FORENSIC MEDICINE & TOXICOLOGY SUPPLEMENTS

NISHTAR MEDICAL UNIVERSITY MULTAN

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www.facebook.com/humanfountainsarc

Drawbacks of being married to a forensic geneticist

REFERENCES

FORENSIC MEDICINE & TOXICOLOGY

1. G. Principles and Practice of Forensic Medicine, 2nd Ed., by Prof. Nasib R. Awan.
2. Review of Forensic Medicine and Toxicology, 3rd Ed., by Gautam Biswas

CONTENTS


HUMAN
FOUNTAINS


HUMAN
FOUNTAINS

1

LAW, LEGAL PROCEDURES & FORENSIC PSYCHIATRY

1 SEQ + 5 MCQs = 10 Marks

TYPES OF DELUSIONS

Delusion is disorder of thought is defined as a false, but firm belief in something that is not a fact.

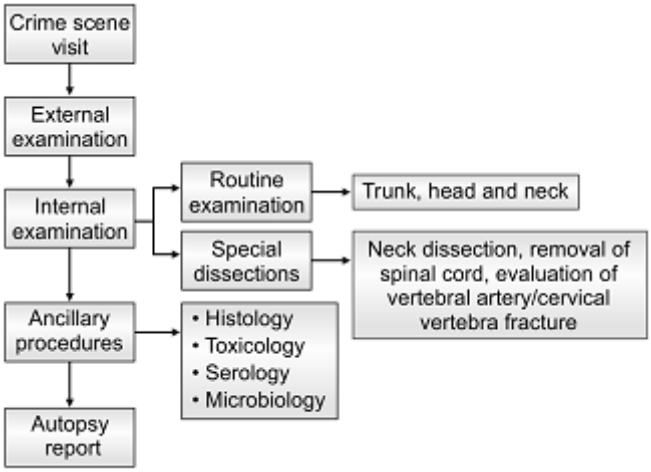
1. **Hypochondriacal delusion**
   Person feels that something is wrong in his or her body, though he or she is healthy.
2. **Delusion of poverty**
   Person thinks he or she is poor/pauper, though he or she is rich.
3. **Nihilistic delusion**
   Person declares that he or she does not exist and the world also has no existence, etc.
4. **Delusion of grandeur**
   Person imagines that he is rich/and famous, wherein he is actually poor/and inconsequential.
5. **Delusion of persecution (paranoid delusion)**
   Person thinks that his or her nearest and dearest relatives are trying to poison or kill him or her.
6. **Delusion of reference**
   Person believes that people, things or events happening around him or her are referred to him or her in a special or indirect way.
7. **Delusion of influence (control)**
   Person feels that he or she is controlled by an outside power, agency, radio, hypnotized telepathy, etc.
8. **Delusion of infidelity**
   Person imagines that his/her spouse is unfaithful.
9. **Delusion of self-accusation**
   Person keeps on blaming himself/ herself on trivial incidents that happened in the past.

2

AUTOPSY & EXHUMATION

1 SEQ + 3 MCQs = 8 Marks

OBJECTIVES OF FORENSIC (MEDICO-LEGAL) AUTOPSY



1. Determine the cause of death
2. Determine the mode of death i.e. which system of three vital systems failed first
3. Determine the manner/circumstances of death i.e. natural or unnatural
4. Establish identity of deceased when not known
5. Estimate time since death
6. Collect evidences to identify the object causing death and to identify criminal
7. Document injuries and to deduce how the injuries occurred
8. Retain relevant organs/viscera and tissues as evidence
9. Whether deceased received any treatment before death.
10. In newborn infants – determine the issues of live birth and viability

DIFFERENCE BETWEEN FORENSIC & MEDICAL AUTOPSY

Feature	Forensic Autopsy	Medical Autopsy
Synonyms	Medico-legal OR Postmortem Examination	Academic, Hospital, Clinical, OR Pathological
Consent	No consent is required	Consent of relatives is must
Conducted	Conducted under legal authority	Not so
Requisition	From legal authority is necessary	No such requisition is required
Procedure	Always complete	Complete or incomplete depending on consent
Aim	"Mentioned above"	To confirm make clinical diagnosis

AUTOPSY AS A DIALOGUE WITH DEAD BODY

Autopsy is a dissectional study of dead body in which examining doctor tries to seek and establish circumstances of death and it tells doctor "nothing but truth". It is dialogue between doctor and dead body. The deceased is interrogated to answer following questions:

QUESTIONS	SAMPLE ANSWERS
Who are you? Identity of dead body	Age, sex, race, height, weight, ID marks, health status, scars, tattoos, occupational marks etc.
When & where were you hurt and died? Cause of death	• Disease • Injury (trauma, firearm, hanging etc.) • Intoxication
Which system failed first to cause death? Mode of death	• Asphyxia (stoppage of respiration) • Syncope (stoppage of circulation) • Coma (stoppage of innervations)
How were you hurt and then died? Manner of death	• Natural (disease) • Unnatural (homicide, suicide, accident)
How long it has been that you died? Time since death	• Changes in temperature, texture, condition of deceased • Putrefactive changes, maggots, adipocerous formations
What is your position at time of death? Position of body at death	• Cadaveric Spasm • Pugilistic Attitude
Did anyone poison you? Poisoning being cause of death	• Colour changes i.e. CO: cherry red, $CuSO_4$: Blue • Odor changes i.e. Fishy: Zn sulphide, Fruity: Ethyl Alcohol • Corrosion of lips, mouth, chin, hands etc • Injection, bite or sting marks • Poisonous fluids, tablets, powders in the body

ADVANTAGES & DISADVANTAGES OF DIFFERENT TYPES OF INCISIONS

Type	Advantages	Disadvantages
Straight or I-shaped	• Common method • Easy • Fast technique	• Do not give adequate exposure and access to axillary region and neck organs
Y-shaped	• More cosmetic • Spares the skin at neck • Axillary & neck regions are easily accessed	• More tedious procedure • Require more time
Modified Y-shaped	• Better exposure of neck region • Faster than Y-shaped technique • More tedious procedure	• Require more time • Do not give adequate exposure and access to axillary region

COLLECTION OF SAMPLES IN AUTOPSY

Material	When Required?
CHEMICAL EXAMINATION Preservatives used are: a. Saturated NaCl Solution (All poisoning cases and carbolic acid + Urine) b. Rectified Spirit i.e. 99% Ethyl Alcohol **OR** 90% Ethyl Alcohol/10% Methyl Alcohol (Urine + Acid poisoning except carbolic acid, acetic acid, alcohol, phenol, paraldehyde & phosphorous) c. Thymol, Concentrated HCl or Sodium benzoate for Urine	
Bottle 1: Stomach and contents	Routine Examination
Bottle 2: 60 ounce Liver (right lobe) with gall bladder Spleen One kidney (2 in infants)	
Bottle 3: 3 feet upper small intestine and contents	
Bottle 4: Preservative Used	
Bottle 5: 100-200 ml Urine	
5-10 ml Blood in ampule	
Heart	Strychnine, digitalis
Spinal cord	Strychnine
CSF	Alcohol
Vitreous humor	Alcohol, chloroform
Lung	Gaseous poisons, hydrocyanic acid, Alcohol, chloroform
Skin	Injected poisons (insulin, morphine, heroin, cocaine) Firearm injuries
Bone, hair and nails	Heavy metals (arsenic, antimony, thallium)
Fatty tissue	Pesticides and insecticides
Uterus and its appendages	Criminal abortion
Muscle	Decomposition
Brain	Alkaloids, organophosphorus, opiates, strychnine, carbon monoxide, cyanide, barbiturates and volatile organic poisons; hydrophobia/rabies (for negri bodies)
PATHOLOGICAL EXAMINATION Preservatives used is 10% Formalin	

EXHUMATION

It is the lawful digging out of an already buried body from the grave for postmortem examination.

Reasons

1. Criminal cases
   i. Establishing the cause and manner of death in suspected homicide disguised as suicide.
   ii. Death as a result of criminal abortion and criminal negligence.
   iii. Retrieving some vital object which may throw light on the case, e.g. bullet from the dead body, if the person was killed by a firearm.
2. Civil cases:
   Identification of deceased for accidental death claim, insurance, workmen's compensation claim, liability for professional negligence, survivorship and inheritance claims, disputed identity, separation overseas, and burial of the wrong body inadvertently or by fraud.

Authorization

A written order from:

a. First Class Magistrate
b. District Magistrate
c. Sub-Divisional Magistrate **OR**
d. Executive Magistrate

Procedure

1. Necessary preparation with help of graveyard authorities.
2. Identification of grave by caretaker of graveyard, grave digger and relatives or friends at time of burial
3. Dead body removal from grave and identification
4. Samples collection from earth in case of suspected poisoning, from above, below, sides of dead body and control sample from distant place
5. Autopsy examination and protocol

Precautions

1. Should be performed in day light (open light) with adequate ventilation (person should stand by wind side)
2. Face mask impregnated with $KMnO_4$ and Gloves should be used
3. Disinfectant should be sprinkled on sides of body only (not on the body)
4. Witness for identification of grave, coffin and dead body should be provided by police officer
5. For necropsy wounds, immediately hands should be wash and dipped in disinfectants

Limitations

1. Time lapse between death and exhumation time causes decomposition of body i.e. loss of histopathological examination as soft tissue findings are obscured (No time limit set in Pakistan)
2. Postmortem artifacts may be taken as diagnosis at time of exhumation
3. Environmental and deceased conditions at time of exhumation
4. Toxicological examination i.e. vegetable, volatile or synthetic poisons is lost at time of exhumation
5. Inexperienced and untrained person who misinterpret the findings at time of exhumation

3

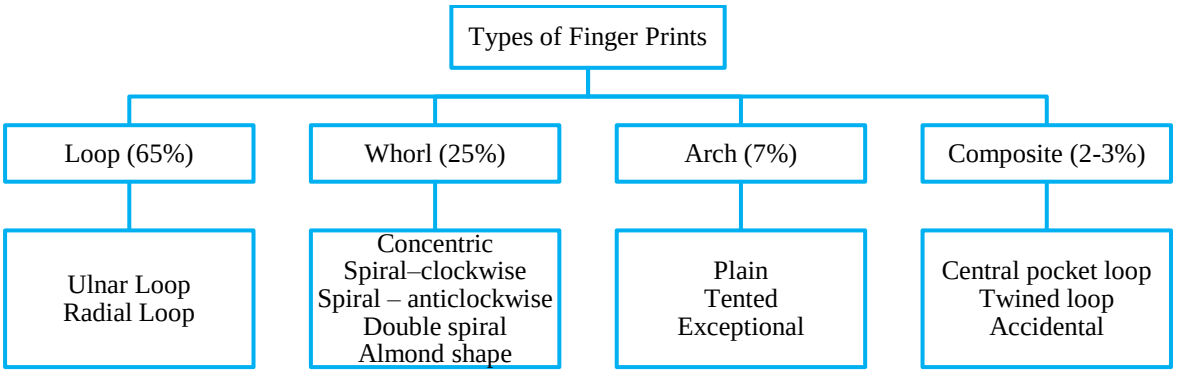
PERSONAL IDENTITY & BIOLOGICAL SPECIMENS

1 SEQ + 5 MCQs = 10 Marks

NEED OF IDENTIFICATION IN LIVING PERSONS

CIVIL CASES	CRIMINAL CASES
• Marriage • Passport/license • Inheritance • Insurance claim • Pension • Missing persons • Disputed sex	• Persons accused of assault, murder or rape • Interchange of newborn babies in hospitals • Impersonation • Absconding soldiers and criminals • Road accident • **Dead Persons:** Homicide, Suicides and other accidental dead bodies

CLASSIFICATION OF FINGER PRINTS



DIFFERENCE BETWEEN TYPES OF TEETH

FEATURE	DECIDUOUS TEETH	PERMANENT TEETH
Number	20 (8 incisor, 4 canine, 8 molars)	32 (8 incisors, 4 canine, 8 pre molars, 12 molars)
Premolars	×	✓
Size & weight	Smaller and lighter, Delicate	Larger and heavier, Stronger
Colour	China white	Ivory white
Placement	Anterior teeth are vertically placed	Anterior teeth are inclined/projected forward
Neck	More constricted	Less constricted
Presence of ridge	Present between neck and body	×
Root of molars	Smaller and more divergent	Longer and less divergent
Replaced by	Permanent teeth	×
X-ray	Reveals bud or germination center of permanent teeth	×

DETERMINATION OF SEX

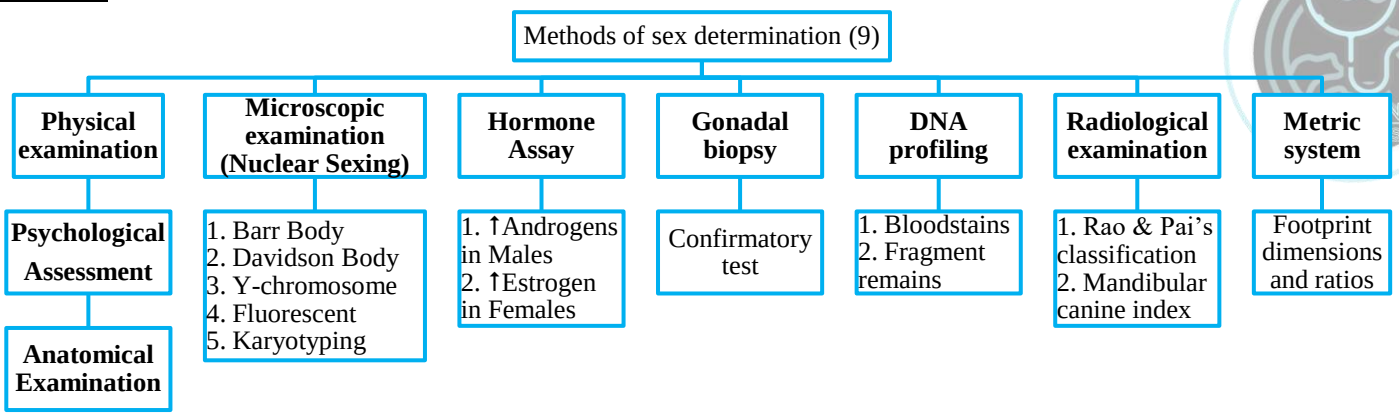
Medico-legal Importance

1. For the purpose of identification in living or dead or from skeletal remains.
2. For determination of sex of a person with ambiguous, concealed or intersex
3. For deducing whether an individual can exercise certain civil rights reserved to one particular sex only.
4. For deciding questions related to legitimacy, divorce, paternity, affiliation, heir-ship and criminal offences.
5. In case of national or international sports meet or games.

Sexual Evidence

EVIDENCE	BASIS	LIMITATION
Presumptive	**External appearance** (General body features and appearance, clothing, body contour, distribution of hairs, habits, voice, etc)	Concealed Sex
Probable	**Assessment of secondary sexual characteristics** (Development of breasts & genitals, presence of vagina in females & penis in males, distribution of subcutaneous fat, muscular development etc.)	Ambiguous or Intersex
Positive	**By genital, gonadal or microscopic tests**	

Methods



Physical Examination of Humans

FEATURE	MALE	FEMALE
Built	Muscular and strong	Less muscular, delicate
Height	More	Less
Weight	More	Less
Scalp hairs	Short and coarse	Long and fine
Eyebrow	Coarse and thick	Fine and thin
Voice	Hoarse after puberty	Soft
Moustache	Present	Absent/rudimentary
Beard	Present	Absent/rudimentary
Hair on pinna	Present	Absent
Body hairs	Grow over chest, abdomen, limb	No significant growth of hairs
Pubic hairs	Thicker, coarse, extend upwards towards navel	Horizontal, covering only mons pubis, triangular distribution
Breast	Rudimentary	Well developed
Thyroid cartilage angle	Prominent and angle < 90°	Less prominent, angle >120°
Shoulder and hip	Broader than hip	Hip broader than shoulder
Chest and abdomen	Chest dimensions more	Abdomen dimensions more
Waist	Not well defined	Well defined
Gluteal region	Flat	Full and roundish
Forearm	Antero-posteriorly flat	Roundish
Thigh	Cylindrical	Conical
Wrist and ankle	Coarse and rough	Smooth and delicate
External genitalia	Scrotum, testis and penis	Labia, clitoris, and vagina
Internal genitalia	Vas deferens, prostate, seminal vesicle, ejaculatory ducts	Ovaries, uterine tube, and uterus

Psychological Assessment

i. **Transvestite:** One who is obsessed with clothing of opposite sex
ii. **Transexual:** One who has dominant wish to identify with opposite sex

Anatomical Examination of Humans

FEATURE	MALE	FEMALE
SKULL		
(Book Page # 50)		
PELVIS		
(Book Page # 50)		
MANDIBLE		
Size	Large	Small
Architecture	Ragged	Smooth
Muscular impression	Prominent	Not prominent
Mandibular angle	Everted	Inverted
Chin	Square shaped	Round
Shape of bone	"V" shaped	"U" shaped
Mental tubercle	Large and prominent	Insignificant
Myelohyoid line	Prominent and deep	Shallow
Height at symphysis menti	More	Less
Ascending ramus	Broad	Narrow
Condylar process	Larger	Smaller

DIAGNOSTIC INDICES		
Ischiopubic Index = $\frac{\text{Length of Pubis}}{\text{Length of Ischium}} \times 100$	73-94	91-115
Sciatic Notch Index = $\frac{\text{Width of Sciatic Notch}}{\text{Depth of Sciatic Notch}} \times 100$	4-5	5-6
Sternal Index = $\frac{\text{Length of Manubrium}}{\text{Length of Body}} \times 100$	46.2	54.3
Corporobasal Index = $\frac{\text{Breath of body of S1 Vertebra}}{\text{Breath of base of Sacrum}} \times 100$	>42	<42
Sacral Index = $\frac{\text{Transverse diameter of base of Sacrum}}{\text{Anterior length of Sacrum}} \times 100$	<114	>114

Rao & Pai's Classification of Costal Cartilage Calcification Pattern

i. Square bracket type – found in male
ii. Linear type – found in male
iii. Central tongue shaped type – found in female

Mandibular Canine Index

$$\text{Mandibular Canine Index (MCI)} = \frac{\text{Permanent Mandibular Canine Width}}{\text{Arch Width}} \times 100$$

i. MCI ≤ 0.274 – Female
ii. MCI > 0.274 – Male

Footprint Ratio

$$\text{Footprint Ratio (FPR)} = \frac{\text{Maximum Width of Footprint}}{\text{Maximum Length of Footprint}} \times 100$$

i. FPR ≤ 0.376 or 0.377 for left and right foot respectively – Female
ii. FPR > 0.376 or 0.377 for left and right foot respectively – Male

Difficulties of Sex Determination

1. Concealed sex: Physical and Psychological Study
2. Decomposed bodies, Mutilated bodies or Skeletal remains: Anatomical Study
3. Hermaphroditism or intersex state: Chromosomal or Microscopic Study

MORPHOLOGICAL AGE RELATED CHANGES IN MANDIBLE

FEATURE	INFANCY	ADULT	OLD AGE
Angle between Ramus & Body	Obtuse Angle	Right Angle	Obtuse Angle
Body	Shallow & small	Thin & elongated	Shallow & big
Ramus	Short & oblique	Stunted	Long & oblique
Condylar process	At lower level than coronoid process	Above level of coronoid process	Neck is bent backward
Mental foramen	Placed near to lower border	Midway between upper & lower border	Near alveolar margin

DETERMINATION OF RACE

Race is defined as "biological grouping within the human species distinguished or classified according to genetically transmitted differences".

Determination Methods

1. General Appearance

FEATURE	NEGROS	CAUCASIANS	MONGOLIANS
Complexion	Black	Fair	Yellowish
Eyes	Black	Gray or blue	Black
HAIRS			
Features	Thick, woolly, curly and self spiraled	Straight or wavy, blondes brown or fair.	Coarse, straight or wavy, black or brown
Diameter	60–90 µm	70–100 µm	90–120 µm
Cross-section	Flattened	Oval	Round
Pigmentation	Dense and clumped towards the periphery	Uniform distribution	Dense abundant through the
Cuticle	—	Medium	Cross-section
Undulation	Prevalent	Uncommon	Thick

2. Skeletal characteristics and indices

FEATURE	NEGROS / NEGROID	CAUCASIANS/ CAUCASOID	MONGOLIANS/ MONGOLOIDS
Cephalic Index = $\frac{\text{Transverse Breath of Skull}}{\text{Maximum AP Length of Skull}} \times 100$	70-74.5 Dilichocephalic	75-79.9 Mesaticepahlic	>80 Brachycephalic
Height Index = $\frac{\text{Height of Skull}}{\text{Length of Skull}} \times 100$	72	71	75
Nasal Index = $\frac{\text{Width of Nasal Aperture}}{\text{Height of Nasal Aperture}} \times 100$	55	46	50
Brachial Index = $\frac{\text{Length of Radius}}{\text{Length of Humerus}} \times 100$	>80	<75	-
Crural Index = $\frac{\text{Length of Tibia}}{\text{Length of Femur}} \times 100$	>83	<83	-
Humofemoral Index = $\frac{\text{Length of Humerus}}{\text{Length of Femur}} \times 100$	72.4	69	-
Intermembral Index = $\frac{\text{Length of Humerus + Radius}}{\text{Length of Femur + Tibia}} \times 100$	70.3	70.4	-
Skull	Narrow Elongated	Rounded	Square
Forehead	Small and compressed	Raised	Inclined
Orbits	Square	Triangular	Rounded
Nasal aperture	Broad	Narrow elongated	Rounded
Face	Lower jaw projecting	Small	Large and flattened
Teeth	3rd Molar > Other two	Carbelli`s cusp (Small nodules on lingual surface of maxillary molar)	Shovel shaped of upper central incisors. Enamel pearls Taurodontism (bull tooth) Congenital lack of 3rd upper molar is common.
Hard palate	Rectangular	Triangular	Rounded
Upper extremity	Limb > body Forearm > arms Hand small	Normal	Small
Lower extremity	Leg > thigh Feet wide & flat Heel projecting backward	Normal	Small

3. Religion Basis
   i. Sikhs (5K)
      a. Kais (long untrimmed hairs)
      b. Kerpan (small sword)
      c. Katcha (underwear)
      d. Kanga (comb)
      e. Kara (steel bangle)
   ii. Christians
      a. Cross or any other religious design
      b. Medals around neck
      c. Pants in males and skirts in females
   iii. Parisi
      a. Sudra and Kusti worn by males and females
   iv. Hindu
      a. Males: Sacred thread on left shoulder, Wooden beads necklace, Ear lobules pierced, Colourful marks on forehead
      b. Females: Tattoo marks, Saari, No pubic hair removal, Carmine Autha in palms & soles

v. Mohammedan (Muslims)
   a. Males: Ear lobules not pierced, Callosities due to prayers on different body areas
   b. Females: Burqa, Pubic hair removal, Henna in hands, soles & nails

TATTOO MARKS

Tattoo marks are designs affected by multiple small puncture wounds made through the skin with needles or similar penetrating tools dipped in colouring material.

