
- The cigarette butts, beedi ends, stains on clothes etc. are required to be examined for presence saliva.

- Human saliva contains a fairly large amount of ptyalin, responsible for conversion of starch to dextrine and maltose.
- The enzyme ptyalin can be detected by amylase test.
- The ABO blood group of a secretor person could be determined by examination of the saliva stains by any of the techniques used for determining blood group in dried blood stains.

***EXAMINATION OF URINE STAINS*:**

- Examination of urine stains and sweat stains may be necessary in cases of deaths like strangulation, hanging, murder and sexual assault.
- The presence of urea in these stains can be detected by Gee's method.

***EXAMINATION OF FAECAL STAINS*:**

The identification of faecal stains may sometimes be of great importance especially in cases of sodomy, bestiality etc.

- Microscopic examination for the detection of undigested food particles, pus cells, epithelial cells, cysts of Entamoeba histolytica, ova of intestinal helminths.
- Chemical examination for the detection of Bilirubin. (the normal faecal pigment).

EXAMINATION OF MILK STAINS:

Milk stains may also occasionally be encountered in sexual offences.

- Milk is an emulsion of fat globules in a colloidal solution of proteins, lactalbumin, lactoglobulin and caesin together with a number of crystalloids in solution.

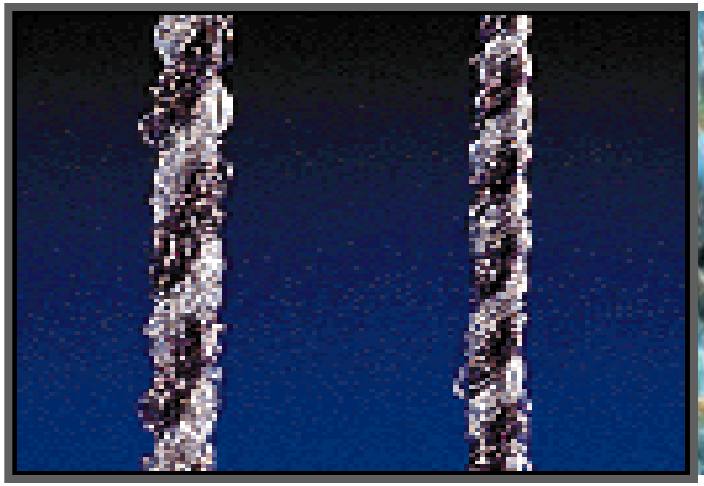
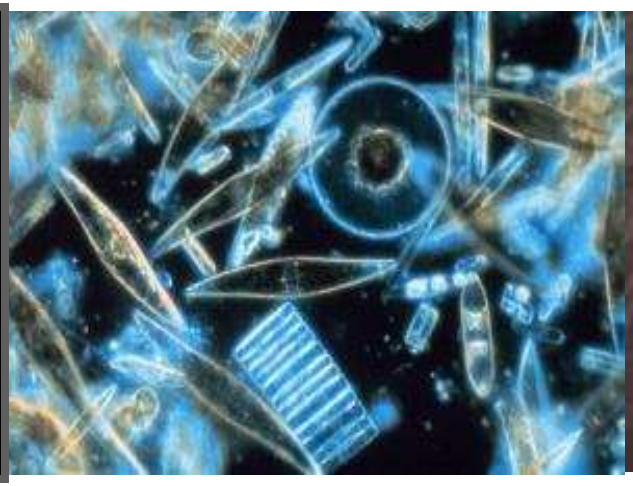
***HUMAN BODY – REMNANTS – EXAMINATION*:**

Maybe present on weapon /in the crime scene.

- The tissues of human body, both the soft and hard, can be sent for examination to the forensic science laboratory for obtaining information regarding the species origin, ABO blood group typing, and DNA profiling.

FORENSIC BIOLOGY




DEFINITION AND SCOPE:

- Forensic Biology is the branch of science dealing with examinations of biological materials encountered in crimes such as murder, road accidents, burglary, robbery, decoity, sexual assault etc.

The section deals with the following types of crime cases:

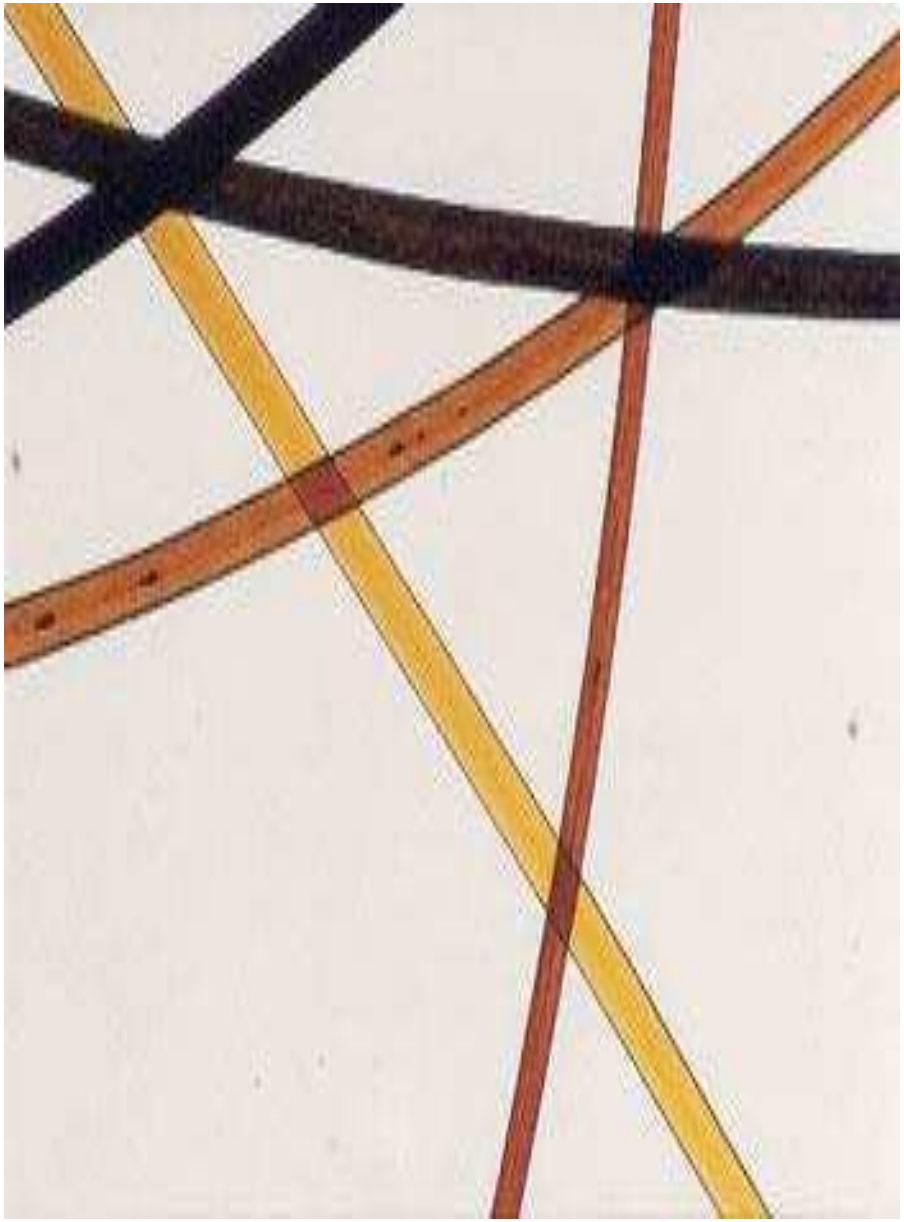
- murder
- road accidents
- sexual assault
- theft
- burglary
- robbery
- dacoity
- drowning
- suspicious death
- cases of missing persons.