Dyes Used

1. **Black**: Carbon (India ink), China ink, Soot
2. **Red**: Cinnabar, Vermilion
3. **Brown**: Ochre
4. **Green**: Chromic oxide
5. **Blue**: Prussian blue (Ferric ferrocyanide), Indigo, Cobalt, Ultramarine

Features

1. Marks in dermis are deeper than in epidermis
2. Covered areas are less exposed to friction so have longer duration of marks
3. Permanent marks depend on dye used.

Revealing

1. Use of ultraviolet light
2. Infrared photography
3. Rubbing area and examining under magnifying glass
4. Visualized by treating the area with 3% H_2O_2 (If marks are obscured by decomposition)
5. Treating the skin with 0.5% caustic potash
6. Faint or faded tattoo marks can be made out on histological examination of regional lymph nodes. The lymph nodes near a tattoo mark show deposit of pigment used for tattooing.

Complications

1. Infection: Septic inflammation, Abscess, Spread of infectious disease such as AIDS
2. Scar or keloid may be formed.

Elimination/Removal

1. Complete excision of tattoo mark followed by skin grafting
2. CO_2 snow
3. Electrolysis: By utilizing 2-5 mA of current with needle to remove mark.
4. Laser beams: Particles of dye get vaporized.
5. Application of caustic substance: Crude method

Medico-Legal Importance

1. Identification of person
2. Religion or God of worship can be known from the pattern or design of tattoo mark
3. Country can be known.
4. Social status can be known.
5. Mental makeup of person can be known
6. Language of the person can be known

SCARS

A scar is a fibrous tissue produced as a result of healing of wound and it is covered by epithelium devoid of hair follicles, sweat glands or pigment.

Features

1. Permanent
2. By damage to dermis
3. Assumes shape of wound
   a. Incised Wound: Linear Scar
   b. Lacerated Wound: Broad and irregular scar.
   c. Stab Wound: Oval, elliptical or triangular scar (depending on shape of weapon)
   d. Bullet Wounds: Circular & depressed
   e. Burns or corrosive chemicals: Irregular and Coarse
   f. Small pox: Multiple scars
   g. From Scalds: Spotted running downwards
   h. Healing of wound by secondary intention: Scar wider & thicker in center than periphery
   i. Vaccination: Circular, oval, flat or slightly elevated
   j. Striae gravidarum: Multiple over abdomen in females who are pregnant or who were pregnant
   k. Drug addicts: Cubital fossa due to repeated injections

4. Time required for formation of scar depends on nature of injury, size and site of wound over body and presence or absence of infection.

Growth

Scars produced in childhood will grow in size with development of person, especially if scars are located on chest or limbs.

Age of Scar

- < 2 weeks: When first formed, scar is red, tender and covered by scab
- 2 week to 2 month: Then it becomes denser and brown
- 2-3 month: Then it becomes whit and glistening, tough and may be wrinkled
- Later: After this no further change occurs and it becomes difficult to date the scar.

Scar Erasure

Scars cannot be erased or removed completely however, size and shape can be altered by operative procedure such as excision and skin grafting.

Recording Scars for Identification

1. Number of scars, shape, size and situation over body
2. Fixed or mobile
3. Consistency of scar
4. Colour of overlying skin
5. Faint scars can be made visible by filtered UV light or by magnifying lens.

Medico-legal Importance

1. Important for identification
2. Type of weapon used for causing injury
3. Age of scar can be determined.
4. Type of injury can be commented e.g. lacerated wound, stab wound etc.
5. Striae gravidarum indicate present or past pregnancy.
6. Scars causing following injuries amounts to grievous hurt (section 320 of PPC):
    A. Permanent disfiguration of face
    B. Causing contracture and/or joint restriction or hamper function of joint
    C. Over cornea causing permanent total or partial loss of vision.

OCCUPATIONAL MARKS

These marks offer help in identification as certain occupation or trade may leave marks.

1. **Temporary marks:**
    a. Paints, dyes or chemical or grease etc. at fingertips in case of painters, dyers, engineers or mechanic respectively.
    b. Microscopic examination of dust or debris under nail beds/in clothes/in earwax may also aid in identification.
2. **Permanent marks:**
    a. Manual labourer: Heavy and rough hands
    b. Tailors: Needle puncture marks on their left index fingers
    c. Butcher: Thickening of palmer skin of fingers
    d. Impart colour changes to hairs e.g. Copper smelters: greenish hair, Cobalt miners: Bluish hairs.

TRACE EVIDENCE

Material left behind at the locus or on body of victim/accused or any other thing, acting as a clue and helping in the identification of person objectively or subjectively.

Types

1. **Biological:** Blood, Semen, Urine, Fecal, Milk, Saliva, Hair, CSF, Vomit, Stomach Wash, Nails etc.
2. **Non-biological:** Weapons, Bullets, Fingerprints, Belongings etc.

Locard's Exchange Principle

It has 2 principles:

1. Every contact leaves a trace
2. Exchange of trace may be and often a two way process

Criminal leaves something or takes something from the scene of crime and detection of such evidence constitutes trace evidence i.e. proves a link between crime and criminal.

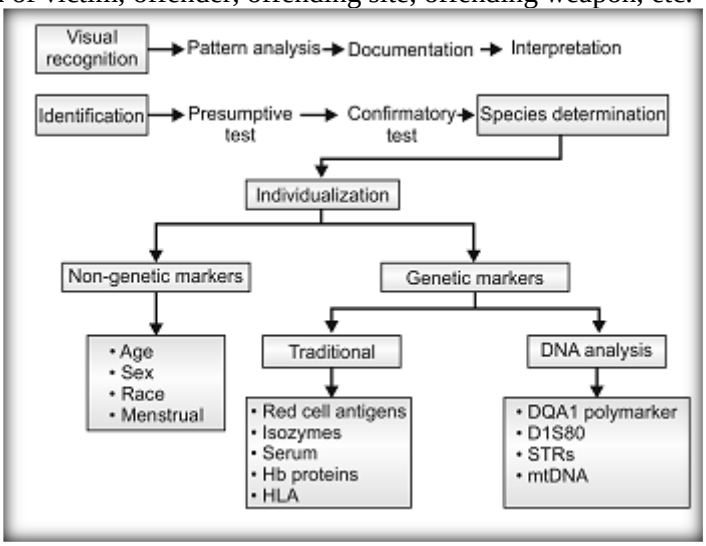
Significance

a. Living: Seminal stains in alleged victim of rape or Blood stains of accused in alleged assault
b. Dead: Salivary dribbling in ante-mortem hanging

EVALUATION APPROACH IN BLOOD STAIN ANALYSIS

Medico-legal Importance

1. Civil Cases
    a. Disputed paternity/maternity
    b. Divorce and nullity of marriage
    c. Civil negligence
    d. Inheritance claims
2. Criminal Cases
    a. Identification of victim, offender, offending site, offending weapon, etc.



<table>
<tr><th>QUESTIONS</th><th>SAMPLE ANSWERS</th></tr>
<tr><td>What is the manner in which a bloodstain was deposited at crime scene?
Pattern Analysis</td><td>• Blood deposition tells about:
i. Distance from impact origin
ii. Object that may have been responsible for impact
iii. Direction of impact
iv. Number of impacts (e.g. shots, blows)
v. Movement of an individual after injury
• Bloodstain shapes are determined by the angle of impact of drop of blood.
i. 90°: Round with spiked edges giving a ‘crown’ appearance.
ii. <90°: Longer & narrower and a tapering or ‘tear-drop’ stain is formed,
iii. 10°: Small separate spot in front resembling ‘exclamation mark’ (lance-shaped)
• Smearing indicates movement of the bloodstained object across the surface.</td></tr>
<tr><td>Is it blood stain?
Identification</td><td>• Bloodstains resemble rust stains or pan stains.
• Identification of blood in stain is based on blood cells, hemoglobin, serum proteins & derivative.
• It is done by presumptive (screening) and confirmatory tests</td></tr>
<tr><td>Identification I
(Presumptive/ Screening tests)</td><td>CATALYTIC COLOUR TESTS
(based upon principle of presence of peroxidase in RBCs)
H_2O_2 + Reduced reagent ↔ H_2O + Oxidized reagent
(Colour 1) (Colour 2)
Procedure
1. Questioned stain is sampled with a clean, moistened cotton swab.
2. One drop of color reagent solution is added, followed by a like amount of H_2O_2.
3. Nascent oxygen is liberated by action of peroxidase on H_2O_2.
4. Immediate color development, (typically particular reagent), indicates blood presence in sample.
<table>
<tr><th>TESTS</th><th>REAGENT USED</th><th>INFERENCE</th></tr>
<tr><td>Benzidine</td><td>Benzidine solution + H_2O_2</td><td>Blue colour</td></tr>
<tr><td>Phenophthalein (Kastle-Meyer)</td><td>Alkaline phenolphthalein + H_2O_2</td><td>Pink colour</td></tr>
<tr><td>Leucomalachite green</td><td>Stock solution of Leucomalachite green + glacial acetic acid + distilled water + H_2O_2</td><td>Bright green colour</td></tr>
<tr><td>Orthotolidine (Kohn & O’Kelly)</td><td>4% Orthotolidine in ethyl alcohol + glacial acetic acid + distilled water + H_2O_2</td><td>Greenish blue colour</td></tr>
<tr><td>Tetramethylbenzidine</td><td>Tetramethylbenzidine + H_2O_2</td><td>Greenish blue</td></tr>
<tr><td>Luminol / Fluorescein</td><td>Luminol (3-aminophthal-hydrazide)</td><td>Blue-white to Yellow-green glow</td></tr>
</table>
False Positive Test
Pus, saliva, mucus, milk, infected CSF, formalin, plant juices, metallic salts (Cu, Ni) etc.</td></tr>
</table>

Identification II (Confirmatory tests)

CRYSTAL TESTS

(Involve non-protein heme group of hemoglobin,called porphyrins)

TESTS	REAGENT USED	INFERENCE
Teichmann or Hemin	1. Place a sample of suspected blood on glass slide 2. Add few crystals of NaCl + few drops of glacial acetic acid from side of cover slip 3. Heat and observe under microscope.	Brown rhombic hematin crystals single or in groups
Takayama or Hemochromogen	1. Place a sample of suspected blood on glass slide 2. Add Takayama reagent (NaOH + Pyridine + Glucose) from side of cover slip 3. Heat and observe under microscope.	Pink feathery crystals of reduced alkaline hematin in groups

SPECTROMETRY

1. Blood is dissolved in water or normal saline
2. Placed in a small test tube which is then kept between spectroscope and source of light.
3. Solution has property of absorbing some of the rays from spectrum, producing characteristic dark absorption bands which vary with the type of blood pigment present.

Spectra of hemoglobin & its derivatives

- Oxyhemoglobin: 2 distinct bands (between D, E lines) & reduced by ammonium sulfide
- Reduced Oxyhemoglobin: 1 distinct band (between D, E lines)
- Carboxyhemoglobin: 2 distinct bands (between D, E lines) but not reduced by ammonium sulfide
- Methemoglobin: 2 distinct bands (between D, E lines), 3rd (between C & D), 4th (beyond E)

THIN LAYER CHROMATOGRAPHY (followed by benzidine test)

1. Thin layer of silica gel is prepared on a suitable glass plate.
2. An appropriate quantity of sample extract, standard hematin chloride solution and control sample of blood are placed on the prepared gel.
3. The plate is then placed in a chamber having a convenient solvent system.
4. After desired run of the solvent to a certain height (front), it is removed from the chamber.
5. When plate is dry, benzidine + H_2O_2 are sprayed on it. (Formation of blue spot confirms blood)

Identification III (Species identification)

MICROSCOPIC EXAMINATION

1. Stained piece is cut and dipped
2. Teased in a watch glass with 2–3 drops of Vibert's fluid (NaCl, $HgCl_2$ & distilled water) for ½ hr.
3. Examined under a microscope.
   - Non-mammalian RBCs: Oval, biconvex and nucleated
   - RBCs of humans & mammals: Circular, biconcave and non-nucleated mostly

ELECTROPHORETIC METHODS

(Separation and identification of hemoglobin & serum proteins by electrophoresis & immunoelectrophoresis respectively.)

Procedure of Precipitin Test

1. Host animal inoculated with human serum protein
2. Host animal will normally recognize protein as foreign antigen & produce antibodies against it.
3. Harvesting antibodies provides an antiserum to foreign antigen
4. When a sample of antiserum and antigen are brought in contact, a precipitin reaction occurs.

TESTS	DESCRIPTION	INFERENCE
Ring precipitin	Simple diffusion between two liquids (antiserum & blood stain) in contact inside a test tube	Precipitin line
Antiglobulin consumption	Human globulin + Antihuman globulin serum = No longer capable of agglutinating Rh+ RBCc sensitized with incomplete anti-D.	Globulin detected
Ouchterlony	Agar gel plates with wells for both antibodies & antigens (both diffuse into gel, where soluble antigens and antibodies form an insoluble complex)	Precipitate formed
Crossed-over	A variant of Ouchterlony test (but electric field used)	Precipitate formed
Latex	Saline extract of bloodstain + Dilute suspension of latex particles sensitized with antiserum.	Agglutination into clumps

RAPID IMMUNOASSAY

Use of Immunoassay test strips - ABAcard Hematrace test strips which involve reaction of antigens in extract with monoclonal antibodies within test strip resulting in antigen-antibody complex where it reacts with dye particles to create visible reactions.)

- Positive Result: 2 pink lines, one in 'T' area (test sample) and one in 'C' area (control)
- Negative Result: Only 1 pink line in 'C' area

ISOZYMES METHODS

(Electrophoretic demonstration of existence of enzymes in blood of same species in multiple molecular forms. E.g. LDH & Peroxidase)

Blood Group Identification (Individualization)

Blood Groups System are classified as:

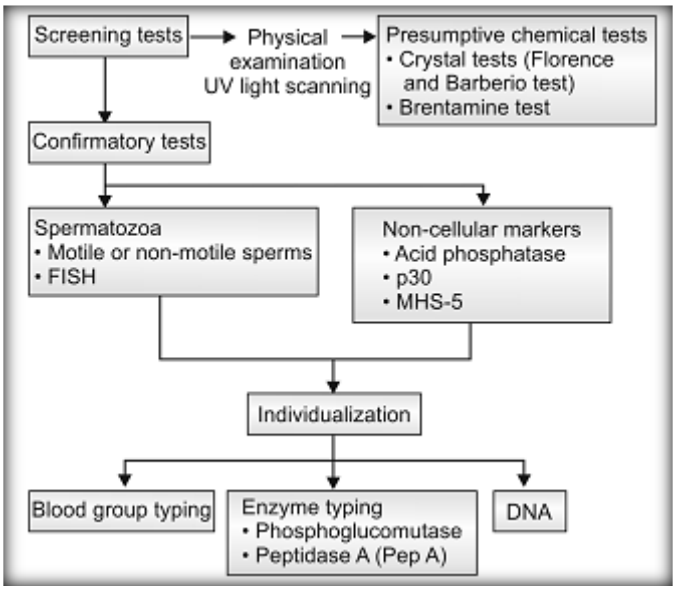
1. RBC based: ABO, MNS, Rh, Duffy, Kidd, Kell, Lutheran
2. Serum based: Haptoglobins, Gm, Gc

<table>
<tr><td></td><td>They are identified by following methods:
1. Direct agglutination
• Ring precipitin test
• Antiglobulin consumption test (Hemagglutination Inhibition Test)
• Crossed over precipitin test
2. Indirect agglutination</td></tr>
<tr><td>What is age of blood stain?</td><td>• Gross examination: fresh stains appear red and sticky. As age advances, it turns brown due to oxidation of hemoglobin to methemoglobin.
• Colorimeter or spectrophotometer
• Immunoelectrophoressis: Gradual disappearance of beta-globulins and gamma-globulins with increase in age of blood stains</td></tr>
<tr><td>What is sex of blood group?</td><td>• By Nuclear sexing (Davidson/Barr body)
• By DNA profiling</td></tr>
<tr><td>What is source of blood?</td><td>
<table>
<tr><th>SOURCE</th><th>APPEARANCE</th></tr>
<tr><td>Arterial</td><td>Bright red</td></tr>
<tr><td>Venous</td><td>Dark red</td></tr>
<tr><td>Nasal bleeding</td><td>Blood mixed with nasal mucous and hair.</td></tr>
<tr><td>Gastric bleeding</td><td>Chocolate colour due to presence of acid, haematin & is acidic in reaction</td></tr>
<tr><td>Menstrual bleeding</td><td>Dark coloured fluid blood with foul smell and with endometrial debris, acidic reaction, vaginal epithelial cells and bacteria are present</td></tr>
<tr><td>Abortion</td><td>Dark clotted blood. Endometrial and placental debris with foetal remnants sometimes present.</td></tr>
</table>
</td></tr>
<tr><td>Antemortem or Postmortem stain</td><td>• Rapid assay for D-dimer using monoclonal antibody coated-latex particles is useful for discriminating between postmortem and antemortem blood in bloodstains.
• Antemortem bloodstains get broken into scales due to the presence of fibrin, whereas postmortem bloodstains become powder</td></tr>
</table>

EVALUATION APPROACH IN SEMEN STAIN ANALYSIS

Medico-legal Importance

1. Civil Cases
   a. Disputed paternity
   b. Inheritance claims (legitimacy)
   c. Artificial insemination
   d. Divorce
   e. Compensation on grounds of acquired sterility/failure of vasectomy cases
2. Criminal Cases
   a. Rape/attempted rape
   b. Sodomy
   c. Bestiality
   d. Sexual murder of female



<table>
<tr><th>QUESTIONS</th><th>SAMPLE ANSWERS</th></tr>
<tr><td>Collection of semen stain</td><td>• Clothing
• Vaginal fluid
• Dried stains on other parts of body like perineum or thighs
• Matted pubic hair
• Stains on smooth surface</td></tr>
<tr><td>Identification</td><td>• It is done by screening and confirmatory tests</td></tr>
<tr><td>Identification I
(Screening tests)</td><td>
PHYSICAL EXAMINATION
• Fresh Semen: Whitish or yellowish-white in color, slightly viscous, jelly-like, sticky and has a characteristic odor. On standing, viscosity is lost due to prostatic fibrolysin, and it becomes thin.
• Dried Seminal Stains on Clothes: Grayish-white or yellowish-gray in color, show an irregular outline and starchy hard in feeling. When examined under filtered UV light, they fluoresce with a bluish-white color (due to choline in semen) which is not specific.
• Fresh Stain on Non-Absorbent Material: Translucent. After a month, it becomes yellow to brown.
PRESUMPTIVE EXAMINATION
• Chemical Tests
<table>
<tr><th>TESTS</th><th>REAGENT USED</th><th>INFERENCE</th></tr>
<tr><td>Barberio’s test</td><td>Picric acid solution (aqueous or alcoholic) + Spermine in semen</td><td>Yellowish needle shaped crystals of spermine picrate</td></tr>
<tr><td>Florence’s test</td><td>Florence solution (potassium iodide + iodine + distilled water) + Choline in semen</td><td>Brown rhomboid crystals of choline iodide</td></tr>
<tr><td>Zinc test</td><td>Presence high concentration of zinc (140 mg/ml) is used as marker for semen</td><td>Semen detected</td></tr>
<tr><td>Acid phosphatase/ Bentamine fast blue test</td><td>Acid phosphatase is found in high concentration in semen compared to other body fluids
α-naphthyl acid phosphate monosodium salt $\xrightarrow{\text{Acid phosphatase}}$ Sodium phosphate + Naphthol
Naphthol + Bentamine $\xrightarrow{\text{Coupling Reaction}}$ Purple Azo Dye</td><td>Purple azo dye</td></tr>
</table>
• Other Tests
i. ELISA – for human semen identification and is based on biotinylated monoclonal antibody to seminal vesicle specific antigen.
ii. Prostate specific antigen (P 30) has been utilized to identify semen as a marker.
</td></tr>
<tr><td>Identification II
(Confirmatory tests)</td><td>
MICROSCOPIC EXAMINATION
The presence of at least one unbroken spermatozoon on microscopy is an absolute proof of semen.
Sperms can be viewed on microscopy by
1. Wet films
2. Smears stained with hematoxylin or Ziehl-Neelsen’s stain
<u>Inference</u>
• Human spermatozoon is 50 µ in length.
• Spermatozoon consist of head, neck and tail
• Spermatozoa may not be seen in semen in Azoospermia, Vasectomy or Old age
FLUORESCENCE IN SITU HYBRIDIZATION (FISH)
Y chromosome specific DNA probe to identify Y-bearing (male) cells. Identifies not only spermatozoa, but also cells of male origin and confirms male-female contact.
ELECTROPHORESIS
LDH isozyme analysis
IMMUNOLOGICAL METHODS
Monoclonal antibody mouse antihuman semen-5 (MHS-5)
</td></tr>
<tr><td>Identification III
(Species)</td><td>• Microscopy
• Precipitation reaction (See blood analysis)</td></tr>
<tr><td>Identification IV
(Individualization)</td><td>• Blood Group Typing (See blood analysis)
• DNA profiling (for identification)</td></tr>
<tr><td>Motility of Sperm</td><td>
• At room temperature – full motility persist for about 3 hour, 50 percent are motile by 8 hour and 10 percent by 24 hour.
• In living persons – intact sperms may be found in vaginal washings up to 12 hours after coitus, while sperm heads can be detected up to 24 hours.
• In dead persons
1. Vagina – sperm head found up to 9 days in vagina
2. Cervix – sperm head found up to 12 days in cervix
3. Uterus – sperm head found up to 15 days
4. Anus – sperms found up to 2 days
5. Mouth/oral cavity – up to 9 hours
</td></tr>
</table>

HAIR EXAMINATION

Study of hairs is called trichology.

Medico-legal Importance

1. Identification of human (Age, Sex, Race, Blood Group)
2. Establish relationship between offence, offender and the victim.
3. Nature of weapon used (by condition of hair and type of injury in region)
4. Nature of assault (by stains)
5. Cause of death (by poisoning)
6. Singed hair (burns/fire arm injury)
7. Alcohol testing
8. Time since death (by knowing rate of growth of different hairs)

<table>
<tr><th>QUESTIONS</th><th>SAMPLE ANSWERS</th></tr>
<tr><td>Whether it is Hair or fiber?</td><td>• Hair is an appendage of skin and is composed of root, shaft and tip.
• Hair consists of three layers namely Cuticle, Cortex and Medulla.</td></tr>
<tr><td>Whether Hair is Human or animal?