The section undertakes the following types of physical evidence:

- hairs
- fibres
- diatoms
- plant material (tobacco, pollen grains, wood etc.,)
- insects and maggots
- skull superimposition

HAIR-

- Hair may be pulled or transferred in violent encounters and hit and run accidents. Pubic hair may be transferred in Sexual Offences.
- Common physical evidence.
- Present in the scene, on victim, on accused,
- On weapon, on clothing, etc.,
- Accused hair in victim's fist.
- Road accident-victims hair on vehicle.



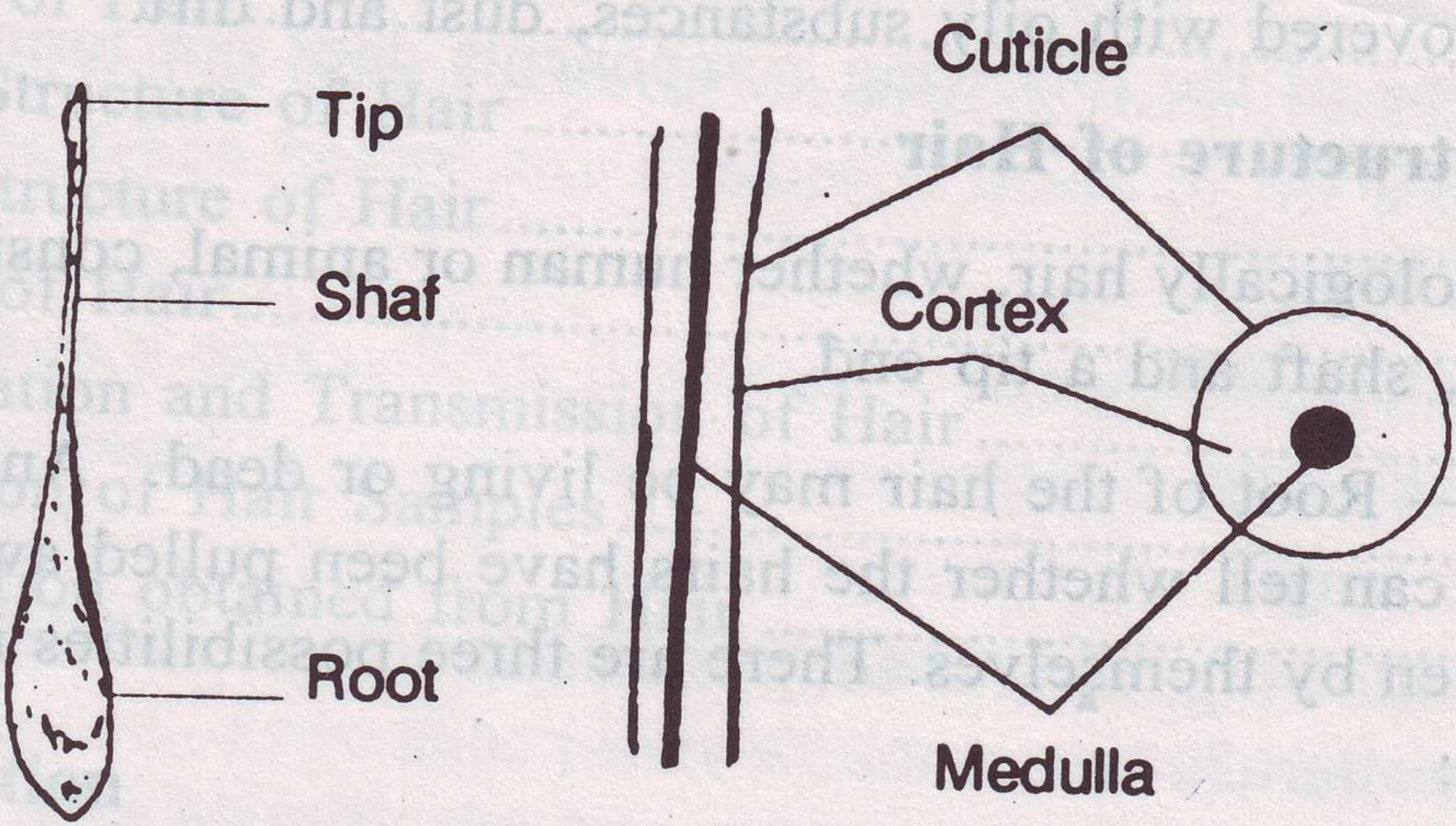


Fig. 13 a. Outer and inner structure of hair

Cuticle:-

- Outermost layer of hair.
- Thin translucent pigment free scales laid one over the other.
- Scales are directed towards the tip of hair.
- Human – flat; Sheep – saw tooth type protrusions.

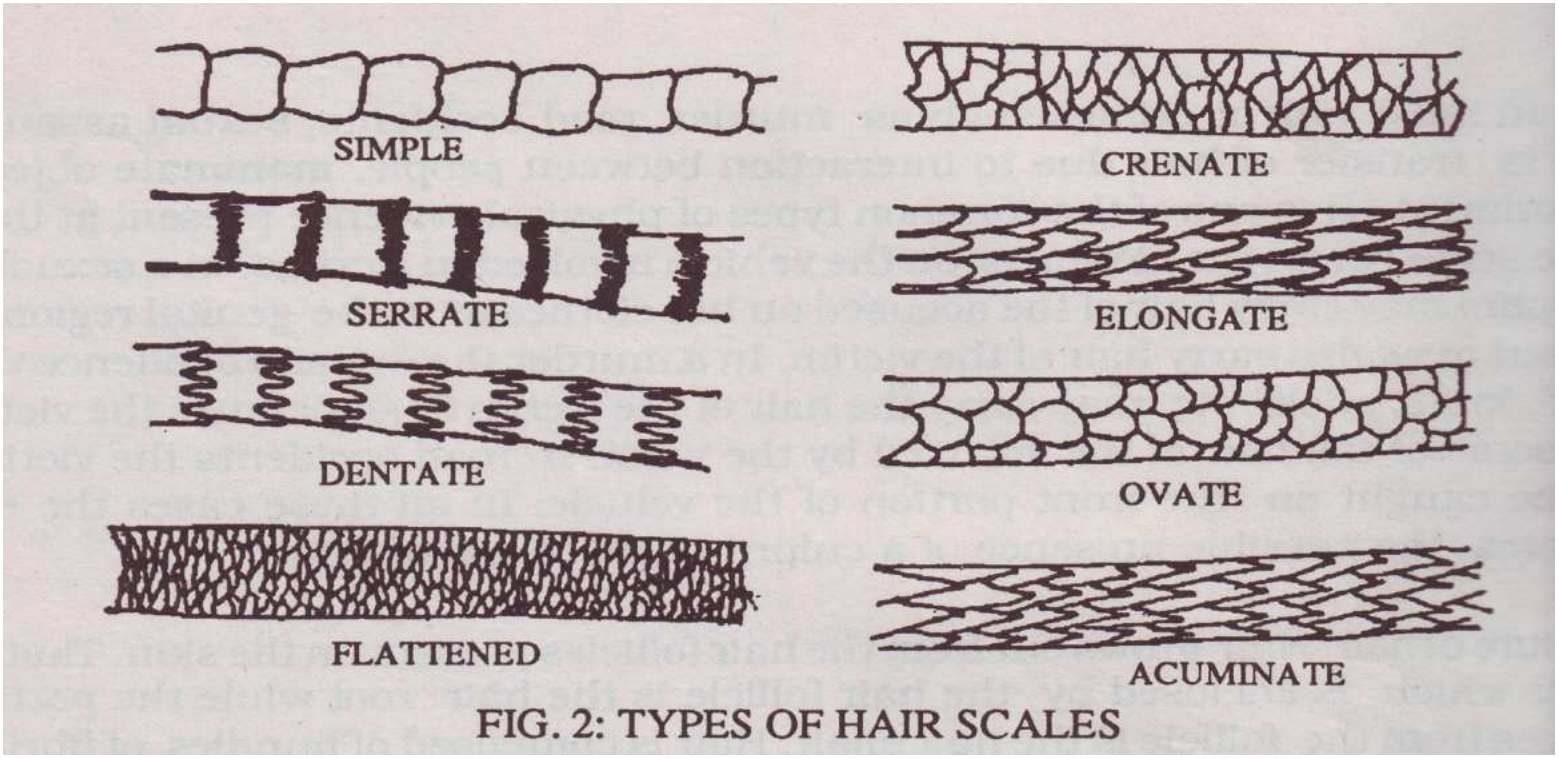


FIG. 2: TYPES OF HAIR SCALES

Cortex:-

- Consists of elongated filaments – parallel to the length of hair – are bounded together by protein – to form hard structure.
- Empty air spaces called cortical fusi – whose shape, size and distribution are important characteristics.
- Contains pigments – granules (**melanin)** – synthesized in the hair follicle and passed to the growing hair.
- Concentration of melanin that decides the color of hair. Black – more melanin, gray – no melanin.

Medulla:-

- Central core of hair.
- In some animals it is pigmented & appears dark.
- May be continuous / discontinuous / fragmentary / absent.
- Medullary index – ratio of diameter of medulla & the diameter of hair – varies
  - Human -1/3 or less – narrow
  - Animals – medium size – in cows & horses
    - thick – in other animals
    - continuous .

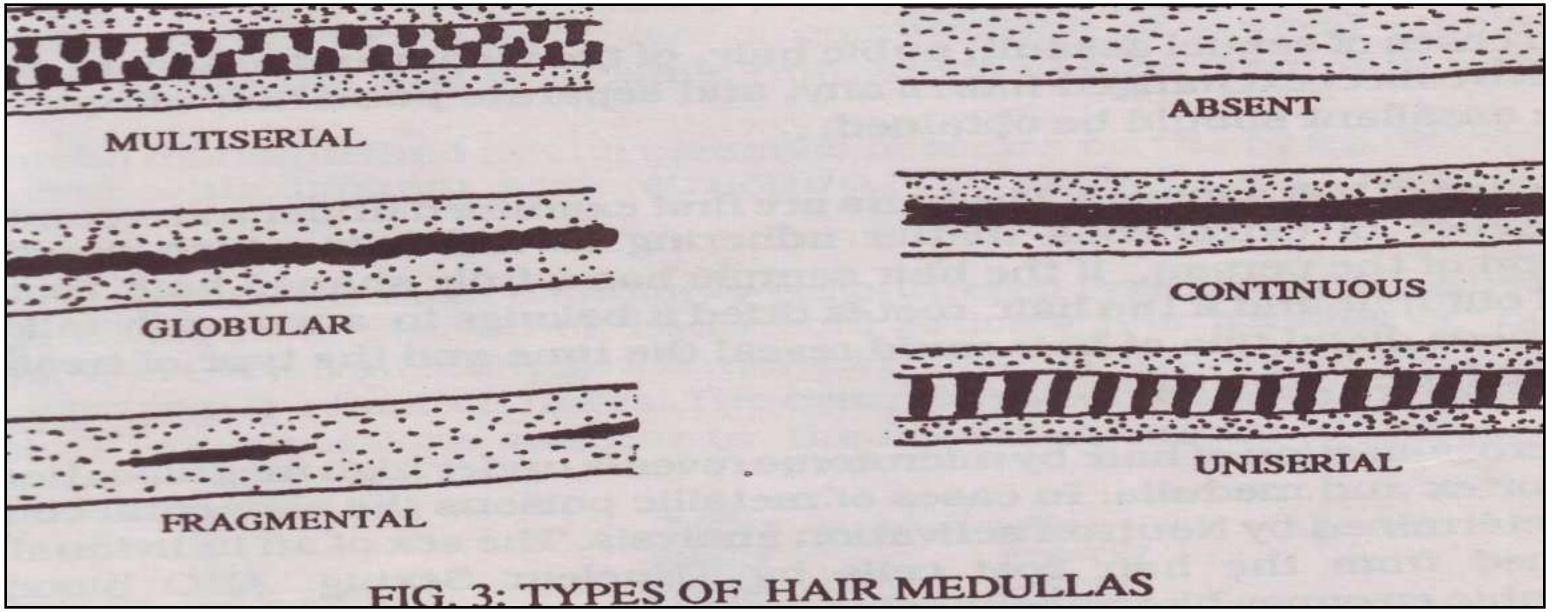
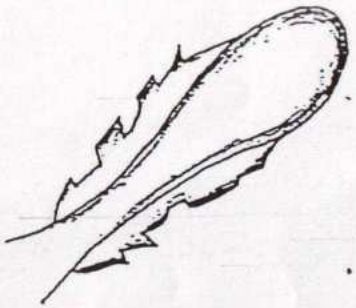