$\text{Medullary Index} = \frac{\text{Diameter of Medulla}}{\text{Diameter of Cortex}} \times 100$</td><td>
<table>
<tr><th>CHARACTER</th><th>HUMAN HAIR</th><th>ANIMAL HAIR</th></tr>
<tr><td>Feature</td><td>Fine and thin</td><td>Coarse and thick</td></tr>
<tr><td>Cuticle</td><td>Scales are small, flattened, serrated margin & surrounds shaft</td><td>Scales are large, projecting, wavy or step like and in various patterns</td></tr>
<tr><td>Cortex</td><td>Thick, 4-10 times as broad as medulla</td><td>Thin, rarely more than twice breadth of medulla</td></tr>
<tr><td>Medulla</td><td>Varies considerably, may be narrow, absent or fragmented or discontinuous</td><td>Broad, always present, continuous and wider</td></tr>
<tr><td>Pigment</td><td>Towards periphery</td><td>Around medulla</td></tr>
<tr><td>Medullary index</td><td>< 0.3</td><td>> 0.5</td></tr>
<tr><td>Shaft diameter</td><td>50-150 µ</td><td><25 µ or >300 µ</td></tr>
<tr><td>Precipitin test</td><td>Positive</td><td>Negative</td></tr>
</table>
</td></tr>
<tr><td>Body hair origin</td><td>• Scalp hairs are oval/circular.
• Beard hairs are triangular.
• Pubic hairs are irregular.
• Eyebrow/eyelash, chest, axillary, leg/arm and nose hairs are circular.</td></tr>
<tr><td>Sex of human body</td><td>• Distribution of hair over body
• Length of hair – long in female, short in males
• Presence of Barr bodies in root sheath</td></tr>
<tr><td>Age of human body</td><td>• Type of hair viz. primordial, lanugo hair etc
• Loss of hair from scalp (baldness) with advancing age
• Graying of hairs
• Appearance of body hairs such as:
1. Lanugo hairs suggest — hairs are from newborn infants
2. Presence of pubic hair suggest — appearance of puberty
3. Presence of axillary hairs suggest — appearance of puberty</td></tr>
<tr><td>Blood group of human</td><td>• By blood group tests</td></tr>
<tr><td>Race of human</td><td>See “Identification of race”</td></tr>
<tr><td>Poisoning</td><td>• By chemical analysis of hairs e.g. arsenic</td></tr>
<tr><td>Dyeing</td><td>• Bleached hairs –brittle, dry and straw coloured
• Dyeing – Not uniform & roots are of different colour than rest part of hair.</td></tr>
<tr><td>Stains</td><td>• Mud stains – place of incident, struggle
• Semen stains – sexual offense
• Blood stains – injury, etc
• Saliva stains – hanging/asphyxia death, etc</td></tr>
<tr><td>Injury</td><td>• Blunt force injury – crush injury to shaft with flattening and splitting
• Sharp weapon injury – clean cut surface
• Burns or firearms – singed hairs & carbon particles in hair</td></tr>
<tr><td>Did Hair fall naturally or was it forcibly removed?</td><td>• Naturally fallen hairs: Root is distorted, atrophied and smooth. Root sheath is absent.
• Pulled hairs: Hair bulbs are larger, irregular. Root sheaths are ruptured.</td></tr>
<tr><td>Fibers</td><td>• Cotton – flattened and twisted fibers with long tubular cells
• Jute – smooth fibers
• Silk – long, clear threads without any cells
• Wool – outer layer of flattened cells and overlapping margins</td></tr>
</table>

SALIVA EXAMINATION

Medico-legal Importance

1. Identification of saliva on bite marks, cigarette ends and on clothes
2. Determination of secretor status

Principle

Salivary stains are identified due to presence of enzyme α-amylase and buccal epithelial cells.

Tests

TESTS	DESCRIPTION
α-amylase detection	**RADIAL DIFFUSION** • Utilizes agar gel containing starch. • Classical starch-iodine reaction (blue or purple colour) **DYED STARCH SUBSTRATES** • Starch is covalently linked to a dye such as cibachron blue or procion red to form insoluble complex. Subsequently to α-amylase activity, dye is released from complex and becomes soluble causing change of color • Spectrophotometry • Forms basis of Phadebas test which uses starch-cibachron blue tablets as substrate.
Precipitin test	For species identification
Absorption-elution technique	For blood grouping

MISCELLANEOUS EXAMINATION

STAIN	MEDICO-LEGAL	PRINCIPLE	TESTS
Fecal	Identification in cases of sodomy and bestiality.	Stains can be identified from odor, and presence of undigested muscle fibers, plant cells, starch, bacteria, stercobilin and urobilinogen.	**UROBILIN TEST** • Urobilinogen is oxidized to urobilin by alcoholic mercuric chloride. • Subsequent addition to alcoholic zinc chloride produces a green fluorescence which is due to formation of a stable zincurobilin complex.
Urine	Identification in cases of murder & sexual assault	Presence of urea, uric acid and creatinine	Urine Examination
Vaginal Secretion		Consists of white coagulated material consisting of shed vaginal epithelium and Doderlein's bacilli.	Glycogen-rich Squamous epithelial cells of vaginal tract may be stained with Lugol's iodine.
Dental	Identification in cases of murder, sexual assault etc.	Dental tissues including dentin, cementum & dental pulp.	Blood Grouping Tests
Nails	Identification in cases of murder, sexual assault etc.	Human nails contain mainly ABO blood group antigens. MN blood groups have been detected in some cases.	Blood Tests

4

FORENSIC SEXOLOGY

1 SEQ + 4 MCQs = 9 Marks

SUPER-FECUNDATION

Fertilization of two ova discharged from ovary at same period of ovulation by two different acts of coitus committed at short intervals.

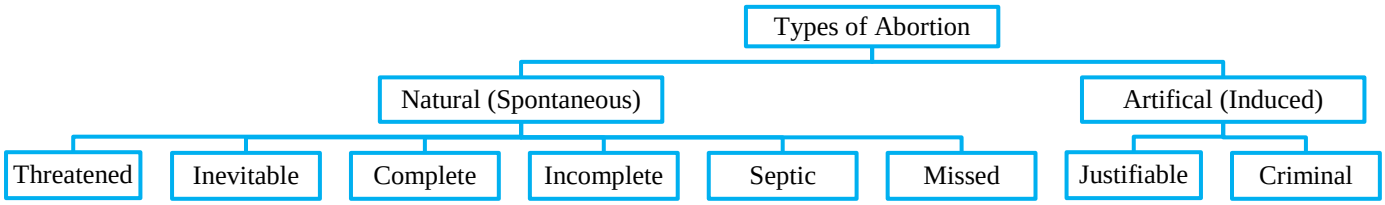
- **Hetero-paternal Super-fecundation**
  Instances of two different males fathering fraternal twins. It leads to possibility of twins also being half-siblings, classic example being one baby is white and other black.
- **Medico-legal Aspect**
  Gross variations may occur in complexion and features of two babies and may give rise to the doubt of adultery and infidelity.

SUPER-FETATION

Fertilization of two ova discharged from ovary at different periods of ovulation.

- It is fertilization of second ovum in a pregnant woman.
- One fetus always remains more developed than other, and may be born either at same time showing different maturation or may born at different periods, varying from 1–3 months.
- Possibility is more with septate or double uterus.
- **Fetus Compressus or Papyraceus**
  In a twin pregnancy, one fetus may grow at the cost of the other. The latter may die, flattened by pressure into a 'mummified' parchment-like state known as fetus papyraceus and may not be recognizable. It is retained till labor expels it.

CLASSIFICATION OF ABORTION



CAUSES OF ABORTION

NATURAL ABORTION

1. **Chromosomal Abnormalities**
   Triploidy
   Turner's syndrome
2. **Placental Abnormalities**
   Acute hydramnios
   Hydatidiform mole
3. **Systemic diseases in Mother**
   Acute infections like malaria
   Hypertension
4. **Drugs/Radiation**
   Inhalation of nitrous oxide
   Toxoplasmosis
   X-rays
5. **Local Abnormalities**
   Fibromyoma
   Cervical incompetence

JUSTIFIABLE/LEGAL ABORTION

1. **Therapeutic Grounds (related to mother)**
   Nephrotic Syndrome
   Uterine Hemorrhage
2. **Eugenic Grounds (related to child)**
   Small pox
   Viral diseases in 1st trimester
3. **Humanitarian Grounds**
   Rape cases
4. **Socio-environmental Grounds**
   Financial Issues
   Already subnormal child in family

METHODS OF INTERFERENCE OF ABORTION

UNSKILLED

- Self-instrumentation
- Abortion stick (15-20 cm Bamboo stick having cotton soaked in arsenic white, red lead or madar)

SEMI-SKILLED

- Instrumentation
- Abortion paste—Utus paste
- Slippery elm bark
- Syringing

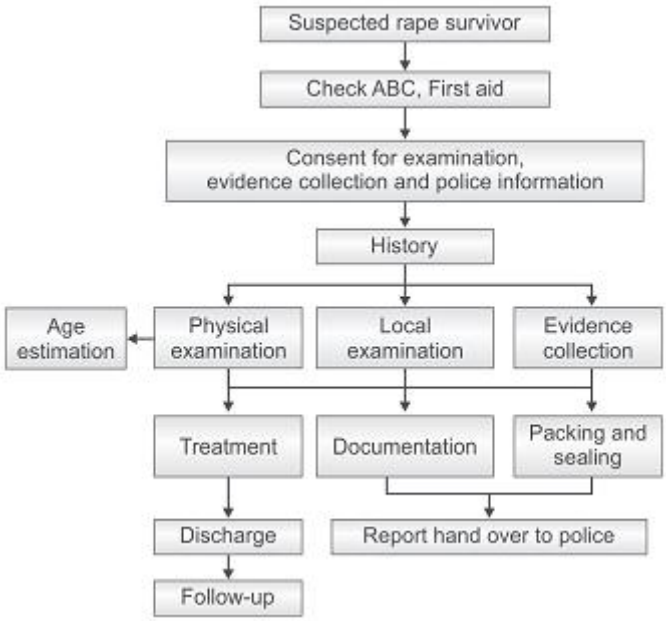
SKILLED

- Dilatation and curretage
- Vacuum suction
- Prostaglandins & Abrortifacients
- Amniocentesis
- Electric current
- Intrauterine instillation of hyperosmotic solution

DIFFERENCE BETWEEN NATURAL AND CRIMINAL ABORTION

CHARACTER	NATURAL ABORTION	CRIMINAL ABORTION
Cause	Predisposing diseases	Pregnancy in unmarried woman or widow
Injuries on genital organs	Absent	Contusions and lacerations may be present
Marks of violence on abdomen	Absent	May be present
Foreign bodies in genital tract	Absent	May be present
Fetal injuries	Absent	May be present
Toxic effect of drugs	Absent	Inflammation of vagina, cervix, GIT or urinary tract may be present
Infection	Rare	Frequent

EXAMINATION OF VICTIM OF RAPE/ZINA-BIL-JABAR



QUESTIONS	DESCRIPTION
Pre-Examination	• **Requisition:** Proper Authority Letter from Police is required • **Person Identification:** Police constable must identify victim (accompanies) & record 2 ID marks • **Consent:** In expressed written form, from adult victim or from parents of victim < 18 years • **Biodata Information:** Victim Name, Father Name, Age, Address, Social Status, Marital Status • **Date, Time and Place of Examination** • **Third Party:** Female doctor or Female nurse or Female Relative • **Other Requirements:** Proper light, stage and other examination instruments • **Position:** Vaginal Exam in Lithotomic Position & Anal exam in Knee-Elbow Position
Medical Examination	**GENERAL IMPRESSION** • Behaviour & Character • Age to access build and development of secondary sex characters • Gait (Broad base & short in rape) • Make up (disturbed) • Mental status (frightened & depressed) • Speech (confuse, shy, slurred) • Struggle evidence marks • Fingernail examination **HISTORY OF EXAMINATION** • **Specific History** ⇒ What were the time, date and place of the act? ⇒ Who removed the clothes from victim and how? ⇒ Who removed the clothes from accused and how? ⇒ What were the relative positions during the act? ⇒ Was there pain during or after the act? ⇒ Was the act performed by one or more persons? ⇒ Was any violence used by accused(s)? ⇒ Was penile penetration partial or full? ⇒ Whether ejaculation took place inside or outside? ⇒ Was any contraceptive used during the act? ⇒ Has victim changed or washed the clothes after the act? ⇒ Has victim bathed or washed away the body parts after the act?

	• **Obstetric History** ⇒ Any medication in last 24 hours ⇒ Previous sexual experience ⇒ Menstrual status and cycle with dates ⇒ Marital status ⇒ Previous child births with dates (if married)
Examination of Clothes	• Make victim stand of plain white cloth free of contamination • Undressing should be done by the victim herself while standing to avoid loss of any trace evidence • Spread the clothes in proper light (day light) and inspect for following: ⇒ Manner and state of clothes ⇒ Damage to clothes due to struggle ⇒ Site and nature of any staining (air dry the wet stains)
Examination of body	**GENERAL EXAMINATION** • **Physical Health:** Height, Weight, Built, Vital Signs, Anemia, Strength, Resistance ability • **Mental Health:** Memory, Concentration, Feeling, Orientation • **Injuries:** ⇒ Bruises ✓ Hands, forearms, arms (griping exerted by pressure of finger tips) ✓ Medial sides of knee and thigh (to separate them) ✓ Hips, Cheeks, Breast (scuffle) ⇒ Abrasions ✓ Back of body (friction in rape) ✓ Back of elbows and front of knees (friction in sodomy) ✓ Nail scratches (on accused body on face and around genitals) ⇒ Bite Marks ✓ Neck and front of chest of accused (imprint abrasions) • **Stains:** Semen, Blood, Saliva, Soil, Vegetation, Oil from thighs. areas around genitalia, breast, mouth, face etc • **Loose Hairs:** From either partner • **Cheeks & Breasts:** Injuries, Scratches, Contusions, Bite marks, Suction areas, Petechial Hemorrhages, Bitten Nipples **SYSTEMIC EXAMINATION** • In both victim and accused • To rule out the possibility of false defense plea by the accused on the grounds of physical ability or other systemic diseases. **GENITAL EXAMINATION** • Most important and is based on physical disproportion between vaginal and anal canals, & penis of accused. • **Modified Findings:** ⇒ Time interval between sexual act ⇒ Previous experiences of sexual intercourse ⇒ First aid rendered after the act ⇒ Changing of clothes and washing of parts • **Requirements:** a. Lithotomy table b. Pedestal lamp c. Surgical gloves d. Specula e. Magnifying lens f. Glister Keen glass rods (for deployment of hymen edges) g. Swab applicators h. Test tubes i. Slides j. Containers **Vaginal Exam** • Divided into 4 stages: A. INSPECTION ✓ Labia majora, labia minora, mons pubis and adjacent parts of thigh ✓ Redness, swelling, lesions, bleedings, discharge, injuries, stains, loose hairs, matted/soiled pubic hairs B. BILATERAL TRACTION OF LABIA ✓ **Make hymen visible** ➢ Female with intact hymen = Virgo intact (no further exam of vagina performed) ➢ 1 mm thick membranous structure that closes vaginal orifice partially ➢ Straight, irregular, partly folded or frim briated edges

- ✓ **Loss of virginity (defloration):** First intercourse rupture the hymen and laceration of tear of hymen
- ✓ **Hymen Examination:**
  - ➢ For making tears visible
    1. Lateral traction of vaginal orifice by placing thumbs at 3 & 9 o'clock
    2. Hymen stretched at 6 & 12 o'clock
    3. Above step repeated in all around
  - ➢ For differentiating old from new scars
    1. Use of Glister Keen glass rods
    2. Old scars: Translucency of hymen brighter
    3. New scars: Translucency of hymen slightly blurred
- ✓ **Digital Tears:**
  - ➢ Manual Interference: Anterior part mostly
  - ➢ Sexual Intercourse: 5 or 7 o'clock position posterior-laterally

C. DIGITAL EXAMINATION
- ✓ Gauge size, tone, tenderness or laxity of vaginal canal
- ✓ Introduction of gloved index finger into vagina and moving its palmer aspect over vaginal epithelium (Note degree of lateral pressure over index finger and extent roughness on bulb of finger)
- ✓ Differentiae habituated and non-habituated vagina
- ✓ Rogosities absent in habituated vagina with proportionate dilatation of vaginal canal

D. SPECULAR EXAMINATION
- ✓ In sexually experienced women only
- ✓ Appropriate size speculum is introduced into vagina to inspect mucosa, roughness, injuries and bleeding
- ✓ Vaginal rugosities: Marked in virgin and obliterated till child birth
- ✓ Vaginal bruises: Mostly on anterior wall dark brown in colour

Anal Exam

- Divided into 4 stages:

A. INSPECTION
- ✓ Anus and surrounding skin
- ✓ 1st anal intercourse: Redness, bleeding, tear of anal skin, sphincter or anal mucosa

B. BILATERAL TRACTION OF ANAL SPHINCTER
- ✓ To locate location of tear

C. DIGITAL EXAMINATION
- ✓ Gauge size, tone, tenderness or laxity of anal canal
- ✓ Differentiae habituated and non-habituated anal canal
- ✓ Habituated canal is lax, absence of anal folds and smooth margins, expanded, sometimes infected

D. SPECULAR EXAMINATION
- ✓ Appropriate size proctoscope is introduced into anal canal to inspect mucosa, roughness, injuries and bleeding
- ✓ Anal bruises: Dark brown in colour

Collection of specimens & their examination in laboratory

"See Book Page # 105 Table 9.11"

Findings

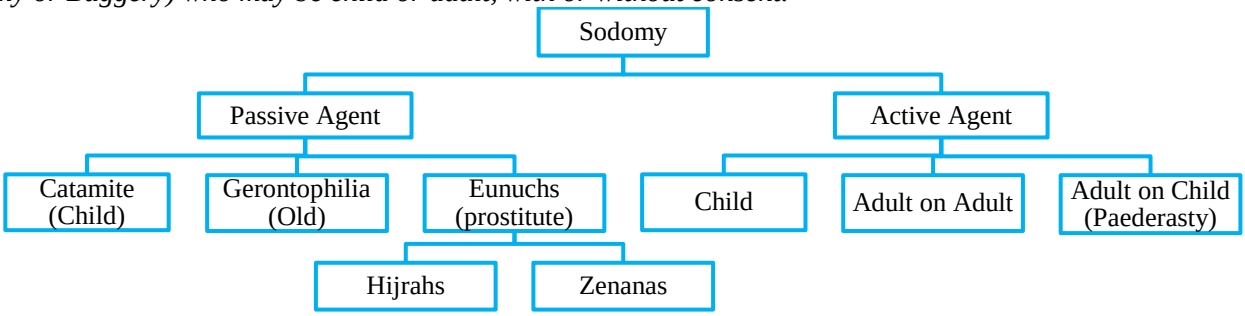
FEATURE	VIRGIN FEMALE	DEFLORATED FEMALE	CHILD
Vulva	Redness, bruises, scratches, tears, bleeding, swelling	Semen detected	Inflammation/abrasion/bruises
Hymen	Recent rupture	Not important	Intact/torn/destroyed
Vagina	Redness, swelling, lesions, bleedings, discharge, injuries, stains, loose hairs, matted/soiled pubic hairs	Semen detected	Great tearing
Perineum	Tears, bruises	Not important	Uncontrolled bleeding/clotted blood
Gait	Broad base & short	Not important	Painful
Struggle Evidences	Different parts of body	Different parts of body	Different parts of body

EXAMINATION OF ACCUSED OF RAPE/ZINA-BIL-JABAR

QUESTIONS	DESCRIPTION
Pre-Examination	• **Requisition:** Proper Authority Letter from Police is required • **Person Identification:** Police constable must identify accused (accompanies) & record 2 ID marks • **Consent:** Can be done without consent or even with force (U/S 53 PPC) • **Biodata Information:** Victim Name, Father Name, Age, Address, Social Status, Marital Status • **Date, Time and Place of Examination** • **Other Requirements:** Proper light, stage and other examination instruments
Physical Examination	• **Physical Health:** Height, Weight, Built, Vital Signs, Anemia, Strength, Resistance ability, Secondary sex characters • **Mental Health:** Memory, Concentration, Feeling, Orientation • **Clothes Examination:** Signs of struggle or any stains • **Injuries:** Struggle injuries on face, neck, hand, or private parts ⇒ Bruises ⇒ Scratches ⇒ Bite Marks
Genital Examination	• **INSPECTION** ⇒ Development of external genitalia i.e. penis, scrotum, testes & their abnormalities (if any) ⇒ Size of penis with respect to vaginal or anal damage of victim ⇒ Any biological stains ⇒ Pubic hair growth pattern, soiling, matting ⇒ Injury, swelling, bleeding or any damage to prepuce and rim of glans penis in uncircumcised penis • **PALPATION** ⇒ Tenderness ⇒ State of penis, and testis in scrotal sac i.e. descent, hernia, atrophy or lesions ⇒ Test of reflexes i.e. scrotal, penile, cremesteric reflexes ⇒ Test for potency (e.g. holding of glans penis with thumb & index finger or prostate cause erection – Pinching the glans will cause drop of fluid) ⇒ Vaginal epithelium stuck onto glens penis (detected by Lugol's Iodine Test) a. Mop the glens penis with filter paper b. Expose the paper to Lugol's Iodine Vapor c. Brownish discoloration of paper confirms vaginal epithelium (due to glycogen content) ⇒ Absence of smegma (which is normally present)

EXAMINATION OF SODOMY

It is the anal sex that is sexual connection of a male with other male (homosexual sodomy), female (heterosexual sodomy or Buggery) who may be child or adult, with or without consent.



EXAMINATION OF PASSIVE AGENT

1. Preliminary Data (requisition, identification, time, date, bio-date)
2. Consent
3. History
4. Behaviour
5. Clothes examination
6. General physical examination
7. Special examination (anal examination) – "same as mentioned in rape victim"
8. Specimens collection (anal & surrounding regions + trace evidences + fecal soiling)

EXAMINATION OF ACTIVE AGENT

1. Preliminary Data (requisition, identification, time, date, bio-date)
2. Consent
3. History
4. Behaviour
5. Clothes examination
6. General physical examination
7. Special examination "same as mentioned in rape accused"
8. Specimens collection (anal & surrounding regions + trace evidences + fecal soiling)

(Only evidence of sodomy is presence of semen in anus)

BATTERED BABY SYNDROME

A battered child is one who has received repetitive physical injuries as a result of non-accidental violence produced by a parent or a guardian.

Other Names

1. Caffey syndrome
2. Caffey-Kempe syndrome
3. Maltreatment syndrome
4. Parent-infant traumatic stress syndrome

Features

CHILD RELATED

1. < 3 year age
2. More common with male children (M:F = 2:1)
3. Illegitimate & unwanted children
4. Eldest or youngest child
5. Abnormal child

PARENT/GUARDIAN RELATED

1. Unmarried couple
2. Young parents
3. Lower level of education
4. Addiction
5. Were victims themselves
6. Psychological factors: Low tolerance threshold, impulsive nature, aggressive personality & imbalanced temperament

SOCIO-FAMILIAL FACTORS

1. Low social background
2. Lack of equality between members of family
3. Lack of family harmony
4. Long-standing emotional problem
5. Financial hardship
6. Trouble at place of work

PRECIPITATING FACTORS

1. Act of disobedience by child.
2. Frequent crying may create annoyance.
3. Refusal to take food.
4. Soiling of napkin or bedclothes.
5. At times, any trifle act of child may annoy mentally challenged father or mother.