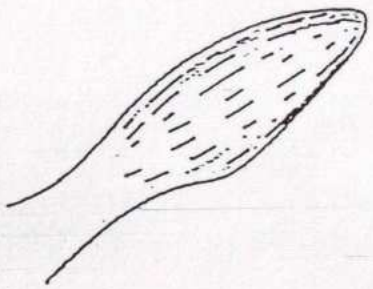
FIG. 3: TYPES OF HAIR MEDULLAS

TYPICAL FEATURES OF HAIR

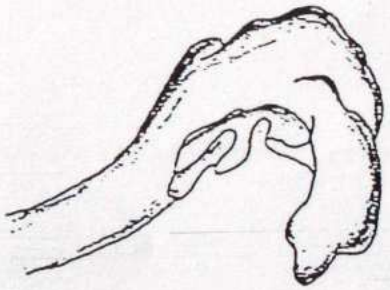
Pulled hair



Fallen hair

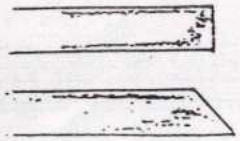


Fallen hair

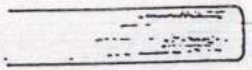


HAIR TIPS

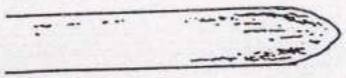
Freshly cut



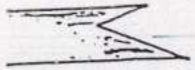
Few days after cut



more than 15 days after cut



Split



Frayed

Natural tip

Collection:-

- **-** Locate with strong light
- - Collect with tweezers / transparent adhesive tape &
- preserve in clean covers
- - Record from where the hair is collected
- - Collect control sample hair by vigorously combing from victim & suspect
- - In sexual assault cases collect exchanged pubic hair first
- - followed by sample hair and preserve them in separate covers.

Information that can be obtained :

- Is it hair?
- If this is not hair, what is it?
- If it is hair, is it non-human or human?
- If it is from non-human, from what animal did it come?

Fixing of individual:

- a) Can be said definitely – that it does not belong to the person.
- b) Cannot be said definitely – that it belongs to the person

  -test for dye, occupational dust etc. may enhance.

FIBRES:

- **Encountered in sexual offences, murder, house breaking, road accidents etc.**
- **Carpet fibres may be transferred to accused footwear**

CLASSIFICATION OF FIBRES-

NATURAL:

Plant – Ex. : Cotton, Jute, Linen, Coir, hemp

Animal – Ex. : Wool, Silk and other animal hairs

MAN – MADE:

Regenerated – Ex. : Rayons

Synthetics – Ex.: Nylon, Polyester, Terylene, Acrilon, Dacron etc.

Miscellaneous/Unusual fibres : Fibreglass, Asbestos

FIBRES:

Structure:

- Tough, pliable & filament like substance
- Long chain like structures of several similar units
- The smallest visible unit – which can be spun into textiles

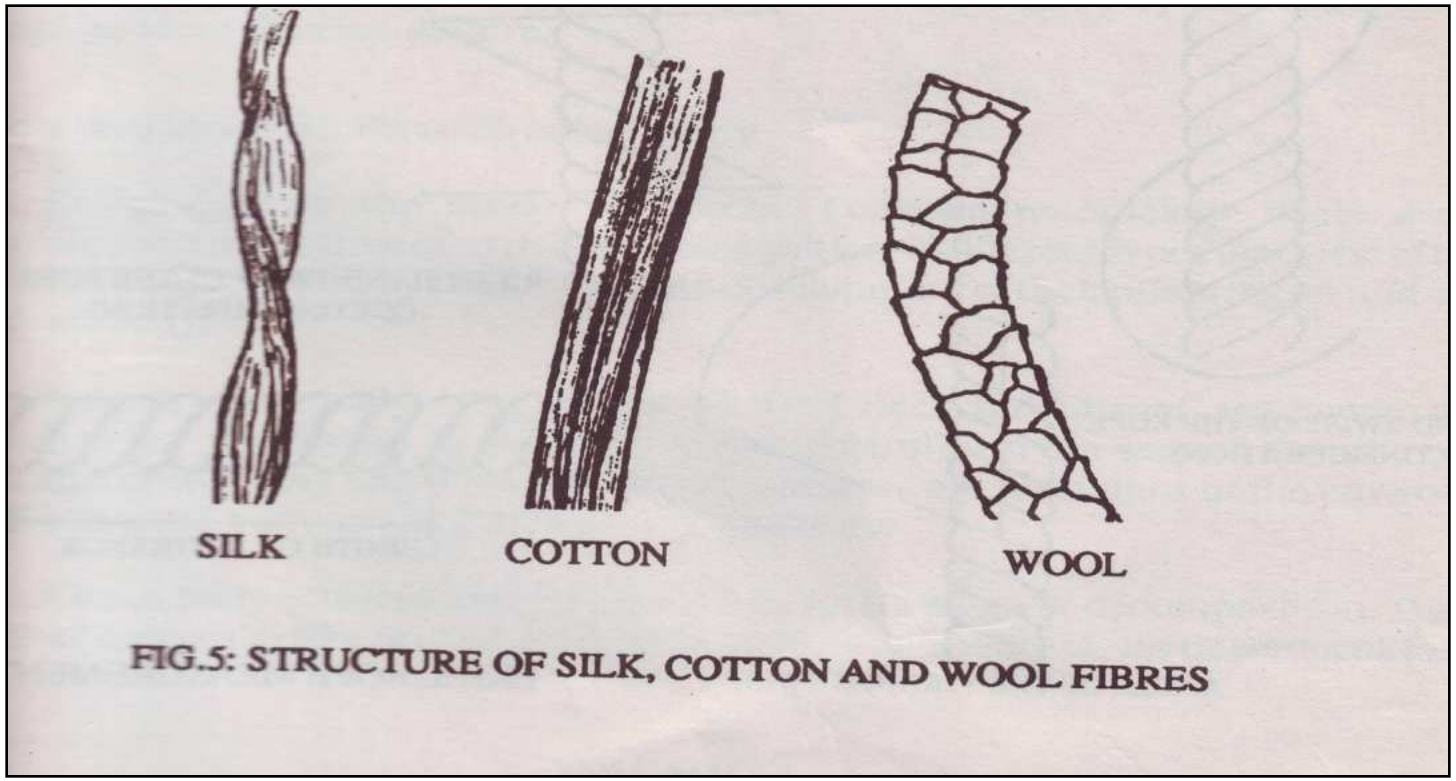


FIG.5: STRUCTURE OF SILK, COTTON AND WOOL FIBRES

Wool

- One kind of hair – having scales
- diameter changes with type of scale structure
- medulla may / may not be pronounced

Cotton

- common in clothing
- flattened ribbon like structure with characteristic twists
- dark central area due to air inclusions & fibrilar Structure

Silk

- from silk worms
- long continuous fiber

Types - raw, processed and wild

raw - two fibres enclosed in sericin
surface is irregular with folds & uneven lumps

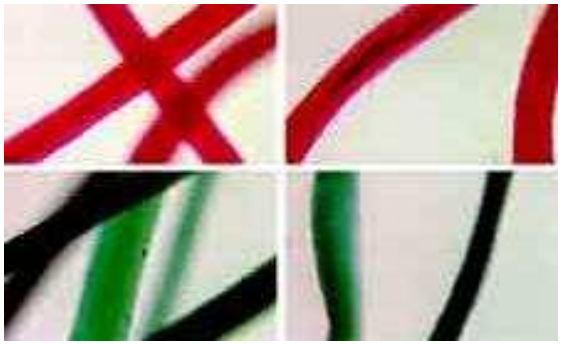
processed - sericin is removed
smooth, translucent and structure less

wild - broad in size with more fibrils

Rayon

- manufactured from cellulose & its derivatives variety of fibres with different chemical composition and appearance
- types- viscose , acetate, nitro cellulose, etc.