Common Injuries

By hand, foot, teeth, stick, belt, shoe, hot water, lighted cigarette, hot frying pan or any household article

FEATURE	INJURIES
Surface	Bruises, abrasions and lacerations, slap marks, lash mark, knuckle punches, pinch mark, bald patches on scalp due to pulling out hair
CNS	By throwing child, striking child with fist or object or against a wall, dropping the child or vigorous shaking of the infant (shaken baby syndrome)
Eyes	Retinal hemorrhages and lens displacement
Visceral	Spleen, liver or hollow viscera (massive hemorrhage)
Burns	Small circular pitted burns and scalds
Skeletal	Transverse fractures, impacted fractures, spiral fractures, metaphyseal chip fractures, subperiosteal hematoma, and multiple deformities of long bones and rib cage
CVS	Blunt trauma to chest cause multiple rib fractures (contusions, pneumothorax, hemothorax, rupture of diaphragm and cardiac tamponade)
Genitourinary System	Physical and sexual abuse

Diagnosis

1. Nature of injuries.
2. Delay in seeking medical treatment.
3. Recurrent injuries.
4. Radiological manifestations, especially those involving ribs, metaphyseal-epiphyseal injuries, and avulsive fractures of the clavicle and acromium process.

Autopsy Findings

1. External Examination (Clothes, Nutritional status, Weight, Height, X-ray of whole body)
2. Internal Examination (mentioned in table above)

SUDDEN INFANT DEATH SYNDROME

Sudden and unexpected death of seemingly healthy infant whose death remains unexplained even after complete autopsy. It is an autopsy diagnosis, and not a clinical diagnosis.

Other Names

1. Cot Death
2. Crib Death

Features

1. 0.2–0.4% of all live births worldwide
2. Between 2 weeks to 2 years.
3. Male infants have a proportionately higher death rate (M:F ratio 3:2).
4. Low and middle class family with poor housing condition, large family and lack of health consciousness.

5. Infant is discovered dead, either in the early morning (death possibly occurring at late night) or sometime after first feed in the morning.
6. Deaths are seen to occur commonly in rainy and winter seasons in temperate zones, but no clear pattern in tropical zones.
7. More among twins (two-fold) as opposed to singletons.
8. Smoking (pre-or postnatal) and drug abuse by pregnant women increases risk.

Causes

1. No definite cause is known.
2. Prolonged sleep apnea makes them susceptible to hypoxia.
3. Respiratory infection may cause viremia which leads to sleep depression of respiratory center
4. Nasal edema and mucus secretion may narrow upper respiratory passages
5. Local hypersensitivity of respiratory tract lumen to cow's milk was thought to cause laryngeal spasm.
6. Bedclothes and pillow falling accidentally over nose and mouth by movement of child.
7. Overlying of baby by a sleeping or intoxicated mother.
8. Conduction system anomalies
9. Hypoparathyroidism & Hypothermia
10. Deficiency of selenium, antibodies, calcium, magnesium & vitamins B, C, D and E
11. House-mite allergy
12. Sodium overload in feeds

Autopsy Findings

1. Postmortem findings are negative.
2. Trachea contains milky vomit, sometimes blood stained with shed epithelial cells.
3. Multiple petechial hemorrhages on heart (posterior epicardial surface), lungs and thymus—agonal in nature.
4. Pulmonary edema is common.
5. Milk or bloodstained froth on child's mouth or bedding. Hands are often clenched around fibers from bedclothes.

HADOOD ORDINANCE 1979

General Zia ul Haq ordained this ordinance in 1979. The important sections of the ordinance are:

SECTION	DETAIL
Section 2 Definitions	• "**Adult**" means a person who has attained, being a male, the age of 18 years or, being a female, the age of 16 years, or has attained puberty. • "**Hadd**" means punishment ordained by the Holy Quran or Sunnah • "**Tazir**" means punishments other than Hadd • "**Marriage**" means marriage which is not void according to the personal law of the parties • "**Muhsan**" means i. A Muslim adult man who is not insane and has had sexual intercourse with a Muslim adult woman who, at the time he had sexual intercourse with her, was married to him and was not insane; or ii. A Muslim adult woman who is not insane and has had sexual intercourse with a Muslim adult man who, at the time she had sexual intercourse with him, was married to her and was not insane; • "**Non-Muhsan**" means same characters as Muhsan but not married (bachelor)
Section 4 Zina	A man and a woman are said to commit 'Zina' if they willfully have sexual intercourse without being married to each other. *Explanation: Penetration is sufficient to constitute sexual intercourse necessary to offence of Zina.*
Section 5 Zina Liable to Hadd	Zina is zina liable to Hadd if: a. It is committed by a man who is an adult and is not insane with a woman to whom he is not, and does not suspect himself to be married; or b. It is committed by a woman who is an adult and is not insane with a man to whom she is not, and does not suspect herself to be, married. *Whoever is guilty of Zina liable to hadd shall, subject to the provisions of this ordinance:* a. *If he or she is a muhsan, be stoned to death at a public place; or* b. *If he or she is not muhsan, be punished, at a public place; with whipping numbering 100 stripes.*
Section 6 Zina Bin Jabar	A person is said to commit zina-bil-jabr if he or she has sexual intercourse with a woman or man, as the case may be, to whom he or she is not validly married, in any of the following circumstances, namely: a. against the will of the victim; b. without the consent of the victim; c. with the consent of the victim, when the consent has been obtained by putting the victim in fear of death or of hurt; or d. with the consent of the victim , when the offender knows that the offender is not validly married to the victim and that the consent is given because the victim believes that offender is another person to who victim is or believes herself or himself to be validly married.

Section 15 Cohabitation caused by a man deceitfully inducing a belief of lawful marriage	Every man who by deceit causes any woman who is not lawfully married to him to believe that she is lawfully married to him and to cohabit with him in that belief, shall be punished with rigorous imprisonment for a term which may extend to twenty-five years and with whipping not exceeding thirty stripes, and shall also be liable to fine.
Section 16 Enticing or taking away or detaining with criminal intent a woman	Whoever takes or entices away any woman with intent that she may have illicit intercourse with any person, or conceals or detains with intent any woman, shall be punished with imprisonment of either description for a term which may extend to seven years and with whipping not exceeding thirty stripes, and shall also be liable to fine.

RAPE

A man is said to commit "rape" if he has sexual intercourse with a woman under circumstances falling under any of the six following descriptions:

1. Against her will.
2. Without her consent.
3. With her consent, when her consent has been obtained by putting her or any person in whom she is interested in fear of death or of hurt.
4. 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.
5. With her consent, when, at the time of giving such consent, by reason of unsoundness of mind or intoxication or the administration by him personally or through another of any stupefying or unwholesome substance, she is unable to understand the nature and consequences of that to which she gives consent.
6. With or without her consent, when she is under sixteen years of age.

Explanation: *Penetration is sufficient to constitute the sexual intercourse necessary to the offence of rape.*
Exception: *Sexual intercourse by a man with his own wife, the wife not being under fifteen years of age, is not rape.*

FORNICATION/ADULTERY

Voluntary sexual intercourse between a married man and someone other than his wife or between a married woman and someone other than her husband, i.e. having sexual intercourse with someone who is not his/her legally wedded spouse.

Punishment

Sec. 497 PPC (imprisonment upto 5 years and with/without fine)
Sec. 498 PPC (imprisonment upto 2 years and with/without fine)

Legal Aspects

1. If proven, adultery is a valid ground for divorce and nullity of marriage.
2. Many Muslim nations practicing Sharia Islamic law, retain the death penalty for adultery.

DIFFERENCE BETWEEN RAPE & ADULTERY

FEATURE	RAPE	ADULTERY
Basic difference	Offence against body	Offence against marriage
Consent	Offence is committed without the consent of woman	Offence is committed with the consent of woman but lacks the consent of her husband
Aggrieved party	The woman	Husband of the woman
Offence by husband	Woman can be raped by her husband if she is < 15 years	Husband cannot commit this offence against his wife
Marital status	Committed against married or unmarried woman	Committed with married woman only
Punishment	7 years to life imprisonment or death penalty and fine	Upto 5 years and fine

INCEST

Sexual intercourse by a man with a woman who is closely related to him by blood or by marriage (prohibited degrees of relationship). E.g. a daughter, grand-daughter, sister, stepsister or aunt

Examples

- Between father and daughter
- Between mother and son
- Between brother and sister

5

THANATOLOGY

1 SEQ + 3 MCQs = 8 Marks

TERMINOLOGY

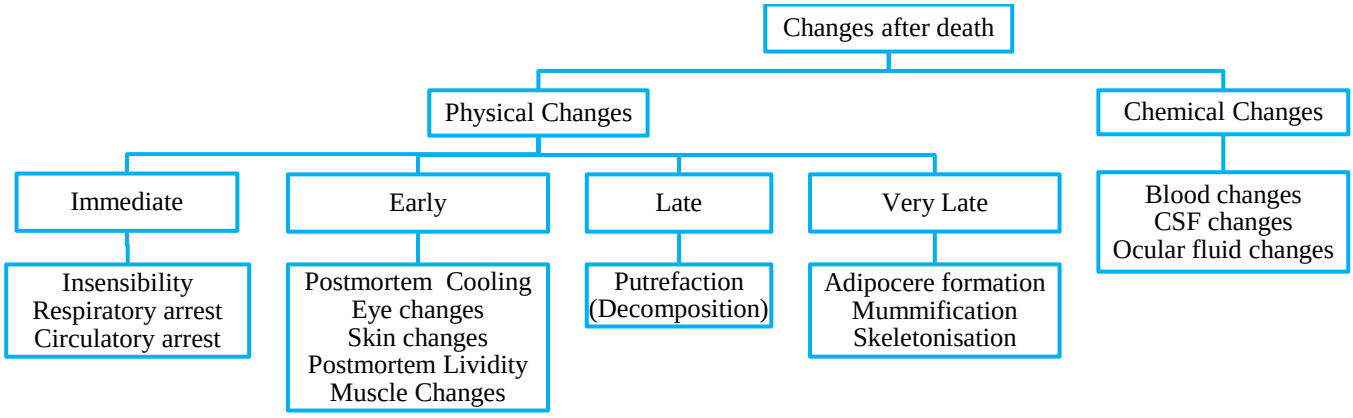
- **Cause of death** is any injury or disease producing physiological derangement, briefly or over a prolonged period and which results in the death of the individual
- **Mechanism of death** is the physiological derangement produced by the cause of death that results in death
- **Manner of death** explains how the cause of death came about.
- **Mode of death** refers to an abnormal physiological state that pertained at the time of death

CAUSE	MECHANISM	MANNER
Hemoperitoneum, as a consequence of – Laceration of the aorta, as a consequence of – Blunt thoracic trauma	Hemorrhagic shock	Accident
Bronchopneumonia, as a consequence of – Stab wound of thorax	Septicemia	Homicide
Cardiac tamponade, as a consequence of – Gunshot of thorax	Cardiac dysrhythmia	Homicide

DIFFERENCE BETWEEN SYSTEMIC AND CELLULAR DEATH

FEATURE	SYSTEMIC DEATH	CELLULAR DEATH
Other Names	Somatic Death, Clinical Death	Molecular Death, Organic Death
Definition	Complete and irreversible cessation of function of brain, and stoppage of circulation and respiration	Progressive disintegration of body tissues with death of individual tissues and cells
Onset	Precedes molecular death	Succeeds somatic death (1–2 hours after stoppage of vital functions)
Tissues and cells of body	Alive and functioning	Dead and non-functioning with no metabolic activity
Response to external stimuli	Muscle responds to thermal, electrical or chemical stimulus	Does not respond
Confirmation	Flat ECG and EEG, and absent breath sounds	Rigor mortis, algor mortis, postmortem staining, putrefaction
Resemblance	Suspended animation, coma, hypothermia	Does not resemble any condition

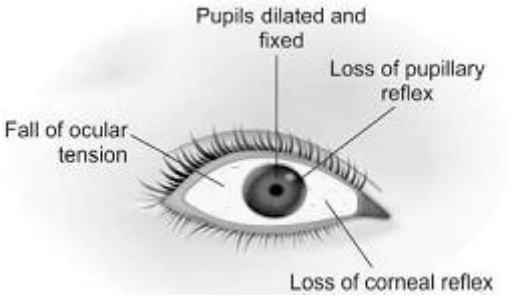
CHANGES AFTER DEATH



Tests for confirming Immediate Physical Changes

CHANGE	TEST
Insensibility	A flat EEG or loss of EEG rhythm. **False Positive:** Prolonged fainting attacks, epilepsy, catalepsy, trance, narcosis, electrocution
Respiratory arrest (Absence of breathing >3 minutes)	• **Auscultation:** No audible breath sounds on continuous auscultation of upper part of chest and in front of or on the larynx for minimum of 5 minutes • **Feather Test:** No movement of a feather held in front of the nose. • **Mirror Test:** Mirror held in front of the nose does not turn dim due to any moisture of breath. • **Winslow's Test:** No movement of surface of water in bowl kept on the chest. **False Positive:** Voluntary acts of breath holding, Cheyne-Stokes, breathing pattern, breathing in apparently drowned, newborn infants
Circulatory arrest (Absence of heart sounds >3-5 minutes)	• **Auscultation:** No audible heart sounds on continuous auscultation on precordial area of chest for a minimum of 5 minutes, and flat ECG recording for 5 minutes • **Magnus's Test (Ligature test):** Fingers fail to show congestion distal to a ligature applied at their base. • **Diaphanous Test (Trans-illumination test):** Failure to show redness in the web space between the fingers on transillumination from behind. • **Icard's Test:** Fluorescent dye on being injected at given site in dead body fails to produces discolouration. • **Fingernail Test:** No blanching and filling of blood in fingernail on application of pressure and release.

Eye Changes



1. **Corneal Changes**
   - First few minutes: Temporary haziness & Loss of corneal reflex
   - By 12 hours: Permanent haziness making cornea milky and opaque due to lack of lachrymal moistening
2. **Sclera Changes**
   Triangular spots formed on sclera due to dust and cellular debris called tachenoires with in 3-4 hours. (From yellow to reddish brown to black spots)
3. **Retinal Changes**
   - 1-3 hours: Retina and area around optic disc yellowish
     Clear choroidal vascular pattern with red background
   - 3-6 hours: Pale and homogenous background
   - 6-9 hours: Optic disc outline starts fading away
     Grayish yellow discoloration of background starts from center
   - 9-12 hours: Grayish yellow discoloration of background reaches periphery
   - After 12 hours: All traces of optic disc and retinal vessels disappear
     Deep brown macula
4. **Flaccidity of eyeball** and sinking into orbits – due to fall of intraocular tension,
5. **Pupillary changes** – usually dilated at death, which constricts later due to development of rigor mortis of iris

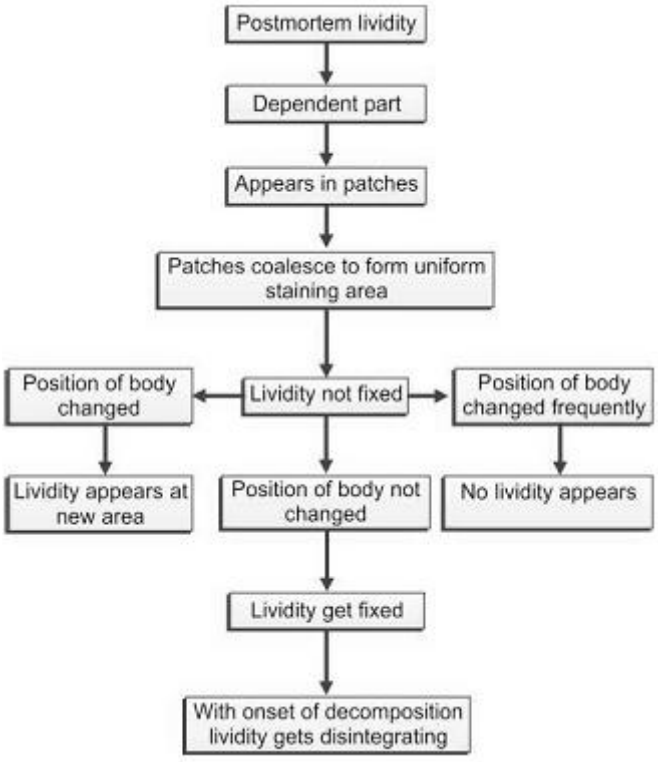
Skin Changes

1. **Loss of elasticity**
2. **Skin colour changes** (Hypostasis/PM Lividity)

CO poisoning, or Cold, Burns	Cherry red
HCN poisoning	Pink
H_2S poisoning	Bluish Green
Asphyxia	Cyanotic tinge
Aniline or Phosphorous poisoning	Brown & Dark brown
Opium poisoning	Black

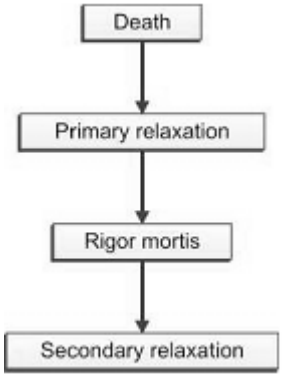
3. **Lips colour changes** to brownish and hard due to drying

Postmortem Lividity (Hypostasis)



FEATURE	PM LIVIDTY	BRUISE/CONTUSION	CONGESTION
Nature	Postmortem	Antemortem	Antemortem
Situation	Irregular on dependant parts	Anywhere	Uniform all over organ
Cause	Passive capillo-venous distension with blood	Extravasation of blood from capillaries	Organ Pathology
Color Changes	Red-blue / Red-purple colour	Reddish (fresh), change with time	Dusky red-blue colour
Tissue level	Undersurface of skin	Subcutaneous tissue level	Internal tissues
Cut section	Oozing of blood from vessels which can be cleaned by washing	Hemorrhage in the tissue which cannot be washed	Exudation of fluid mixed with blood from cut surface
Surface Elevation	–	+	+
Gravity shifting	+	–	–
Contact flattening	+	–	–
Pressure blanching	+	–	–
Vital Reactions like Inflammation & Swelling/Edema	–	+	+
Microscopically	Engorgement of capillaries infiltration	Extravasation of blood, cellular infiltration	Engorgement and swelling of capillaries infiltration + Hemosiderin macrophages
Margin	Defined	Diffuse	Defined
Medico-legal importance	Time since death and position of the body may be known	Nature of injury and weapon used may be known	Cause of dying may be known

Muscle Changes

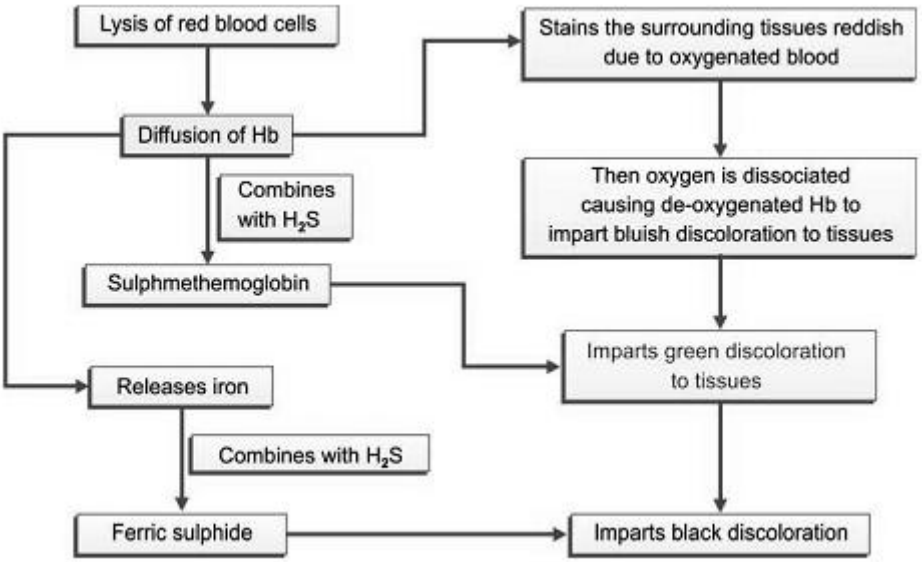


RIGOR MORTIS DEVELOPMENT		INTERPRETATION OF RIGOR MORTIS	
MUSCLE SITES	**TIME AFTER DEATH**	**PERCEPTION**	**INTERPRETATION**
Eyelids	3 - 4 hours	Moves with little force	Present in moderate form
Face and jaw	4 - 5 hours	Moves with more force	Present in strong form
Neck and trunk	5 - 7 hours	Free movement or not present in part tested	Not developed yet or disappeared
Upper extremities	7 - 9 hours	If only proximal parts show rigidity	Developing phase
Legs	9 -11 hours	If only distal parts show rigidity	Developed, disappearing phase
Finger and toes	11-12 hours	-	-

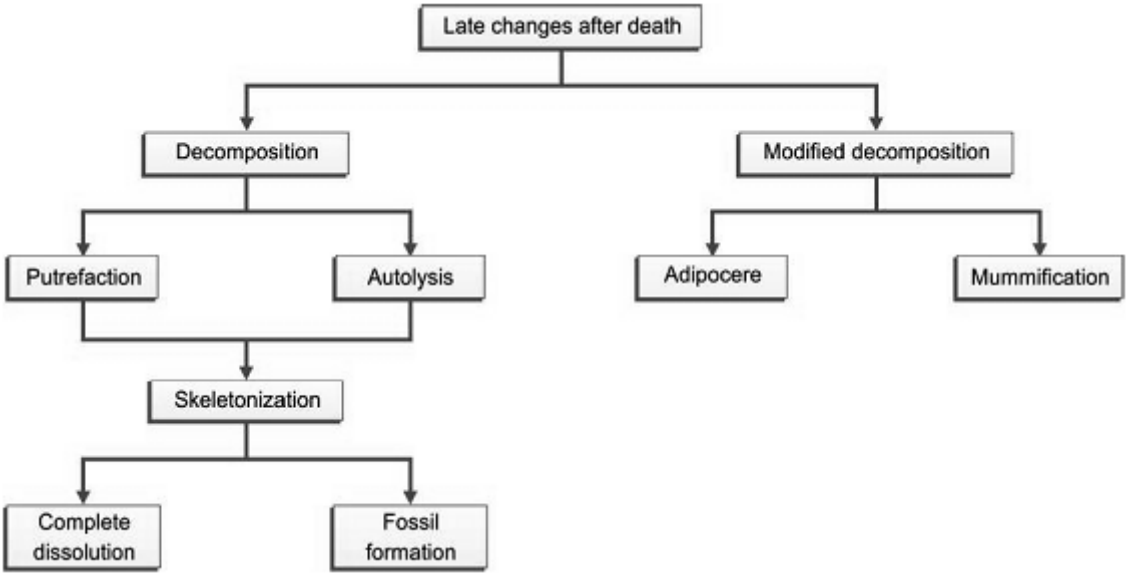
FEATURE	RIGOR MORTIS	HEAT STIFFENING	COLD STIFFENING
Cause	Breakdown of muscles ATP	Heat coagulation of muscle protein	Temperature < 0°C
Time of formation	2–12 h after death	Antemortem or postmortem	Antemortem or postmortem
Role of heat	High temperature enhances process	Occur at a temperature > 65°C or 149° F	Occur at a temperature < 0°C
Degree of stiffness	Moderate	High	High
Mechanical pull at joints	Will revert to rigidity extension (if not fully developed)	Rupture of muscles may occur	Crackling sound or crepitation is heard
External features	Nothing specific	Signs of exposure to heat (burning, blackening, blisters)	Frozen body fluids
Disappearance	In sequence, at various duration	Uniform, with onset of putrefaction	On thawing it goes, and rigor mortis appears

FEATURE	PRIMARY RELAXATION	SECONDARY RELAXATION
Time of occurrence	Immediately after death	After rigor mortis passes off
Molecular death	Has not occurred	Has occurred
Response to stimuli	Responds	Does not respond
Body temperature	Near normal	Cold
External features	Nothing specific	Signs of decomposition present

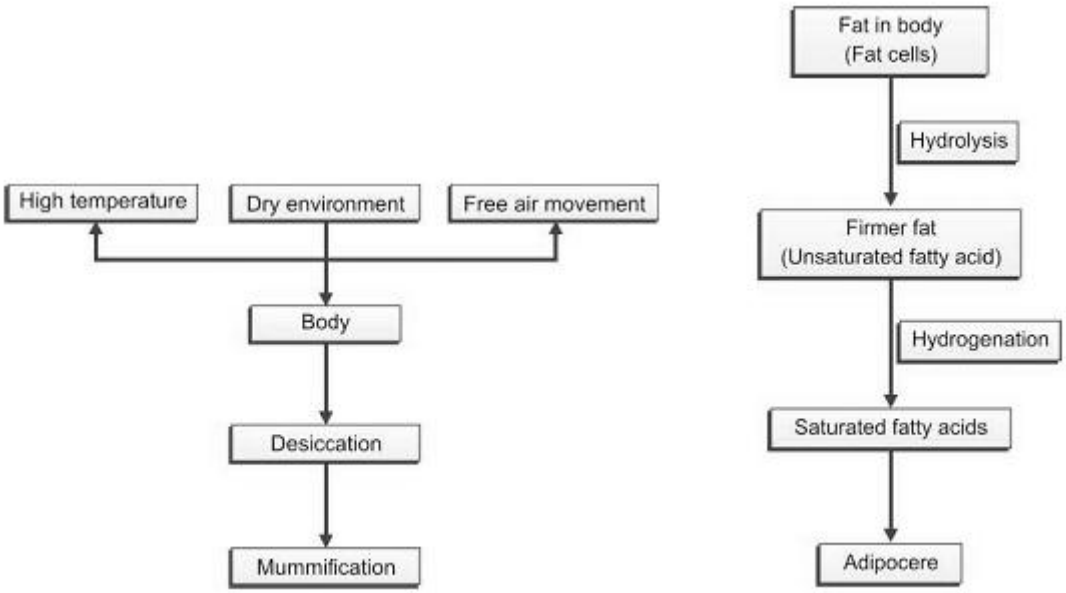
Putrefaction (Decomposition)



Skeletonization



Mummification & Adipocere Formation (Saponification)



TIME SINCE DEATH

FACTORS	TIME AFTER DEATH	EFFECT
PM Cooling (Algor Mortis) Not uniform but almost proportional to difference between body & environmental temperature i.e. average fall of 0.9 to 1.26°F (0.5 – 0.7°C)	1-3 hour 3-6 hour 6-9 hour 10-12 hour 12-15 hour 15-20 hour	1°F fall 2°F fall 2°F fall 1.5°F fall 1.75°F fall ~ surrounding
PM Caloricity	1-2 hours	Temperature rise or remain same
PM Lividity (PM Staining or Hypostasis)	1-3 hour 3-6 hour 6-12 hour	Mottled patches Patches increases in size and coalesce PM Lividity full developed & fixed
Rigor Mortis	1-3 hour 3-12 hour 12-24 hour 24-36 hours	Starts Completely develops Remains Passes off
Eye Changes	See "Eye Changes"	
Putrefaction (Decomposition)	12-24 hour 24-48 hour 48-72 hour	Colour changes starts in ceacal area Marbling starts Colour changes spreads to whole body Marbling becomes prominent Blister formation Foamy Liver formation Loosening of scalp hairs, nails and teeth Bloating Skin Slipping Abdominal bursting External genitalia changes
Infestation by flies (maggots)	18-36 hour 36-60 hour Next 3-4 days Next 3-4 days	Eggs laid Eggs hatched in larva Pupae merge out Adult flies
GIT Content (if present)	15-20 min 2 hours 3 hours 5-6 hours	Milk, Coffee, Tea leaves stomach Wheat grain digested Rice digested Meat digested
Fecal Matter and Urine (if present)	Night death Day death	Present Absent
CSF Changes	1-15 hours 24-48 hours	150ml CSF with Cl^-, Mg^{2+}, Lactic Acid, Non-protein nitrogen and Amino Acid Nitrogen rise CSF disappears
Ocular Fluid Changes	1-125 hours	K+, Pyruvic Acid and Vitamin C rise
Blood Changes	1-24 hours 24-48 hours	pH falls (CO_2, H_3PO_4, Lactic Acid rise) Glucose rise to 300mg/100ml in heart Non protein nitrogen rise to 50mg/100ml Amino acid nitrogen rise to 10mg/100ml Creatinine rise to 10mg/100ml pH rises (ammonia production by proteolysis) Urea nitrogen rise to 100mg/100ml K^+ rises Enzymes rises
Circumstantial Changes	• Hair growth on face (0.4mm/day in male who shave chin daily) • Lice presence in long hairs (dies in 3-6 days after death) • State of clothes wearing (night or day time) • Personal effects like letters, diary, food present at locus	

EMBALMING (ARTIFICIAL MUMMIFICATION/ THANATOPRAXIA)

Embalming is art and science of preserving human or animal remains by treating them (with chemicals) to forestall decomposition.

- Embalming fluid (formaldehyde or solution of As, PbS, K_2CO_3) is injected into femoral artery or aorta.
- Preservation of Dead body:
  1. Natural [Adipocere formation (Saponfication) or Mummification]
  2. Artificial [Embalming (Thanatopraxia) or Refrigeration]

QUESTION OF PRESUMPTION OF SURVIVORSHIP

When two or more persons who are natural heir of one another die at almost the same time, or by a common accident, the question may arise who survived the longest; and if no direct evidence on this point is available the question becomes one of presumption of survivorship.

Example: *Suppose a rich father A has left property by executing a valid will to his son B, and that A and B die by a common accident, no direct evidence being available as to whether A or B died first. Here the question of presumption of survivorship may arise, because*

i. *If A died before B, B may be considered to have succeeded to the property left to him by A.*
ii. *If B died before A, B may be considered to have failed to acquire the property left to him by A.*

6

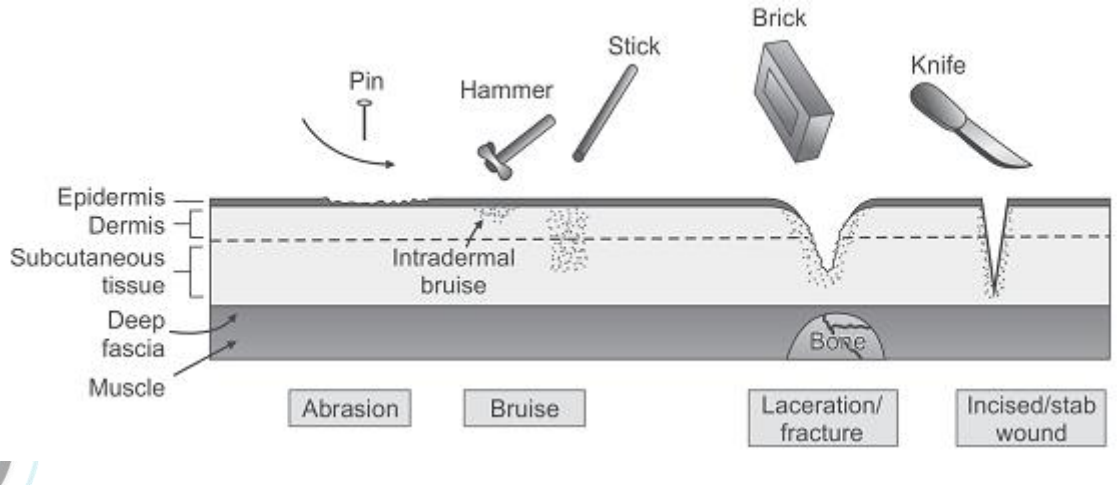
TRAUMATOLOGY

1 SEQ + 9 MCQs = 14 Marks

CLASSIFICATION OF INJURIES

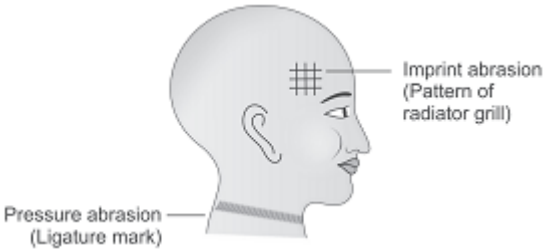
- Classification of Injuries
  - **Causative Factors**
    - Kinetic Injuries
      - Mechanical (Physical)
        - External (Closed)
          - **Abrasion**
          - **Bruise**
        - External (Open)
          - **Laceration**
          - **Incision**
          - **Stab wound**
          - **Fracture**
          - **Fire Arm**
          - **Bomb Blast**
    - Non-Kinetic Injuries
      - Chemical
        - **Corrosives**
        - **Irritants**
      - Radiation
        - **Natural** (UV Rays)
        - **Artifical Ionizing**
        - **Artifical Non-Ionizing**
      - Electrical
        - **High Voltage** (Industrial/ Flash Lesion)
        - **Low Voltage** (Domestic Lesion)
          - Loose Contact (Spark Lesion)
          - Firm Contact (Cotact Lesions)
      - Thermal
        - **Heat**
          - **Effects**
            - Generalized
              - Stroke
              - Collapse
              - Cramp
            - Localized
              - Burns (Dry heat)
              - Scalds (Moist heat)
          - **Nature**
            - Flame
            - Hot Liquid
        - **Cold**
          - **General Effects**
            - Hypo-thermia
          - **Localized Effects**
            - Chilblain (Erythrema)
            - Trench Foot (5-8 °C /Wet cold)
            - Frost Bite (<2.5°C/ Dry cold)
  - **Injury Severity**
    - Simple
    - Grievous
    - Dangerous
  - **Nature of Injury**
    - Suicidal
    - Homicidal
    - Accidental
    - Defense wounds
    - Fabricated or self-inflicted wounds.
  - **Time of Infliction**
    - Antemortem
    - Postmortem

GENERAL CAUSATIVE FACTORS OF MECHANICAL INJURIES



MECHANICAL INJURIES – I (ABRASION) – رگڑیاخراش

- Abrasion
  - Tagential/Sliding force (**Moving Abrasions**)
    - **Scratch Abrasion** (Linear)
    - **Graze Abrasion** (Sliding/Scrap/Brush/ Grinding)
  - Compression Force
    - **Pressure Abrasion** (Crushing/ Friction)
    - **Imprint Abrasion** (Impact/Contact/Pattern)

FEATURE	SCRATCH ABRASION	GRAZE ABRASION	PRESSURE ABRASION	IMPRINT ABRASION
Force	Narrow & sharp sliding force	Wider & broad sliding force	Relative perpendicular compression force	Perpendicular compression force
Cause	Sharp or pointed object passing across skin, such as fingernails, thorn or pin.	Horizontal or tangential friction between skin and hard rough surface	Direct impact or linear pressure of a rough object over skin	When force is applied perpendicular to skin
Appearance	Skin surface layers collected in front of object • Clean area at start • Tags at end	Uneven, longitudinal parallel lines (epidermis being heaped up at opposite end)	• Crushing superficial layers of cuticle • Bruising underneath	• Cuticle gets crushed at point of impact and bears imprint of object causing it • Parchmentized • Slightly depressed
Examples	• Throttling • Sexual assaults • Child abuse	Road Traffic Accidents • Brush Burn • Friction Burn (Clothes)	Ligatures in hanging & strangulation	• Motor-tyre mark • Radiator grill mark
Figure				

Difference between Antemortem and Postmortem Abrasions

FEATURE	AM ABRASION	PM ABRASION
Site	Anywhere on body	Only at bony prominence
Colour	Bright red	Yellowish, parchment like
Exudate	More and scab raised	Less and no scab
Microscopy	Vital reaction +ve	Vital reaction –ve
Healing	Evident	Not seen

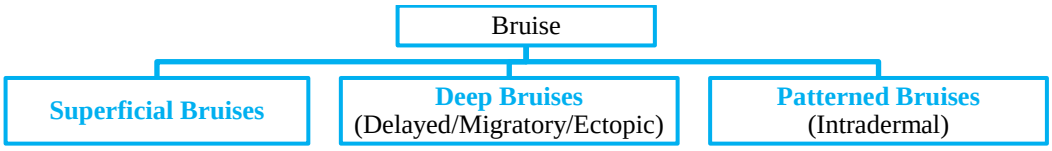
Age of Abrasion

TIME	FEATURES
Fresh	Reddish exudate, no scab
12 – 24 hour	Exudate dries to dark red soft scab (collection of injured epithelium, dried blood or serum & lymph)
1-2 days	Reddish brown scab
3-5 days	Dark brown scab
5-7 days	Blackish scab shrinks and falling begins from margin
7-10 days	Scab falls off, leaving hypopigmented area

Medico-Legal Importance

1. Indicates nature of object causing injury
2. Indicates nature and age of injury
3. Indicates site of impact and direction of force
4. Indicates character, time and manner of injury
5. Shows signs of struggle in case of throttling, sexual assaults and child abuse

MECHANICAL INJURIES – II (BRUISE, CONTUSION, HEMATOMA) – نیل یا داغ



FEATURE	SUPERFICIAL BRUISES	DEEP BRUISES	PATTERNED BRUISES
Cause	Due to infiltration of blood into subcutaneous tissues	Due to infiltration of blood into deep tissues	When a rod/whip etc in used to hit, skin with blood vessels underneath yields to pressure at edges and ruptures bleeding at edges of impacting object
Appearance	• Swelling • Less time to appear externally • Dull margins	• Mild swelling • More time to appear externally • Dull margins • Gravity Shifting	• Round, oval or weapon shape • Sharply defined margins
Examples	• Any part of skin	• Black eye due to blow on forehead	• Doughnut bruise (cricket ball) • Tram bruise (railway line type) • Suction bruise (love bites) • Six penny bruises (finger tips)

Difference between Antemortem and Postmortem Bruises

FEATURE	AM BRUISE	PM BRUISE
Swelling	Present	Absent
Damage to epithelium	Present	Absent
Blood extravasation	Present	Absent
Coagulation	Present	Absent
Infiltration with blood	Present	Absent
Color changes	Seen	Uniform color
Margins	Diffused	Defined
Appearance	More marked in victims who survive	Less marked

Difference between True & False Bruises

FEATURE	TRUE BRUISE	FALSE BRUISE
Cause	Trauma (blunt)	Irritant chemical
Site	Anywhere	Accessible parts
Colour	Typical changes	Dark brown
Shape	Regular	Irregular
Margin	Diffused	Defined + Vesicles
Inflammation	–ve	+ve
Itching	–ve	+ve
Vesicles under nails	–ve	+ve
Ecchymosis	+ve	–ve
Content	Blood	Acrid serum
Chemical test	–ve	+ve

Age of Bruise

TIME	FEATURES
Fresh	Red (oxygenated blood)
Few hours to 3 days	Blue (deoxyhemoglobin)
4–5 days	Bluish black to brown (hemosiderin)
5–6 days	Green (biliverdin)
7–12 days	Yellow (bilirubin)
2 weeks	Normal

Medico-Legal Importance

1. Indicates nature of object causing injury
2. Indicates nature and age of injury
3. Indicates differentiation between AM & PM bruises. Also true & false bruises.
4. Indicates character, time and manner of injury
5. Shows relation with crime in case of throttling, sexual assaults and smothering

MECHANICAL INJURIES – III (LACERATION)

- Laceration
  - **Split Laceration** (Crush/Incised Looking)
  - **Overstretch Laceration**
  - **Grinding Laceration** (Flaying/Avulsions)
  - **Tears Laceration**
  - **Cut Laceration** (Chopped)

FEATURE	SPLIT LACERATION	OVERSTRETCH LACERATION	GRINDING LACERATION	TEARS LACERATION	CUT LACERATION
Cause	Sudden compression of skin & tissues by blunt force	Over-stretching of fixed skin till it ruptures	Grind compressing of tissues to such extent that skin gets detached from deep tissues resulting in degloving of skin	Tearing of skin & tissue by localized impact by blunt force	Heavy sharp edged weapon causes a deep and wide cut over body tissue
Appearance	• Skin breech • Tissues shows minimal irregularity • Edges bruised • Hairs pushed into tear • Hair bulb crushed	• Skin breech • Skin flaps • Pointed bruise • External hemorrhage	• Multiple skin perforations • Crushed muscles • Extravasations of blood into potential spaces • External hemorrhage • Swelling & Pain • Precipitate fat embolism & Cushing syndrome	• Ripped skinned	• Skin breech • Tissues breech • Edges bruised • Sharp margins • Underlying bones cut
Examples	In body parts with underlying bones without much tissue in between • Scalp • Forehead • Chin	• Industry accidents • Road accidents	• Passing of heavy automobile over limbs	• Car door handle • Blows with broken glass bottles	• Axe cut • Chopper cut • Hatchet cut

Difference between Antemortem and Postmortem Lacerated Wounds

FEATURE	AM LACERATION	PM LACERATION
Blood extravasations	Present	Absent
Coagulation	Present	Absent
Increased Enzyme Activity	Present	Absent
Infection	Present	Absent
Healing	Present	Absent

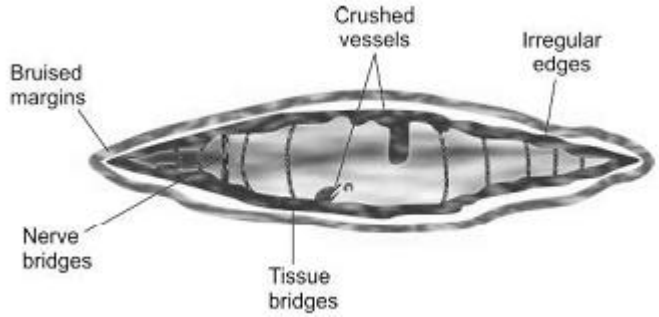
Age of Lacerated Wound

TIME	FEATURES
Fresh	Bleeding or fresh clot is attached; margins are red, swollen and tender
12–24 h	Margins swollen, red and covered by dried blood clots and lymph
3–5 days	Margins strongly adherent with each other and covered by dried crust
6–7 days	Crust/scab falls off or can easily be taken off, soft reddish tender scar
Few weeks	Scar is whitish, firm and painless

Medico-Legal Importance

1. Indicates nature of object causing injury and direction of force applied
2. Indicates nature and age of injury
3. Indicates differentiation between AM & PM lacerations
4. Indicates character, time and manner (homicidal, suicidal or accidental) of injury

Features of Lacerated Wound



MECHANICAL INJURIES – IV (INCISED WOUND, SLASH, SLICE, CUT)

Incised Wound

- **Homicidal**
  - Head
    Front of neck
    Trunk
    Nose
    Ears
    Genitals
- **Suicidal**
  - Fatal wounds
    Neck, Groin, Chest, Back of legs
  - Hesitation Cuts
    Multiple, small, superficial cuts around incised wound
  - Unintentional Cuts
    Safety razor while gripping in hands
  - Self Inflicted or Fabricated Wounds
    Multiple, Parallel, Superficial, Accessible parts of body like wrist, nose etc with knife or razor & Superimposed with tailing, Clothes not Involved
- **Accidential**
  - Around hands
    (like butcher)
- **Defense**
  - Forearm
    Palm
    Front of Chest

Difference between Homicidal & Suicidal Cut Throats

FEATURE	HOMICIDAL CUT THROAT	SUICIDAL CUT THROAT
Side of the neck	Any side–Rarely bilateral	Left side in right handed
Level of the wound	Below thyroid cartilage	Above thyroid cartilage
Hesitation cuts	–ve	+ve
Tailing of wound	–ve	+ve
Defense cuts	+ve	–ve
Cadaveric spasm of hand	–ve	+ve
Injury to carotid artery	+ve	–ve
Location	Not so	Isolated
Clothes Involvement	+ve	–ve

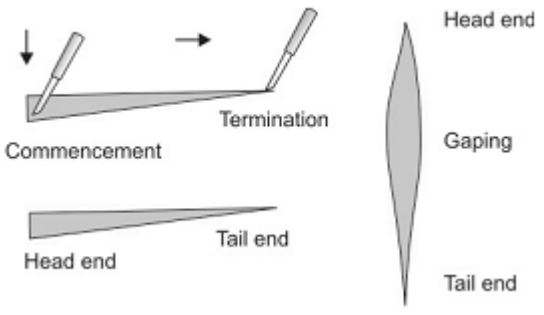
Age of Incised Wound

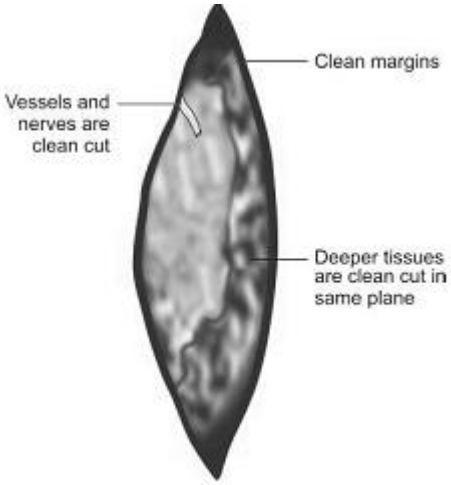
TIME	GROSS FEATURES	MICROSCOPIC FEATURE
Fresh	Red with clotted blood	Capillary dilatation, Neutrophils arrival, reactive changes in tissue histiocytes
12 h	Margins red, swollen & adherent with blood & lymph	Reactive changes in fibroblast & monocytes
24 h	Continuous layer of endothelial cells cover surface with a scab of dried clot	Endothelium begins to grow at edges, vascular buds begin to form
2–3 days	-	Vascularized granulation tissue formation
4–6 days	-	Formation of new fibrils
7 days	Scar formation	Scar formation

Medico-Legal Importance

1. Indicates nature of object causing injury and direction of force applied
2. Indicates nature and age of injury
3. Indicates character, time and manner (homicidal, suicidal or accidental) of injury

Features of Incised Wound





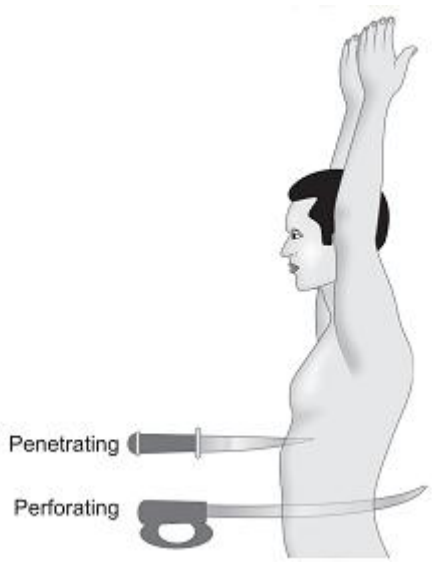
MECHANICAL INJURIES – V (STAB WOUND, PUNCTURED WOUND)