Cross-section of a man-made fiber



Fibers under a microscope

Threads, Yarn, Rope, Cordage:

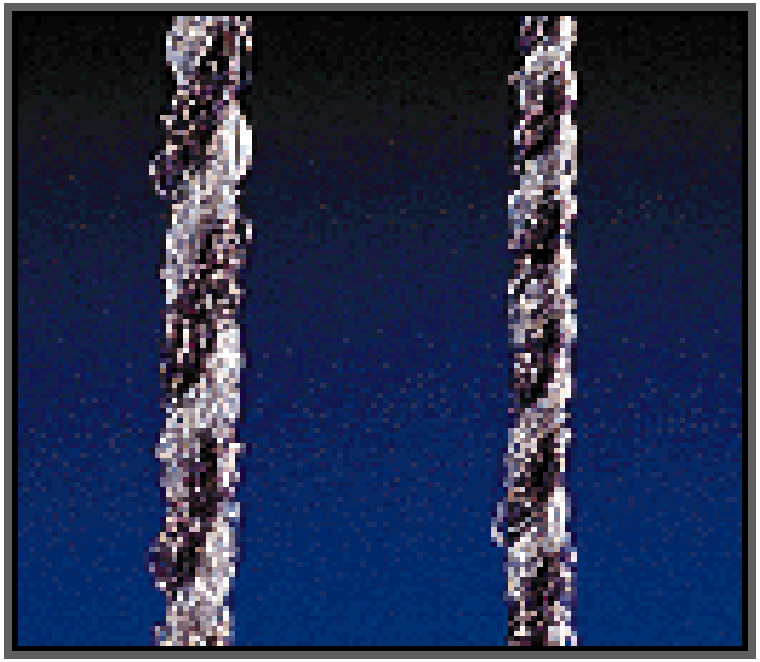
- Smallest component is fiber (staple) twisted together to form thread or is a filament.
- This thread can then be twisted with other threads to form a thicker thread (string, etc.).
- Small cords or fibers twisted together to form larger cords.
- At each step,

  the **number of cords**

  can be counted.
- At each step,

  the **twist direction**

  is either “S” or “Z”



Collection:

- use vacuum cleaner / clean broom
- place it in a clean paper & then in a cover
- clothing of accused & victim worn at the time of offence – as early as possible
- pack each exhibit separately & label them

Examination:

- Surface, cross sectional shape, diameter, color, etc.
- optical properties
- Direction of twist (s/ z), twists per unit length, presence of foreign matter
- Absorption of I.R .radiation (specific frequency)
- Fluorescent properties
- TLC - to identify dyes on fibres

Fibers are very useful as trace evidence:

- Vary widely in class characteristics
  color, shape, chemical composition, etc.
- Easily transferred from one source to another (carpets, clothes, etc.)
- Significant persistence (won't degrade).

DIATOMS:

- If drowning is the cause of death, DIATOMS will bare the facts. These minute single celled algal plants are resistant to decomposition and putrefaction. This is because of the silica coating on the cell wall.

- Diatoms are a major group of eukaryotic algae, and are one of the most common types of phytoplankton.
- Most diatoms are unicellular, exist as colonies in the shape of filaments or ribbons.
- Cell wall made of silica (hydrated silicon dioxide) called a frustule.
- Fossil evidence suggests that they originated during, or before, the early Jurassic Period.
- Diatoms are commonly found like water bodies in ponds, lakes, canals and rivers etc.
- Their concentration can be low or high in a particular water body, depending upon the season.

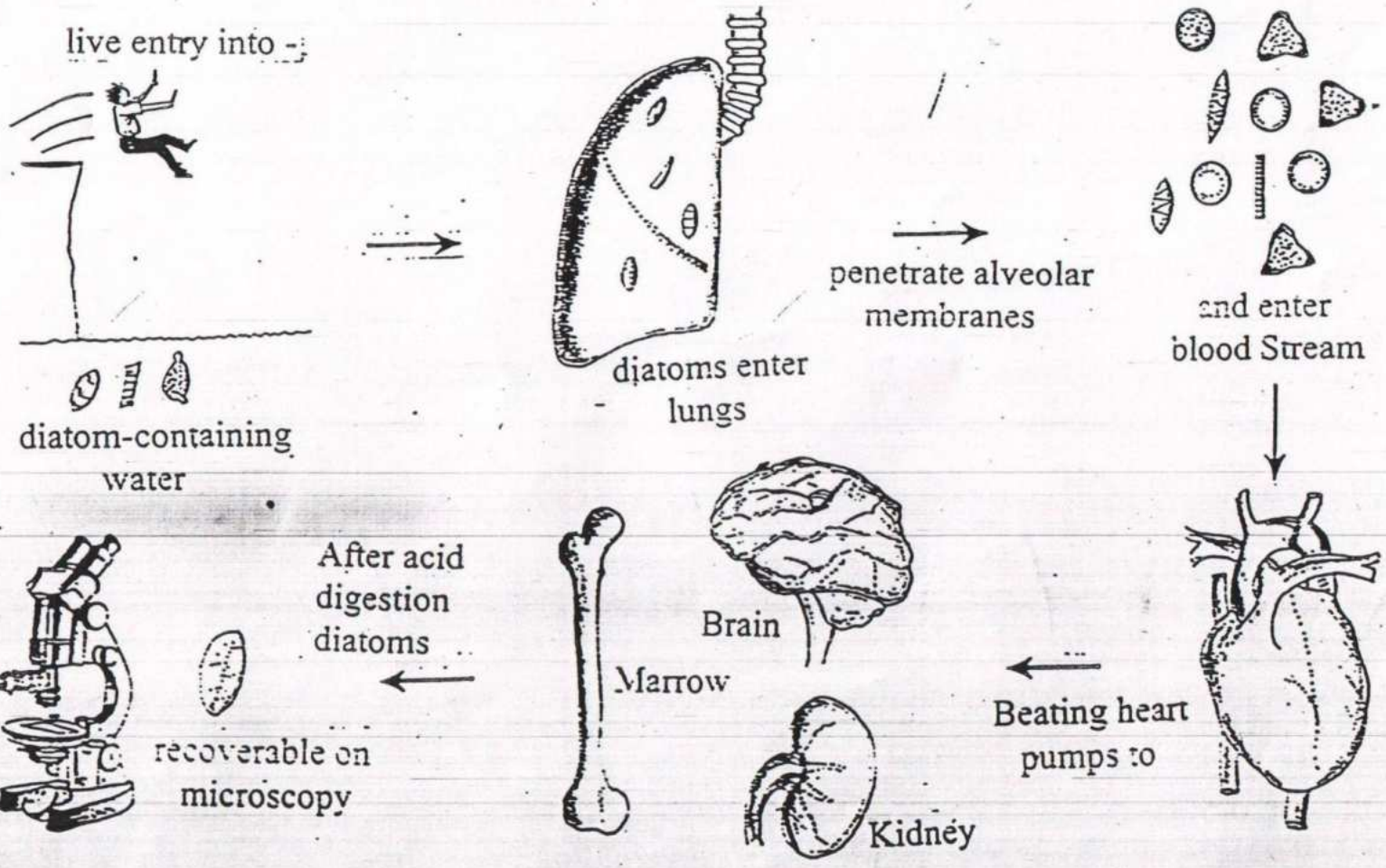
MORPHOLOGY:

- About 15,000 types of diatoms (in fresh water + in sea water).
- Differ in shape.
- Vary in size (2 microns to 1 mm).
- May be single / in group.
- Not visible to naked eye.
- Can be seen only with microscope.
- Drowning is type of asphyxia death by submersion in a liquid/fluid.
- Whether or not the fluid is aspirated into the lungs.
- When drowning takes place, diatoms enter into the lung cavity of a person through the aspirated water.
- This water exerts a pressure on lung cavity and rupturing of the lung alveoli takes place.
- Thus water enters into the lungs. Diatoms in that water enter into the brain, liver, bone marrow through blood circulation.
- It is not possible if the dead body is thrown in the water as there is no blood circulation.

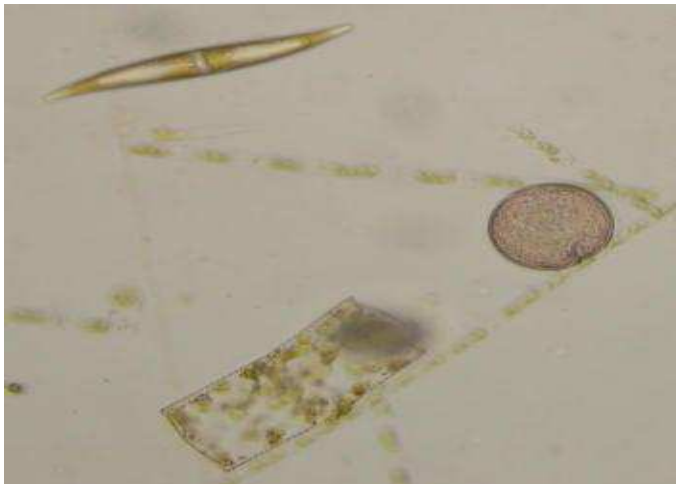
HOW DIATOMS HELP

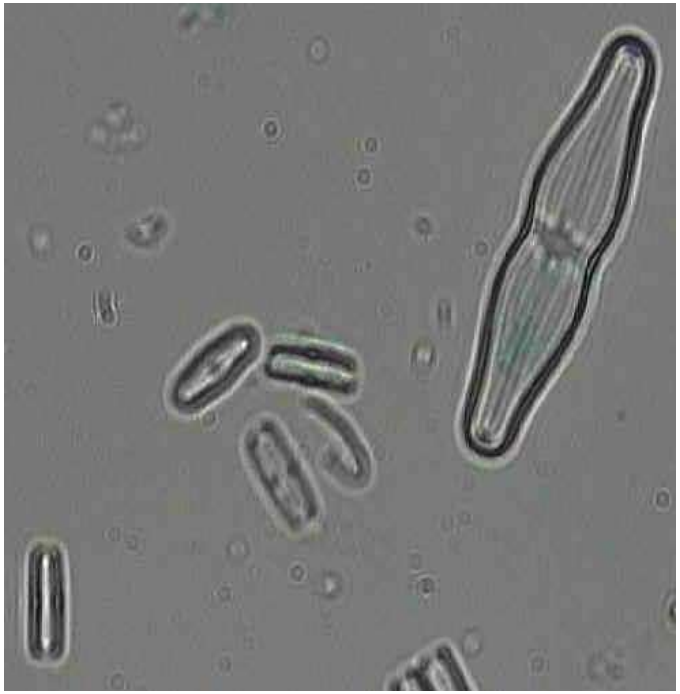
- When a live person drowns many diatoms contained in the water enter the lungs along with the water. These diatoms may penetrate the alveolar walls and enter the blood circulation and are carried to different organs like the brain, kidney, heart, bone marrow etc.
- During autopsy, the above organs are collected & then examined. The presence of diatoms in any of these organs indicates that drowning was the cause of death.

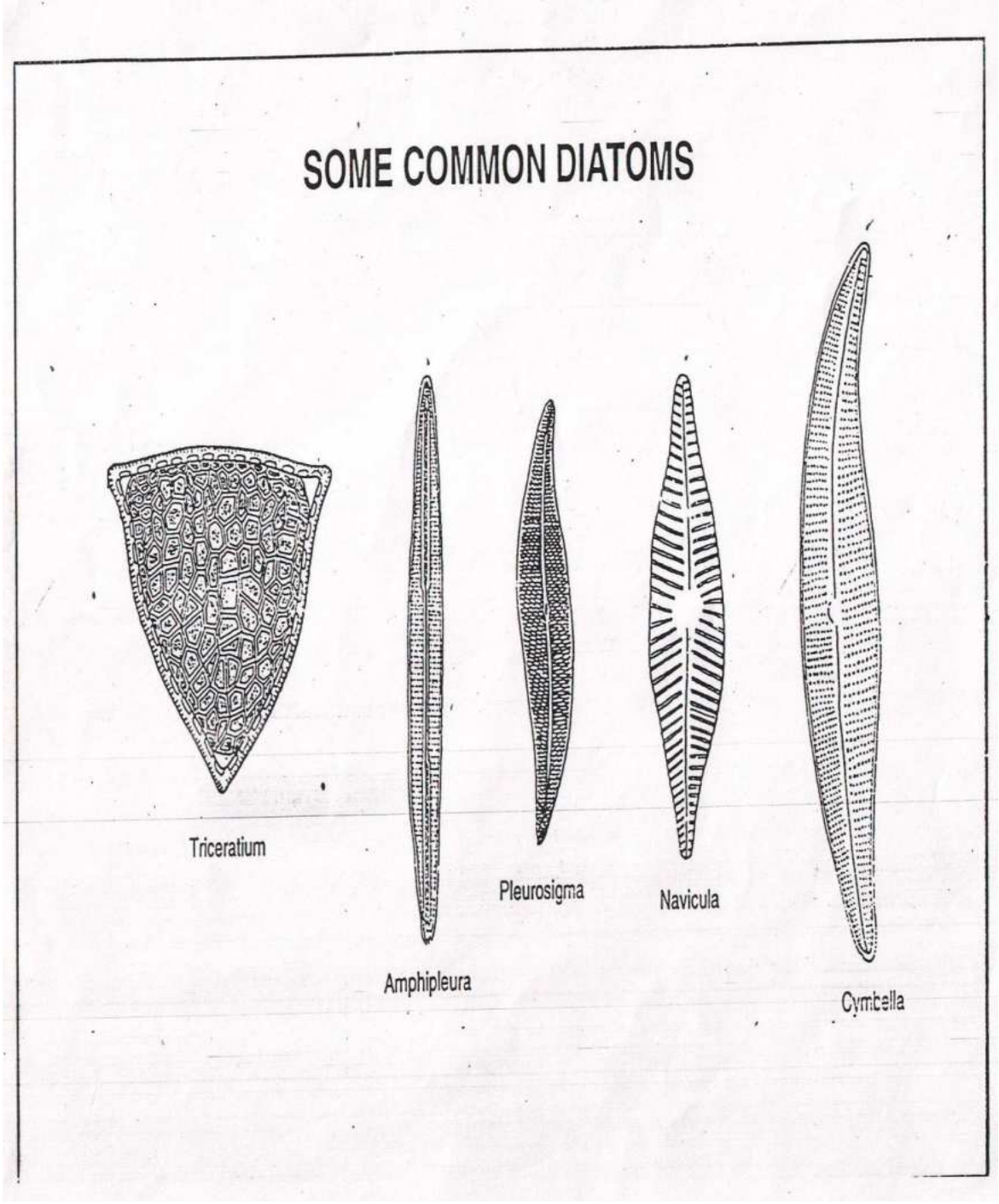
THE PRINCIPLE OF THE DIATOM TEST FOR DROWNING
WHEN A DEAD BODY ENTERS THE WATER DIATOMS CANNOT PROGRESS FURTHER THAN THE LUNGS.



Microscopic Observations







PLANT MATERIAL: There are many kinds of plant materials.

- Identification of a particular plant fragment is useful for investigation. It includes leaves, tobacco, stems, wood, flowers, pollen, grains, seeds etc.
- What Botanical Evidence Can Do:
  - determine the circumstances and cause of death
  - estimate time frames in relation to the death
  - establish where the death could have taken place
  - determine if there were multiple crime scenes
  - prove or disprove an alibi
  - place a suspect at the scene of a crime

WOOD:

- Sometimes criminals leave behind or carry away from the scene of crime, bits of wood. This could have been chipped off accidentally by a tool, bullet or sharp edged weapon; or a chip of wood from an intended destruction during burglary. The piece of wood missing is found at the scene of crime be helpful in tracing the accused.

SEEDS:

- Sometimes there are imposters in the seed bags. Inside bags imitating popular brands are spurious seeds. The imposters are caught red handed by studying:
- Physical features of seeds like length, breadth, thickness, weight etc.
- Microscopical features of seeds
- Physical impurities in the seed bags.

POLLEN:

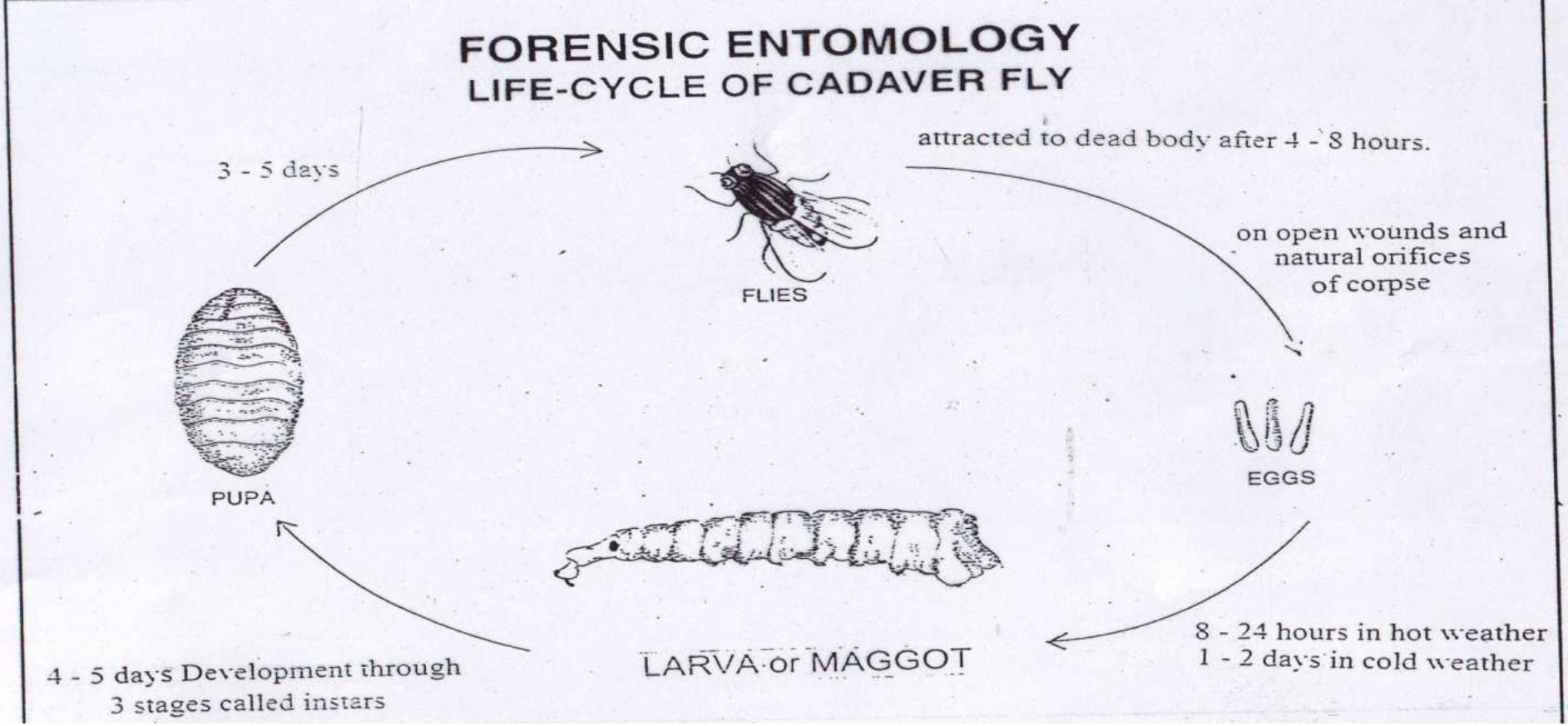
- Pollen grains in flowers are reproductive units of plants.
  - Easily stick to the clothing / objects that touch them.
  - Are microscopic – may not be visible to suspect.
  - If a person who is not normally exposed to such pollen- happens to have that pollen on him / his clothing – proves his presence in the scene.

Other plant residues:

- Leaf fragments, bark , twigs, etc.; adhering to clothing / weapon etc.
  - Useful in locating the scene / from where the body has been shifted
  - Unusual plant material – more useful for fixing the scene.

Insects and maggots:

- Entomology is the study of insects.
- A dead body attracts insects depending on its stage of decomposition. Different kinds of insects arrive on the dead body at various stages of decomposition. One of the important aspects in crime investigation is the estimation of time since death, which is called post-mortem interval.
- Determination of this is extremely difficult in cases involving decomposed bodies where conventional methods like rigormortis, post mortem cooling etc. do not work. In such cases the use of entomological data based on insects infesting a corpse is helpful.
- Dead body attracts insects depending on its stage of decomposition.
- Appearance of various kinds of insects in chronological order which is well established.
- Fully grown larva – time 5 to 7 days



Collection:

- Collect larva in alcohol & send.
- Collect larva in wide mouthed container with a small piece of flesh from dead body (for feeding).
- Cover with cloth piece (for aeration).