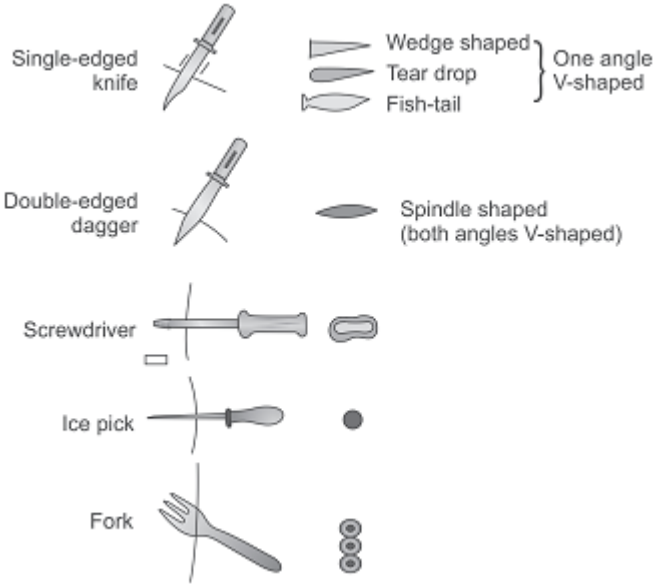
- StabWound
  - **Perforating Wounds** (Wound of Entry + Exit)
  - **Penetrating Wounds** (Wound of Entry)

Difference between Wound of Entry & Wound of Exit

FEATURE	WOUND OF ENTRY	WOUND OF EXIT
Presence	All stab wounds	Only Perforating Stab Wounds
Size of skin rupture	Larger	Smaller
Weapon Used	Sharp	Sharp with tapering end
Shape	Depends on shape of weapon	Depends on usage of tapering weapon
Margins	Clear Inverted mostly	Everted
Bruising	May be (if weapon is not sharp)	No

Shapes of Weapons Used for Stab Wounds





Medico-Legal Importance

1. Indicates nature of object causing injury and direction of force applied
2. Indicates nature and age of injury
3. Indicates character, time and manner (homicidal, suicidal or accidental) of injury

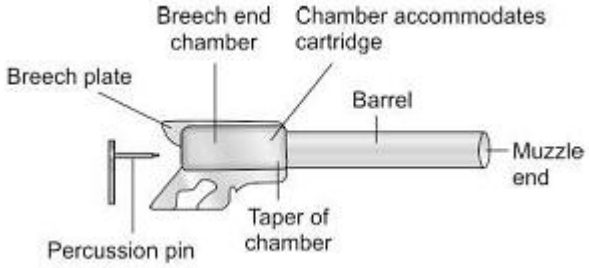
a.	**Suicidal**	Rare	Heart or Abdomen Region	Not more than 2 or 3
b.	**Homicidal**	Most Frequent	Chest, Back, Neck	One or Multiple
c.	**Accidental**	Frequent	By projecting nails, glass	Depends

MECHANICAL INJURIES – VI (FRACTURES)

- Fractures
  - **Etiology**
    - Traumatic
    - Pathological
  - **Displacement**
    - Displaced
    - Undisplaced
  - **Skin Related**
    - Simple (Close)
    - Compound (Open)
  - **Pattern**
    - Transverse fracture
    - Spiral fracture
    - Oblique fracture
    - Segmental fracture
    - Comminuted fracture
  - **Direct**
    - Focal fracture
    - Crush fracture
    - Penetrating fracture
  - **Indirect**
    - Traction fracture
    - Angulation fracture
    - Rotational fracture
    - Vertical compression fracture
    - Angulation-compression fracture

MECHANICAL INJURIES – VII (FIREARM INJURIES)

Parts of Firearm

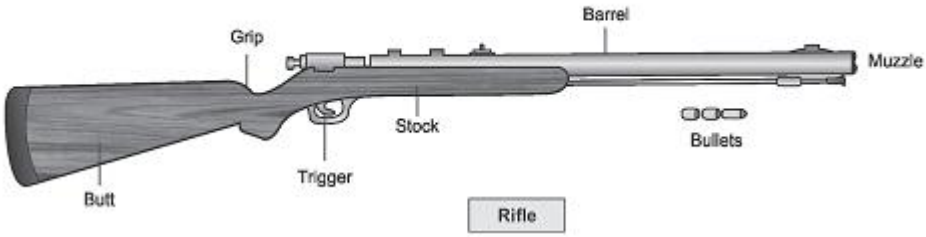


Classification of Firearms (on basis of barrels)

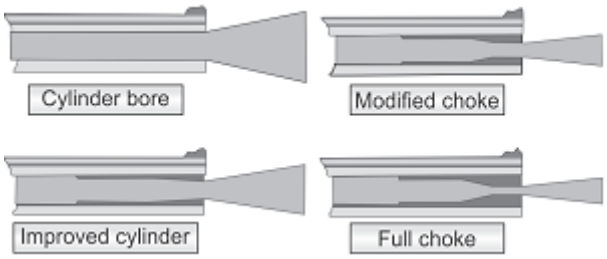
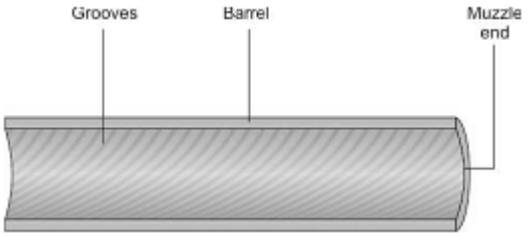
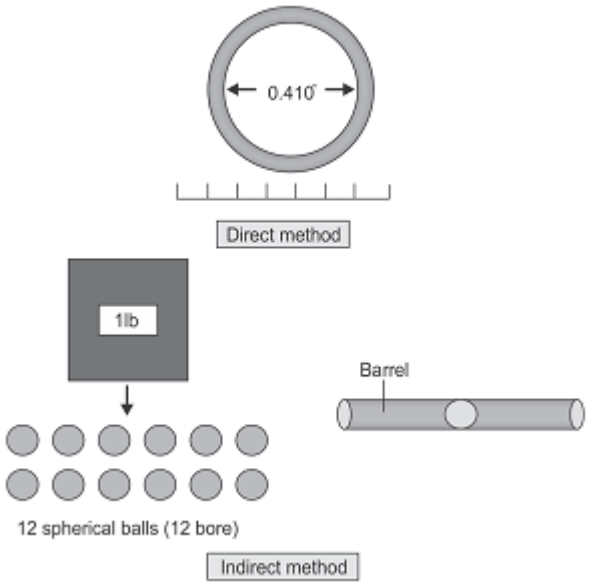
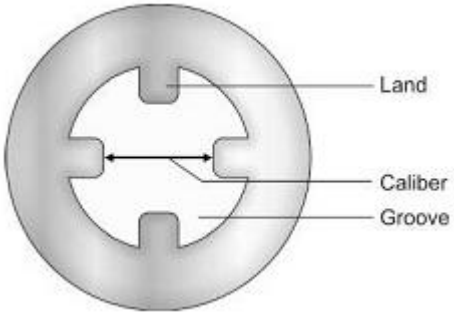
1. Smooth bore weapons: Shot guns
2. Rifled weapons: Rifles, evolvers, Pistols, Machine Guns

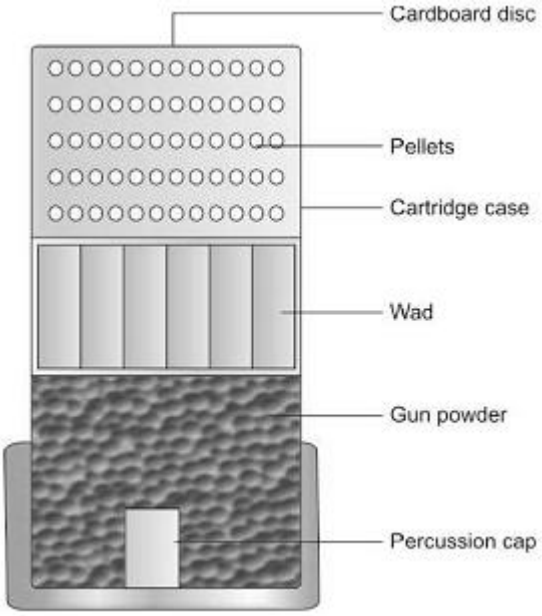
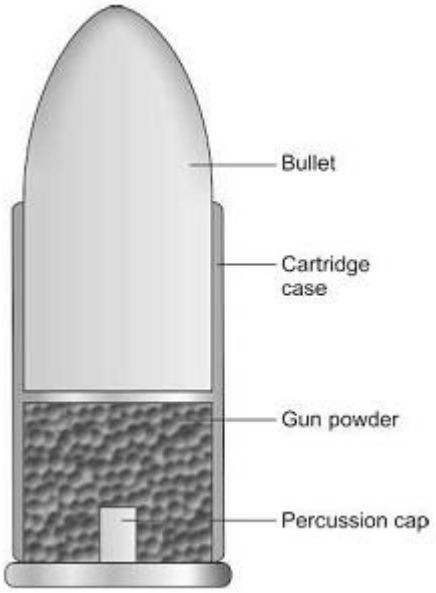
Revolver

Pistol

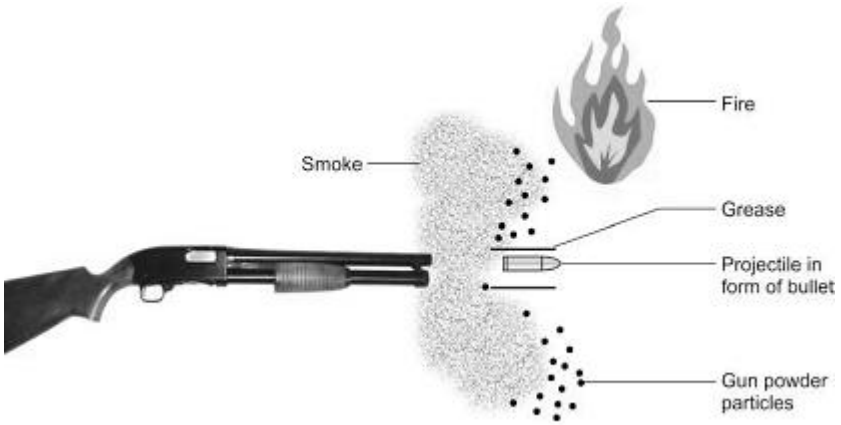


Rifle

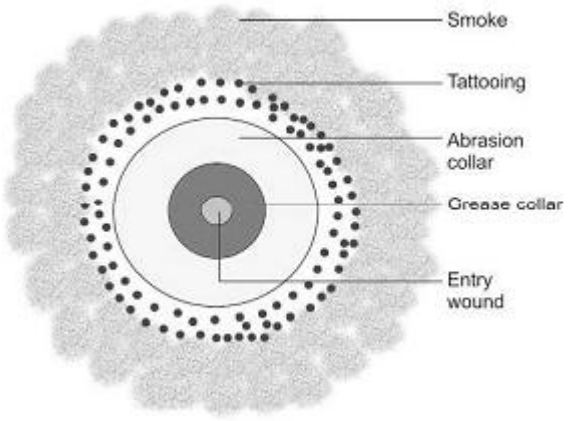
FEATURE	SMOOTH BORE WEAPONS (SHOT GUNS)	RIFLED WEAPONS
Bore of Firearm		
Caliber of Bore		

Cartridge of Firearm		
Cartridge Case Wad Projectile Cardboard	Posteriorly metal & Anteriorly cardboard disc Present Pellets Present	Metal Absent Bullet Absent

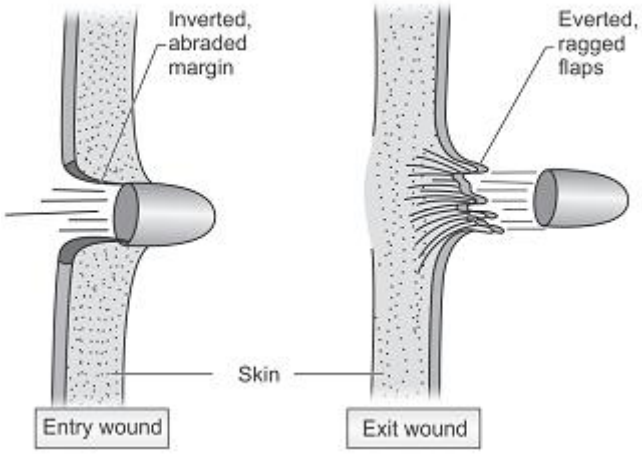
Components Emerging from Muzzle end of Firearm



Effects produced over Body by Firearm



Difference between Wound of Entry and Wound of Exit



FEATURE	WOUND OF ENTRY	WOUND OF EXIT
Size	Small if near shot Large if distant shot	Larger when near shot Smaller if distant shot
Margin	Inverted	Everted
Soiling of wound	+	–
Abrasion collar		
Contusion collar		
Grease collar		
Foreign bodies		
Dispersion of pallets (Shot gun)		
X-ray Metallic Ring		
Bright red (carboxy Hb)	+ (Near shot)	
Blast effect	+ (Contact shot)	
Bleeding	Less	More
Protrusion of fat	–	+

Wound of Entry for Different Shots of Rifled Weapons

FEATURE	CONTACT SHOT	CLOSE SHOT	NEAR SHOT	DISTANT SHOT
Range	Contact with skin	< 8 cm	30 – 60 cm	> 60 cm
Size of entry wound	> Bullet	= Bullet	< Bullet	< Bullet
Shape of entry wound	Varied	Circular	Circular	Circular
Blow Back Effect	+ (Everted)	– (Inverted)	– (Inverted)	– (Inverted)
Scorching	+	+	–	–
Singeing	+	+	–	–
Blackening	+	+	+ (upto 30 cm)	–
Tattooing	+	+	+	–
Abrasion collar	+	+	+	+
Grease collar	+	+	+	+

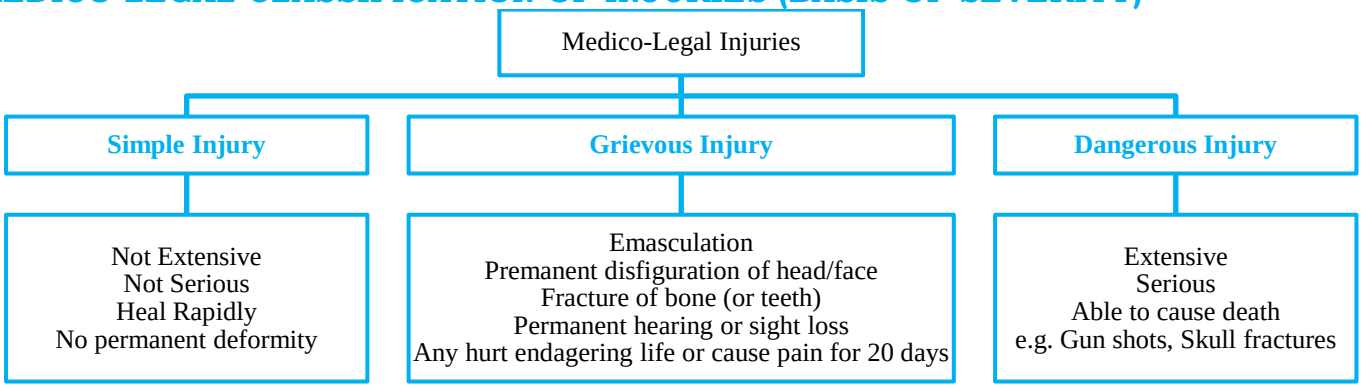
Wound of Entry for Different Shots of Smooth Bore Weapons

FEATURE	CONTACT SHOT	CLOSE SHOT	SHORT SHOT	MEDIUM SHOT	DISTANT
Range	Contact with skin	< 15 cm	15 cm – 1 m	1 – 4 m	> 4 m
Number of wound	Single	Single	Single	Multiple	Multiple
Shape of wound	Circular/Varied	Circular	Rat Hole	Stellate wounds around central	Wider spread
Blackening	+	+	+	–	–
Tattooing	+	+	+	–	–
Singeing	+	+	+	–	–
Scorching	+	+	+	–	–

GENERAL DIFFERENCE BETWEEN ANTEMORTEM & POSTMORTEM WOUNDS

FEATURE	AM WOUNDS	PM WOUNDS
Hemorrhage	Copious with deeper staining	Slight with light staining
Blood Clotting	+ (variegated colour)	± (yellow or red colour)
Wound Gaping & Eversion	+	–
Vital Reactions	+	–
Blood Cells	+	–
Enzymes Histochemistry *(ATPase, Aminopeptidase, Acid phosphates, Alkaline phosphates)*	+	–

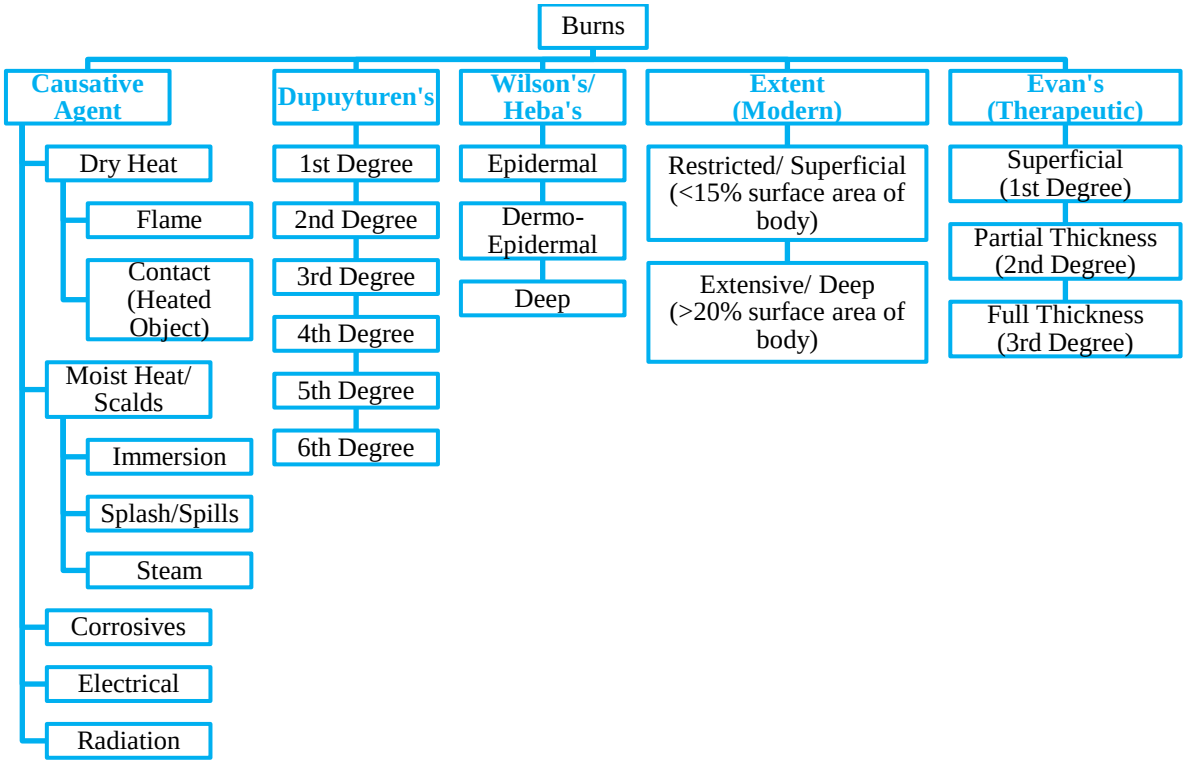
MEDICO-LEGAL CLASSIFICATION OF INJURIES (BASIS OF SEVERITY)



THERMAL INJURIES *(For general classification consult page number 41)*

LOCALIZED EFFECTS

Classification of Burns



Difference between Dupuyturen's, Wilson's & Evan's Classification of Burns

FEATURE	DUPUYTUREN'S	WILSON'S / HEBA'S	EVAN'S / THERAPEUTIC
Erythema + Singeing of Hairs	1°	Epidermal	Superficial (1°)
Vesication + Blister formation	2°		
Destruction of superficial skin	3°	Dermo-Epidermal	Partial Thickness (2°)
Destruction of whole skin (+ dermis)	4°		
Destruction of deep fascia, muscles	5°	Deep	Full Thickness (3°)
Complete charring involving vessels, nerves & bones	6°		

Difference between Degrees of Evan's Classification of Burns

FEATURE	1°	2°	3°
Depth	Epidermis	Dermo-Epidermis	Deeper to dermis
Color	Red/pink	Dark red	White/gray/black (charring)
Pain to stimuli	Painful, tender	Very painful	Painless (Nerve endings destructed)
Blanching	+	+	–
Blisters	– (may be)	+	±
Appearance	Dry	Moist	Dry/leathery
Healing time	3–6 days; skin peeling	3 weeks	Take months (skin grafting)
Scar	–	+	+
Cause	Dry or Moist Burns	Dry, Moist or Corrosive Burns	Any Type of Burn
Medico-legally	Simple	Grievous	Grievous

Difference between Different Causative Agents of Burns

FEATURE	DRY BURNS	MOIST BURNS (SCALDS)	CORROSIVE BURNS	ELECTRICAL BURNS	RADIATION BURNS
Cause	Flame, heated objects or X-rays	Solid steam or liquid > 60 ºC	Corrosives	Sparks, Flashes, Lightening	X-Rays, UV-Rays, Laser
Formation Site	At or above	At and below	At or below	At or above	At or above
Skin	Dry, wrinkled	Sodden, bleached	Corroded, devitalized	Lacerated, Stabs	Itchy, dry, red
Color	Black	Bleached	Distinctive	Dark Brown	Red
Splashing	–	+	+	+	–
Vesicles/Blisters	+ (rare)	+	–	+	+
Red line	+	+	–	–	+
Charring	+	–	–	+	–
Singeing	+	–	–	±	+
Ulceration	–	–	+	+	+
Scar	Thick, contracted	Thin, less contracted	Thick, contracted	Thick	Thin
Clothes Burnt	+	– (Wet)	±	±	±

Difference between Antemortem and Postmortem Burns

FEATURE	AM BURNS	PM BURNS
Vesicles	Contain serous fluid, rich in albumin, chloride and some polymorphs	Contain air; if fluid is present, it contain little albumin and no chloride
Base of vesicles	Red and inflamed	Dull, dry, hard and yellow
Soot in upper respiratory tract	+	–
Line of redness	+	–
Inflammation and repair	+	–
Healing	+	–
Scar Formation	+	–
Carboxyhemoglobin	+	–
Enzyme reaction in periphery	↑	–

Age of Burns

TIME	FEATURES
Immediate	Redness
1–2 h	Vesication or Blister Formation
12–24 h	Exudates begins to dry
48–72 h	Dry brown crust formation and pus formation
4–6th day	Superficial slough separates
15th day	Deep slough separates
>15 days	Granulation tissue begins to cover
Several weeks	Formation of scar and deformity

Factors affecting Severity of Burns

1. Temperature & duration of exposure
2. Extent of surface area involved (Walace Rule of Nine)
3. Site of Injury (head, trunk, genitals are more fatal)
4. Age, physical health & sex of victim