Wild life Forensic science

- **In wildlife forensics, the major difference is the victim is an animal.**

- **These scientists must identify what species the evidence came from to determine if poaching or hunting violations had occurred.**

SKELETAL REMAINS &TEETH

- Dead body will be reduced to skeleton / bones in two weeks.
- May be available in abandoned / isolated places.
- By examination it can be ascertained –

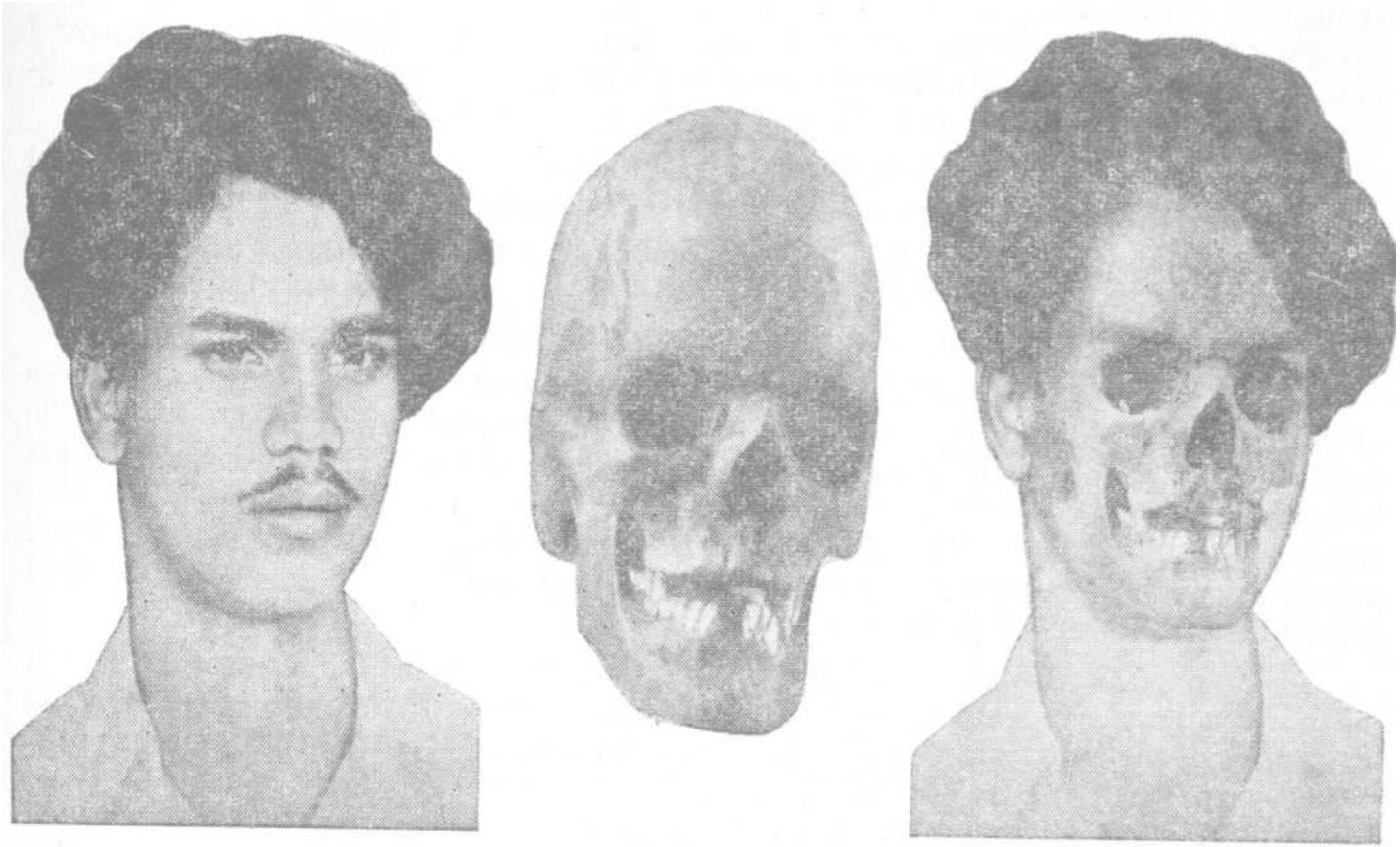
- a) Belongs to one or more persons
- b) Male / Female
- c) Age
- d) Time of death
- e) Cause of death
- f) Peculiar features (if any]
- g) Teeth which are indestructible (in fires / mass disasters)

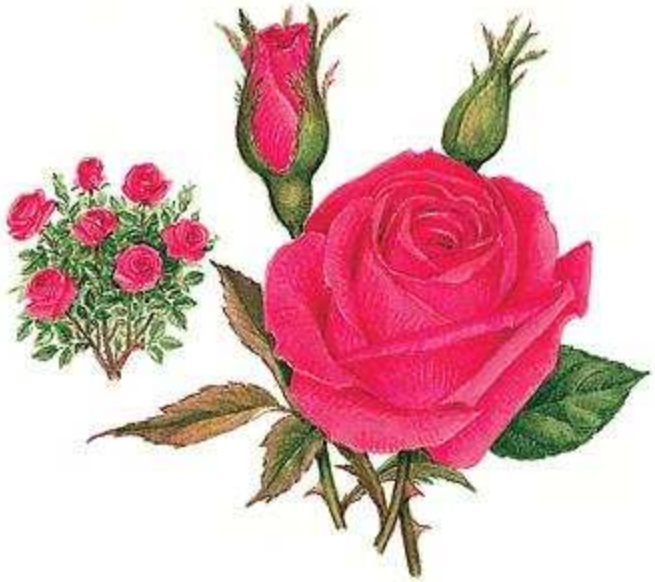
SUPERIMPOSITION OF SKULL

- Establishing the identity of a missing person with the help of the latest photograph and the skull in question is done with the help of skull-photo-superimposition technique. The conventional technique of superimposition involves the preparation of negative plates of the photograph and the skull. Then these two negatives are placed one over the other to procure a superimposed positive print.

- Skull forms the bony core of the head & face.
- A recent photo of deceased (front view, lateral / semi lateral view) is required.
- Person can be identified – by superimposition of negatives of skull & of life size photo of the deceased.
- Enlargement can be done by considering a standard point (like nose ring, ear ring, necklace, design of dress, etc.,) so that the interpupillary distance corresponds to the two orbits of the skull.
- While superimposing the following should be considered – eyes in orbits, point at which nasal bone joined with forehead (nasion), point between two front incisor teeth on upper jaw (prosthion), the nasal spine & lower border of the nose
- Perfect matching - if all anatomical landmarks in both the photographs superimposed- then the skull is identified with the missing person.

Frontal skull on photo
(Skull Superimposition)





THANK YOU