Postmortem Findings

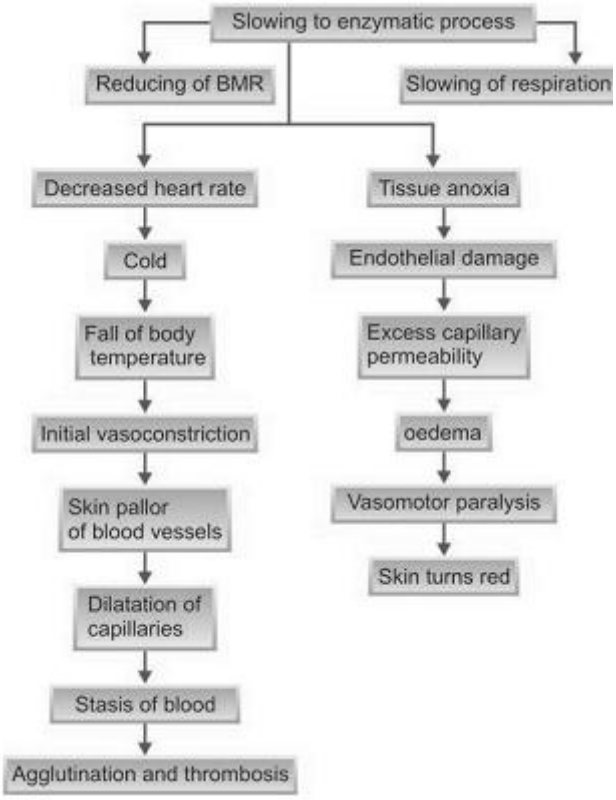
1. External
    a. Smell, staining, discoloration and direction of ignition may be determined from clothes
    b. Pugilistic attitude (specific boxer) of body
    c. Cherry red hypostasis (↑Carboxyhemoglobin)
    d. Leathery, hard and splitted skin
    e. Bleached skin
    f. Skin charring & roasting
    g. Hair singeing
    h. Vesications/Blisters formation
    i. Swollen distorted face
    j. Heat fractures
2. Internal
    a. Brain: Congested, Shrunken, Extradural Hemorrhages
    b. Respiratory System: Soot in URT
    c. GIT
        i. Soot in upper oesophagus
        ii. Curling ulcers in duodenum
    d. CVS: Heart full of thick, cherry red blood
    e. Liver: Cloudy smell
    f. Spleen: Cloudy smell
    g. Fissured fractures of skull
    h. Heat hematoma

Medico-Legal Importance

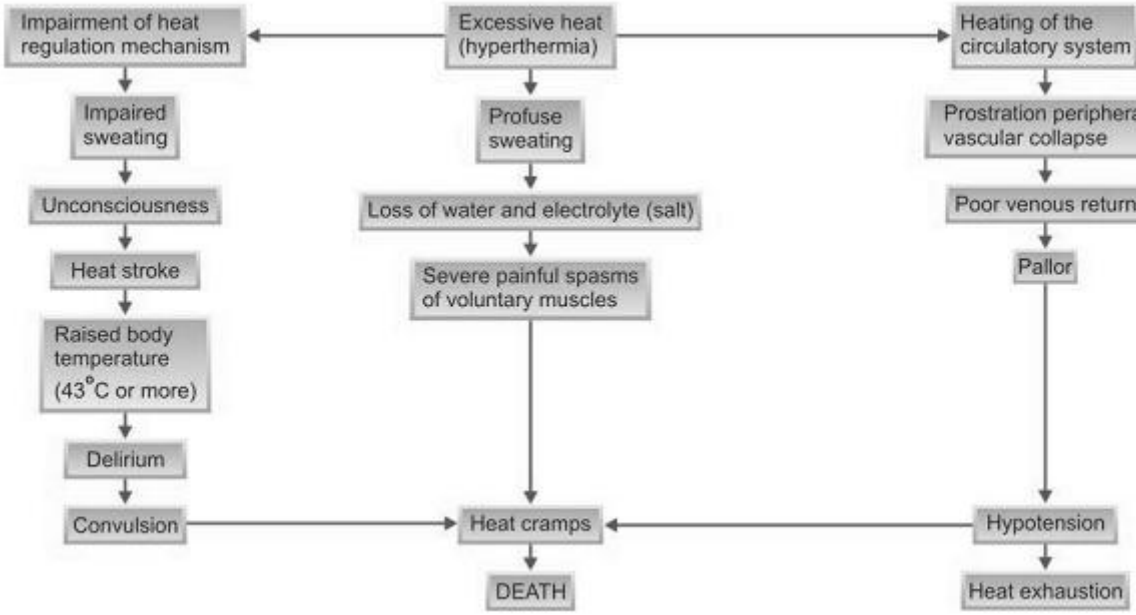
1. Identify the deceased
2. Indicate AM or PM burns.
3. Indicates cause, time and manner (homicidal, suicidal or accidental) of death
4. Indicates nature and time of burns
5. Whether AM burns were sufficient to cause death?
6. Bride burns and dowry death.

GENERALIZED EFFECTS

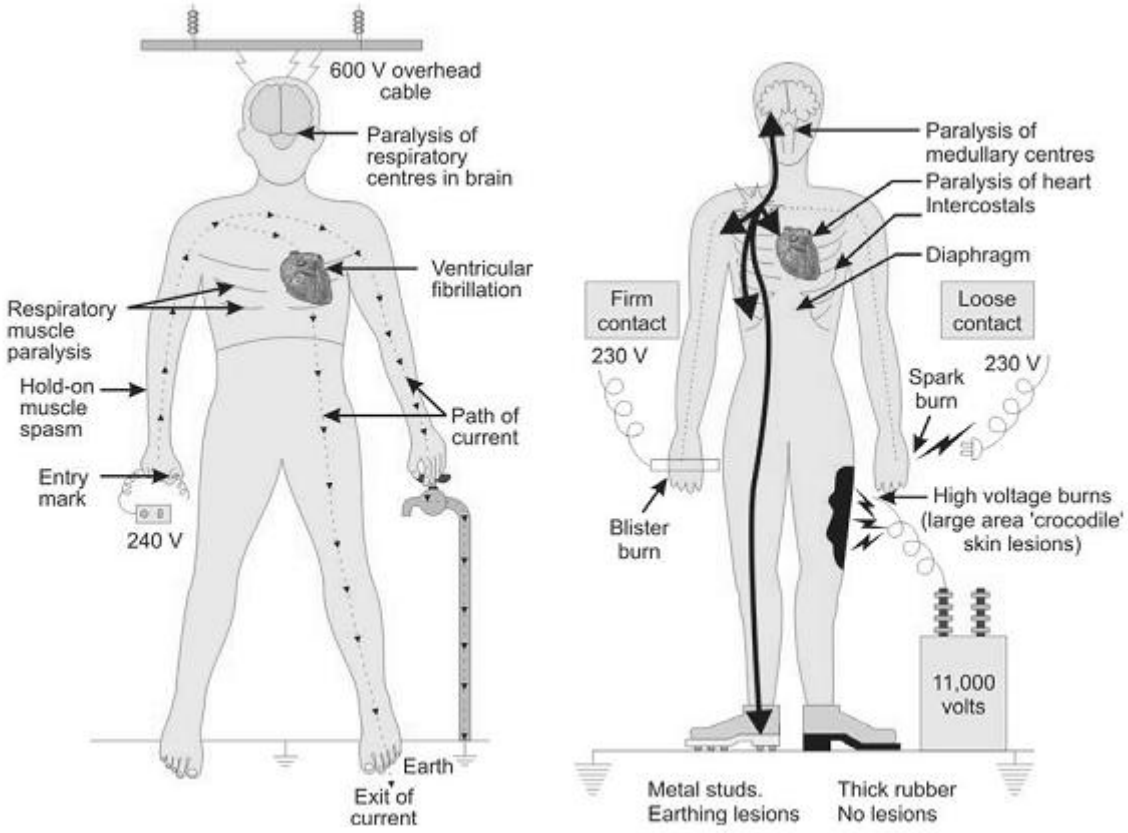
Hypothermia



Hyperthermia



ELECTRICAL INJURIES *(For general classification consult page number 41)*



Increasing Order of Resistance of Tissues for Electrical Current

Blood Vessels < Nerves & Muscle < Skin < Tendon < Fat & Bone

Types of Electrical Lesions

FEATURE	LOW VOLTAGE (DOMESTIC LESION)		HIGH VOLTAGE (FLASH/ INDUSTRIAL LESION)
	LOOSE CONTACT (SPARK LESION)	FIRM CONTACT (CONTACT LESION)	
Cause	Skin burns from heating of tissues by passage of electric current		Flash, flame or current itself
Injury Sites	Hands (entry point), OR Foot or opposite hand (exit point)		Any part of body
Type	Exogenous burn	Endogenous burn	Exogenous burn
Characters	Arcing effect produced pitted, dry wound covered by yellow scab	No red line around burns but white chalky line at entry (Joule burn/Blister burn)	Skin keratin melt and fuses on cooling into brownish nodule, raised above surface (crocodile skin)

Postmortem Findings

1. External
    a. Face is pale, eyes are congested and pupils are dilated. Petechiae are seen on eyelids and conjunctiva.
    b. Dark blue-red hypostasis
    c. Rigor mortis appears early
    d. Joule burn at the site of entry is diagnostic.
    e. Extensive charring due to heat coagulation of muscles
2. Internal (Similar to asphyxia)
    a. Heart: Focal necrosis with variable hemorrhage and acute contraction bands in the myocardium
    b. Congestion:
        i. Lungs
        ii. Brain & Meninges
        iii. Parenchymatous organs
        iv. Heart Conduction System
    c. Petechial hemorrhages:
        i. Along line of passage of current
        ii. Endocardium & Pericardium
        iii. Pleura
        iv. Brain & Spinal cord

Medico-Legal Importance

1. Identify the deceased
2. Indicates cause, time and manner (homicidal, suicidal or accidental) of death
3. Indicates nature electrical burns
4. Not possible to indicate AM or PM electrical burns.

Lightning

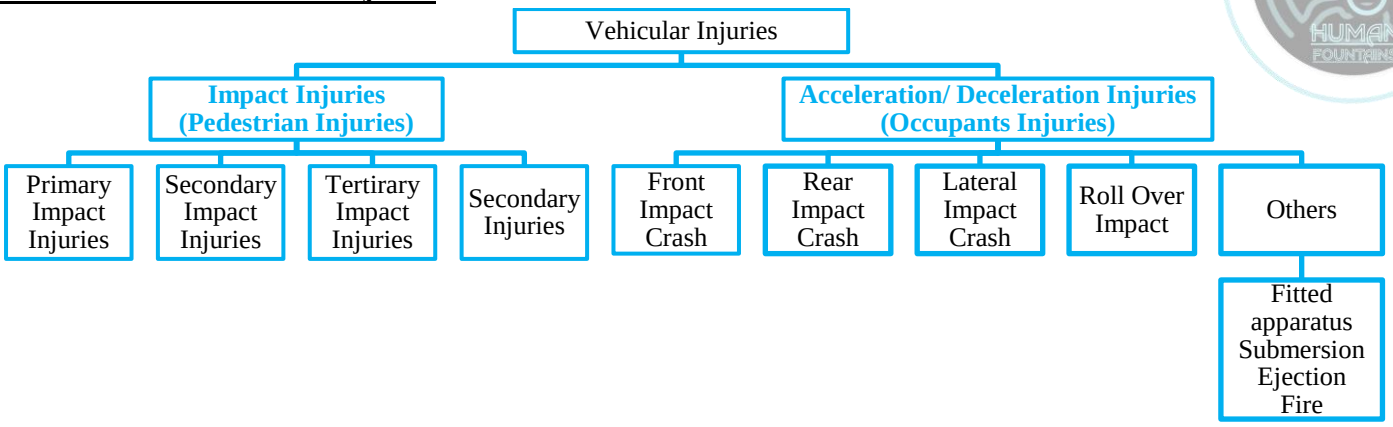
A lightning bolt is produced when charged undersurface of a thundercloud discharges its electrical charge to the ground.

- Differs only in degrees from ordinary electric currents.
- Under surface of the cloud is usually negatively charged but
    a. Virtually all discharges are negative charges.
    b. Approximately 5% are positive charges.
- Most frequent in mountain regions.
- A flash of lightning from a thundercloud to earth
    a. Pass direct current of enormous potential (≥1000 million Volts)
    b. Along track of current much energy is liberated (mostly in form of heat)
- Mechanical injury may occur if person falls or is thrown by muscle contraction.
- Mechanisms:
    a. **Direct strike:** Lightning bolt hits victim directly.
    b. **Contact/Conduction through another object:** Victim making contact with another object which is hit by lightning and thus getting injuries rather indirectly.
    c. **Side Flash Strike:** Bolt of lightning hits an object, such as a tree, and then jumps from object, striking individual nearby.
    d. **Ground current:** Lightning energy has flown into the body of a victim, move towards the ground/ earth and this results in injuries.
    e. **By Upward Streamer:** Such as flag, bunting, pole etc.
- Causes of death are same as in electric current lesions.
- Postmortem Findings:
    a. External
        i. Ecchymosed burns of all degrees
        ii. An arborescent marking is a fern-like injury (filigree burns or lightning prints, etc.) on skin by positive charges due to transient erythema which appears within an hour & gradually fades within 24 hours.
        iii. Rigor mortis appears early
        iv. Clothing torn, shoes burst
        v. Hairs seared (singed)
        vi. Burns on skin due to metal zipper and other metal objects heated by the lightning
        vii. Burns of entrance and exit of current.
        viii. Rupture of tympanic membrane is common.
    b. Internal
        i. Congestion of all organs
        ii. Petechial hemorrhages in all organs
        iii. Lacerations in internal organs
        iv. Coronary thrombosis
        v. Rupture of gangrenous caecum

TRANSPORTATION INJURIES

VEHICULAR ACCIDENTS

Classification of Vehicular Injuries



Impact Injuries

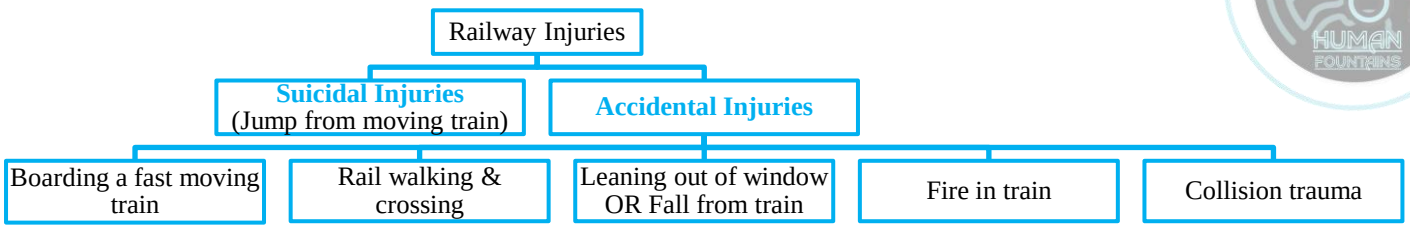
TYPE	SITE OF IMPACT	REGION OF INJURIES	INJURIES
Primary impact	Bumper, Fender, Lights, Radiator or Body of Car	Depends on height of victim • Children: Head & torso • Adults: Torso & Lower extremity	<u>STRUCK FROM REAR</u> • Thoracic/Lumbar fracture • Bumper fracture (Spiral/wedge shape fracture of tibia & fibula of one or both legs) <u>STRUCK LATERALLY</u> • Unilateral fracture of nearest leg or bruising <u>STRUCK FROM FRONT</u> • Torso injuries
Secondary impact	Bonnet/Hood, Windscreen	Depends on point of center of gravity • Children: (above center of gravity) Head & torso • Adults: (below center of gravity) Head and torso	<u>CHILDREN</u> • Thrown to ground • Run over by same car <u>ADULT</u> • Lift victim on bonnet, hood or behind
Tertiary impact	Ground & fixed object	Head and torso	<u>RUN OVER INJURIES</u> • Degloving of skin • Tyre marks on clothes & body parts • Avulsion injury of viscera <u>BURN INJURIES</u>
Secondary	Crushing, car or another vehicle	• Found on parts opposite to primary impact & head i.e. torso • Due to sudden fall of the person on ground	• Injuries due to contact with ground includes bruises over face, hands, hips & legs. • Lacerations over bony prominences like knee & elbow • Fracture of ribs

Acceleration/Deceleration Injuries

TYPE	MECHANISM	INJURIES
Front Impact Crash	• Deceleration of vehicle • Occupants move forward continuously & strike anteriorly	• Fracture of wrist, arms, pelvis, legs, teeth, jaw, facial bones and ribs. • Superficial cuts, contusion, laceration and abrasion • Partial or complete rupture of aorta (severe thoracic compression) • Head injury and dislocation of atlanto- axial joint can (strike against pillars) • Chest and abdomen (unfasten seat belt) • Whiplash injury to cervical and thoracic spine (due to rapid acceleration and deceleration) • Fractured steering wheel spikes penetrate chest & lacerate heart and lungs • Wind shield pieces on injured parts
Rear Impact Crash	• Acceleration of vehicle • Occupants move backward	• Whiplash injury to cervical and thoracic spine (due to rapid acceleration and deceleration)
Lateral Impact Crash	Thin aluminum wall of automobiles	• Dicing or bird foot injury (right angles or V-shaped cuts caused by dices or cubical fragments of tempered glass of broken side windows) • Exclusive tearing of lungs • Cervical spine, ribs fractures • Contusion , laceration , abrasions
Roll Over Impact	Slower deceleration of vehicle	<u>NON BELTED OCCUPANTS</u> • Tumble around inside vehicle & striking against sides of vehicles • Ejected from vehicle and gets abrasion and contusions

RAILWAY ACCIDENTS

Classification of Railway Injuries



Injuries

TYPE	INJURIES
Suicidal	• Extensive injuries • Amputation of limbs or trunks
Accidental	• Head, spine and legs injuries • Penetrating injuries • Amputation of limbs or trunks • Primary impact and Roll on injuries

Diagnosis

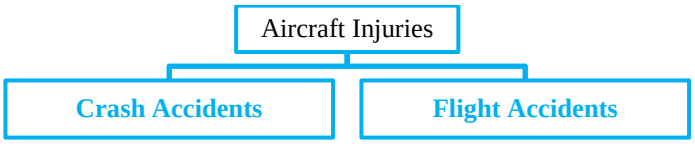
- History (State of health, Intoxication or Member of Criminal Gang)
- Scene of crime
- Injuries: (Presence of throttling or stab injuries can help in case of homicidal incident.)
- Hypostasis valuable clue for time since death
- Rigor mortis
- Laboratory examination for detection of any chemical in viscera.

Medico-Legal Importance

- Mode of death (suicidal, homicidal or accidental)

AIRCRAFT ACCIDENTS

Classification of Aircraft Injuries



Injuries

TYPE	INJURIES
Crash Accidents (sudden deceleration on crashing)	• Fracture of skull, cervical vertebrae (due to hyperextension) • Laceration of abdominal viscera (liver, spleen, kidney, etc.) • Laceration of abdominal major blood vessels (aorta) • Burns injuries (about 20% of fatal crashes result in fire) • High proportion of CO fumes due to fire
Flight Accidents (door or window breaks, pressures inside cabin drops & results in anoxia)	• Blow away passengers from cabins tearing them into pieces

Medico-Legal Importance

- Identification of dead (burnt and charred body or body parts dispersed over a wide area of ground)
- Diseases in operator
- Reconstruction of sequence of accidents
- Presumption of Survivorship “see Chapter 5 Thanatology”

WHIPLASH INJURY

Head strikes back ward, followed by rebound movement and as a result chin strikes against front of chest and neck is hyperflexed. This phenomenon is known as whiplash or acceleration-deceleration injury. It results in:

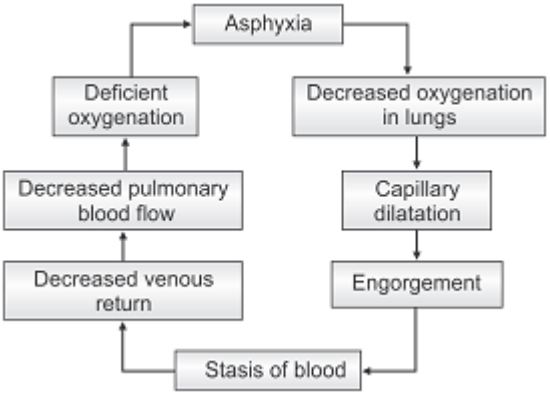
i. Muscle spasms
ii. Injury to ligament of neck.

ASPHYXIA

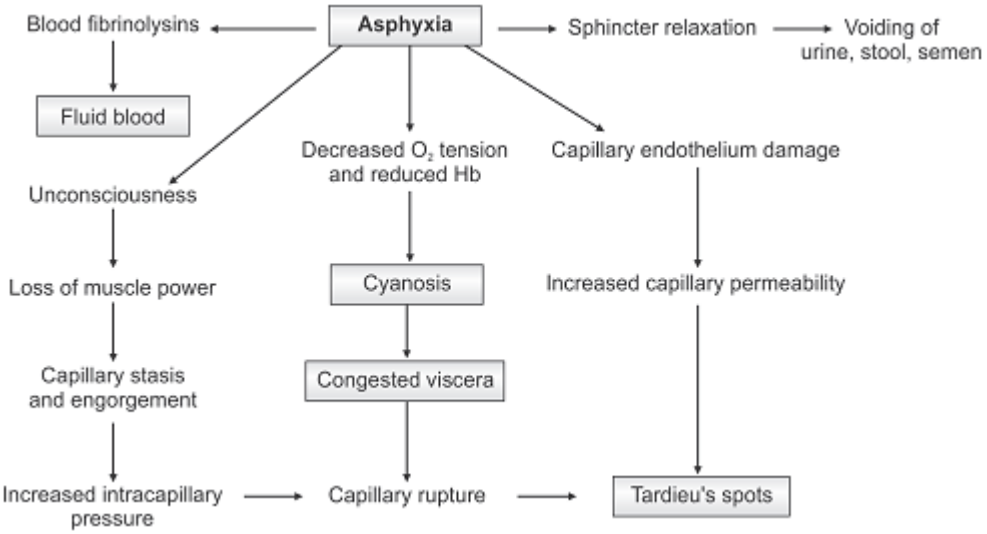
Anoxia: Lack of Oxygen Supply

- **Anoxia**
  - **Anoxic Anoxia** (No oxygen enters blood) e.g. Hanging
  - **Anemic Anoxia** (Blood cannot carry oxygen) e.g. CO poisoning
  - **Stagnant Anoxia** (Failure of circulation) e.g. Congestive Cardiac Failure
  - **Histotoxic Anoxia** (Cell cannot utilize oxygen) e.g. Cyanide poisoning
    - **Extracelluar** (Failure of tissue enzyme system) e.g. Carbonic anhydrase
    - **Pericellular** (Decreased permeability) e.g. Chloroform toxicity
    - **Substrate Deficiency** (Decreased metabolism) e.g. Hypoglycemia
    - **Metabolic** (Accumulation defect) e.g. Urea

Vicious Cycle in Asphyxia



Pathophysiology in Asphyxia



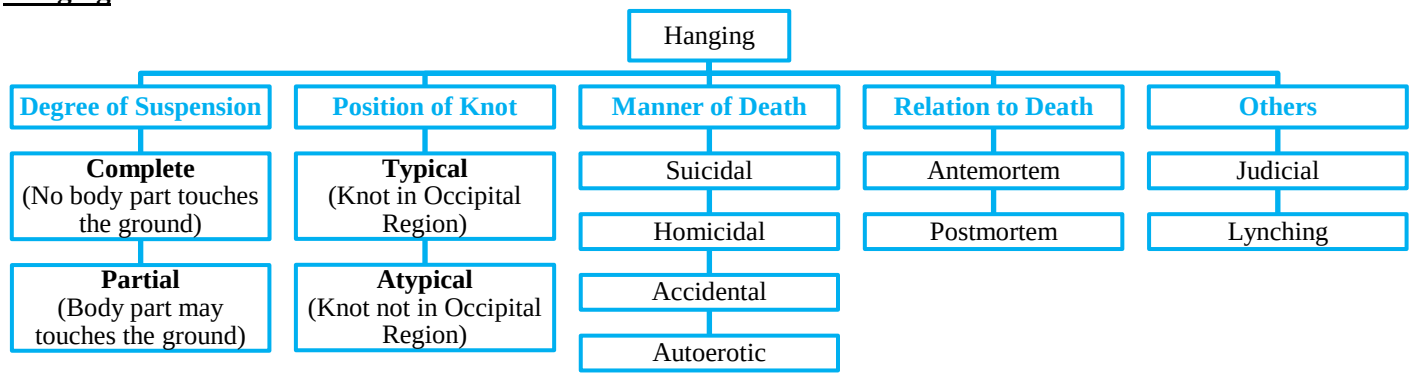
Types of Asphyxia

- **Asphyxia**
  - **Mechanical** (Obstruction)
    - **External Respiratory Orifice Block**
      - Suffocation (Smothering & Gagging)
        - Overlying
        - Sexual/Autoerotic
    - **Neck Compression/ Constriction**
      - Hanging
      - Strangulation
    - **Foreign bodies in Respiratory Tract**
      - Choking
    - **Compression/ Fixation of Trunk**
      - Traumatic Asphyxia
    - **Inhalational fluid into Respiratory Tract**
      - Drowning
  - **Pathological** (Disease)
  - **Toxic** (Poison)
  - **Environmental** (Insufficent O_2)
  - **Iatrogenic** (Medical Intervention)
  - **Positional** (Forceful flexion of neck)
  - **Sexual/ Autoerotic** (Gratification)

CONDITION	CAUSE OF DEATH & FATAL PERIOD	PM FINDINGS	MEDICO-LEGAL ASPECTS
Smothering	• Anoxic anoxia	• General asphyxial signs • Specific signs a. Bruises around nose & mouth b. Rupture of lip mucosa c. PM Staining d. Broken teeth e. Fractured nasal bone	• Homicidal a. House breaking b. Sexual Adventure • Infanticide • Accidental a. Infant in prone position on pillow b. Children with plastic bags c. Ill or intoxicated adult d. Old man fall in mud
Gagging	• Anoxic anoxia • Reflex vagal inhibition • Reflex laryngeal spasm	• Same as "Smothering" + • Forced back tongue • Bruises & bite marks on tongue • Gag material in mouth	
Overlying	• Anoxic anoxia	• General asphyxial signs • Specific signs a. Compressed & pale face, nose, chest b. Pressure marks of clothing & bedding	• Infanticide • Accidental a. Infants while feeding b. Old man
Sexual (Autoerotic)	• Cerebral anoxia	• General asphyxial signs • Specific signs a. Ligature marks	• Accidental
Hanging	IMMEDIATE • Anoxic anoxia (3-5 min) • Cerebral anoxia • Reflex vagal inhibition (Immediate) • Cerebral congestion • Combination of anoxia and congestion • Fracture dislocation of cervical vertebrae. (Immediate) DELAYED • Aspiration pneumonia • Infection and septicemia • Pulmonary edema • Hypoxic encephalopathy • Laryngeal edema • Brain abscess /encephalitis	• General asphyxial signs • Specific signs *(see difference between AM & PM Hanging + difference between Hanging & Strangulation)* • Outward compression of Hyoid bone	• Suicidal (mostly partial hanging) • Homicidal (child, old, intoxicated) • PM hanging • Accidental a. Playing child b. Autoerotic
Ligature Strangulation & Garroting	• Anoxic anoxia (3-5 min) • Cerebral anoxia • Reflex vagal inhibition (Immediate) • Combination of anoxia and congestion • Fracture dislocation of cervical vertebrae (immediate)	• General asphyxial signs • Specific signs *(see difference between Hanging & Strangulation)* • Inward compression of Hyoid bone & finger tip marks on neck (Throttling)	• Homicidal • Suicidal (knotting device) • Accidental a. Autoerotic b. Infants umbilical cord
Throttling (Pressure for >2 min)			• Homicidal a. Infant, Child, Women in sexual assaults b. Intoxicated, Old people • Accidental (rare)
Mugging	• Anoxic Anoxia • Reflex vagal inhibition (Immediate)	• General asphyxial signs mostly	• Homicidal • Accidental
Choking	IMMEDIATE • Anoxic anoxia (2-3 min) • Reflex vagal inhibition (Immediate) • Reflex laryngeal spasm DELAYED • Pneumonia • Lung abscess • Bronchiectasis	• General asphyxial signs without cutaneous petechiae • Specific signs a. Foreign body in respiratory tract b. Bite marks c. Internal bruises	• Suicidal (psychiatric patients and prisoners) • Homicidal (health issue, intoxication, infants) • Accidental a. 95% in <5 years of age b. **Café coronary:** Bolus of food causing obstruction & mimic cardiac arrest

Traumatic Asphyxia/ Perthes Syndrome	• Restriction of chest movements (2-5 min)	• General asphyxial signs mainly head, neck, chest, conjunctiva • Specific signs a. Rib fractures b. Bruised intercostals c. Pnemothorax d. Lacerations (lung & heart) e. Internal hemorrhages	• Accidental (mostly) • Homicidal a. Infants b. Burking (in combination with smothering)
Drowning	IMMEDIATE • Anoxic anoxia (3-5 min) • Reflex vagal inhibition (Immediate) • Cerebral congestion • Ventricular fibrillation • Myocardial anoxia • Reflex laryngeal spasm • Exhaustion • Hypothermia • Concussion/head injury DELAYED • Septic aspiration pneumonia • Sudden bursting of aneurysm	*"see postmortem findings in drowning"*	• Accidental (fishermen, bathers, intoxicated) • Suicidal (Women mostly) • Homicidal (rare)

Hanging



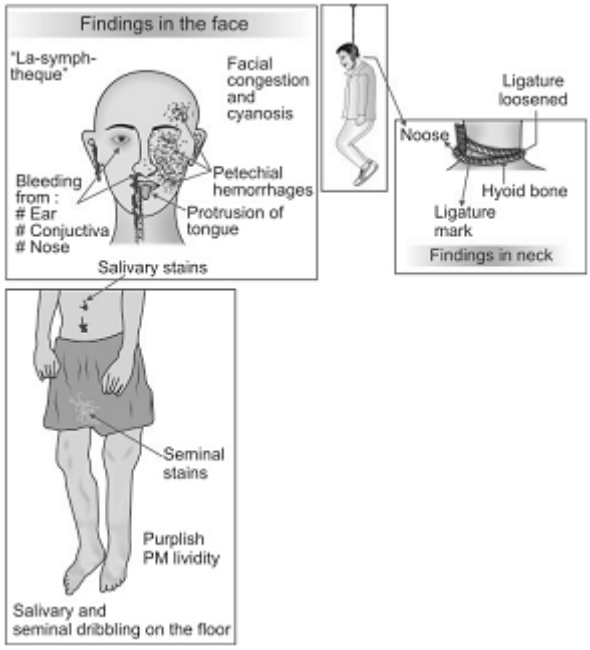
Lynching is a form of homicidal hanging.

- A suspect, an accused or an enemy is overpowered by several persons, acting jointly and illegally, and hung him by means of a rope from a tree or some similar object.
- It was prevalent in North America, where it was practiced by Whites on Blacks.

Difference between Antemortem Hanging & Postmortem Hanging

FEATURE	AM HANGING	PM HANGING
Salivary dribbling mark	+	–
Fecal/urinary stains	+	–
Elongation of neck	+	–
PM staining *(Above ligature mark, in lower limbs, Glove-stocking like)*	+	–
Cyanosis	+ (deep)	± (faint)
Evidence of injury Self-inflicted Tear of carotid artery intima Imprint abrasion Struggle	 + + + –	 – + – ±
Emphysematous bullae on lungs	–	+
Ligature mark Direction Continuity Level in the neck Parchmentization Vital reaction Knot Histochemistry	 Oblique Non-continuous Above thyroid + + Single, simple, on one side of neck Increased serotonin and histamine	 Circular Continuous At or below thyroid – – Multiple, granny type on occiput/chin Not so

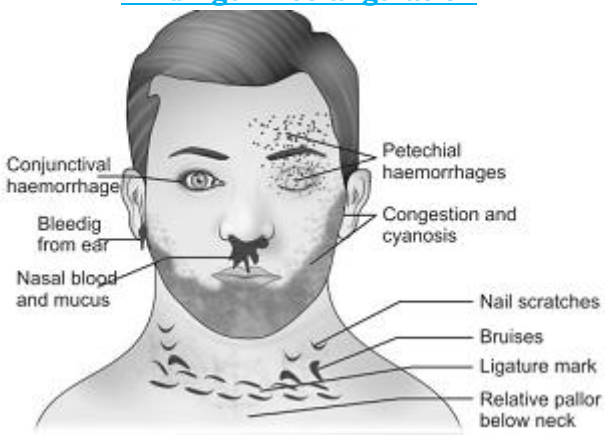
Postmortem Findings in Hanging



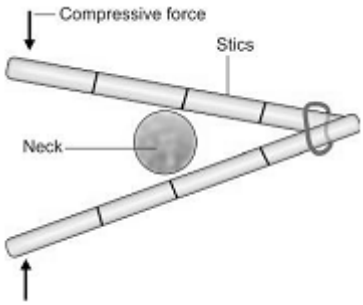
Strangulation

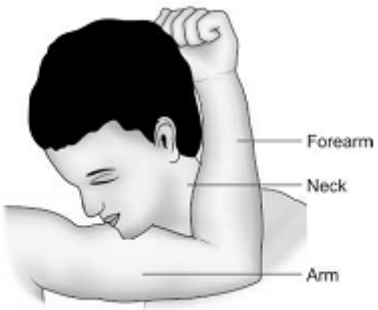
- Strangulation
  - Means of Constriction
    - **Ligature strangulation** (Ligature material is used)
    - **Manual strangulation** or throttling (Use of human fingers, palms & hands)
    - **Mugging or Chokehold** (Use of bend of elbow or knee)
    - **Bansdola** (Use of 2 bamboo or stickes & then tied with ropes at ends)
    - **Garroting** (Ligature material is used from back)
    - **Palmar strangulation** (Use of one palm on nose & mouth, other on neck)
  - Manner of Death
    - Homicidal
    - Accidental

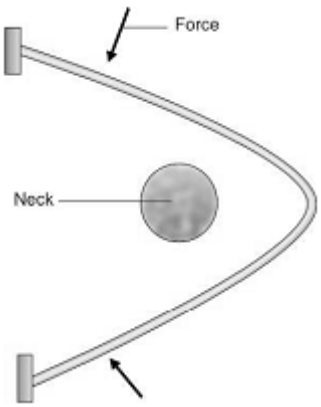
Findings in Strangulation



Bansola, Mugging & Garroting



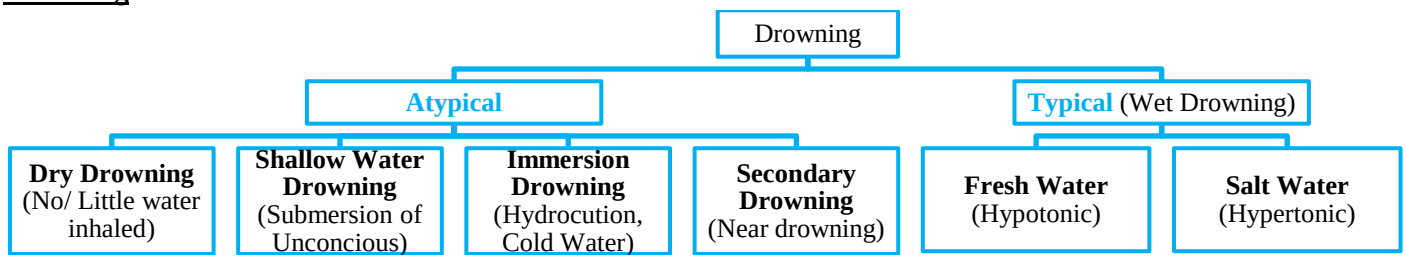




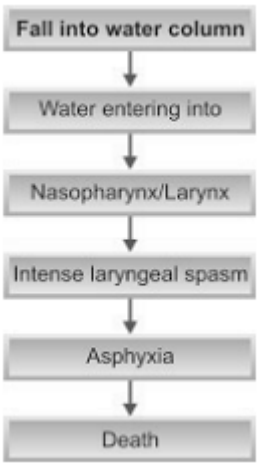
Difference between Hanging & Strangulation

FEATURE	HANGING	STRANGULATION
Age	Young or elderly adults	No age limit
History	Previous unsuccessful suicidal attempts	No
Suicide note	Usually present	No
Place of occurrence	Usually in own bed room with doors and windows bolted from inside	Any place, not necessary inside room, not bolted from inside
Signs of struggle	Absent	Always present, unless taken unaware
Tongue (swelling & protrusion)	Less marked	More marked
Bleeding (nose, ears, mouth)	Uncommon	Common
General Asphyxial Signs Cyanosis Facial congestion Petechiae Hemorrhage	 Mild/Absent Less Marked (Pale) Less	 Intense Marked Numerous
Neck Size Hyoid bone fracture Thyroid fracture Larynx fracture Trachea fracture Bruising of Muscles Carotid Arteries	 Stretched, elongated Common Uncommon Uncommon Uncommon Uncommon Damage in intima	 Not so Uncommon Common Common Common Common Rare
Ligature Length Application Knot	 Long Single turn Simple, slip knot, on one side of neck	 Short Multiple turns Granny or reef type, tied with force in front
Ligature mark ('furrow') Direction Continuity Site Base (Skin) Subcutaneous tissue Abrasion & Bruises around Nail marks around	 Oblique Noncontinuous Above thyroid Pale, hard, parchment-like White, hard, glistening Uncommon Uncommon	 Transverse Continuous Below thyroid Soft and reddish Ecchymosed Common Common
Involuntary discharge Seminal Fluid Feces and urine	 Common Uncommon	 Uncommon Common
Emphysematous bullae on lungs	Uncommon	Common

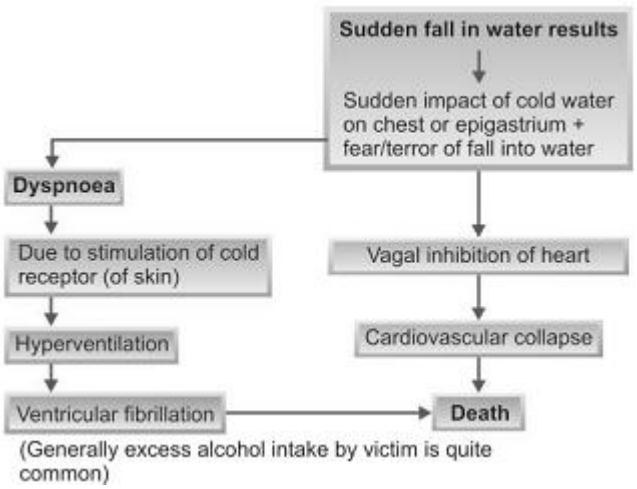
Drowning



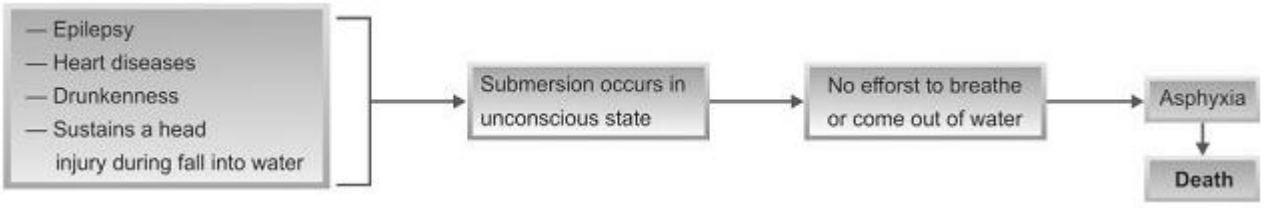
Dry Drowning



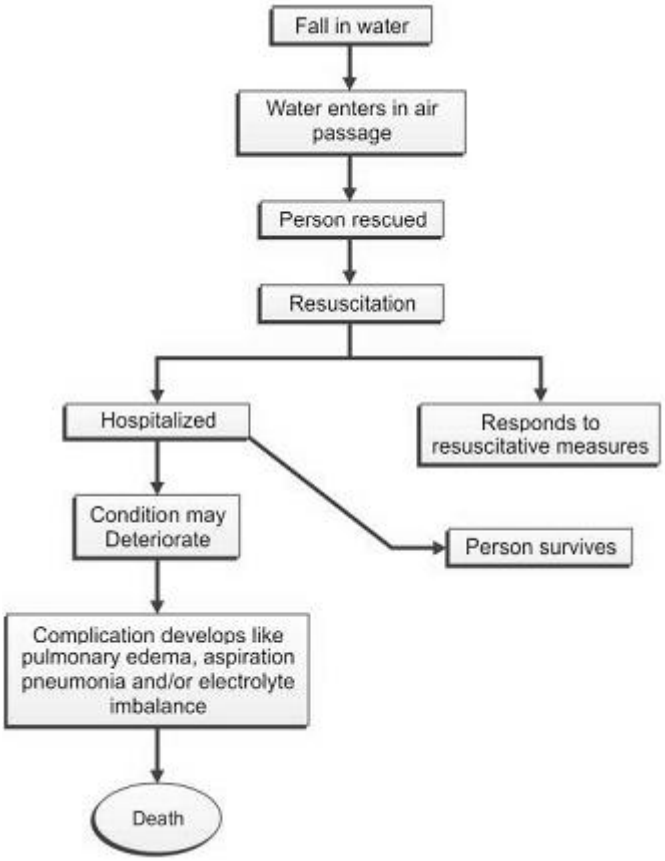
Immersion Drowning



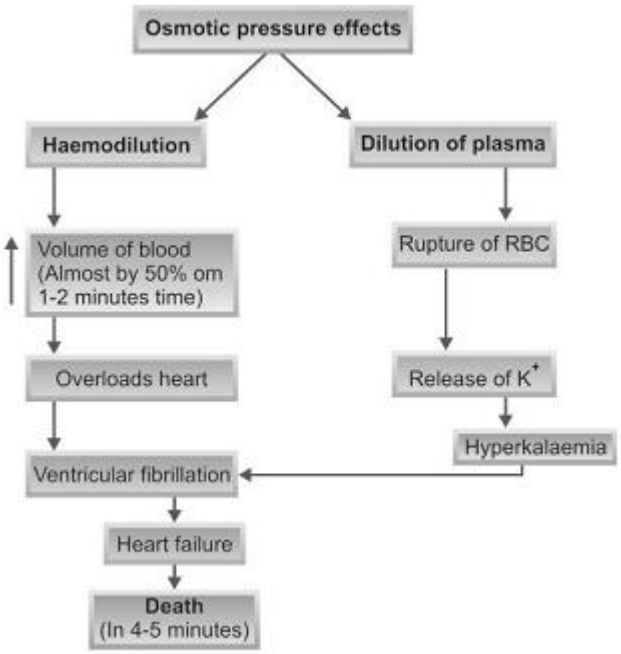
Shallow Water Drowning



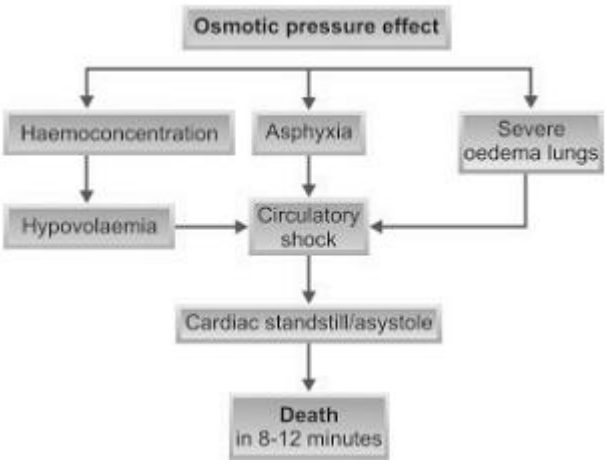
Secondary Drowning



Fresh Water Drowning



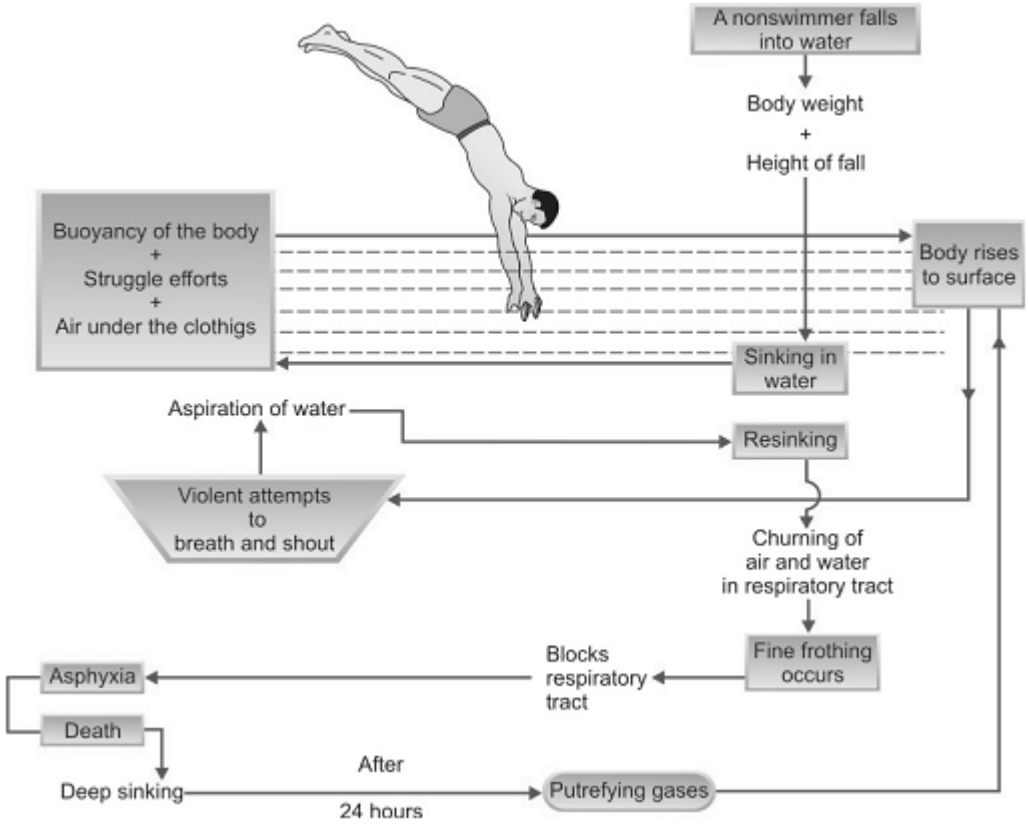
Salt Water Drowning



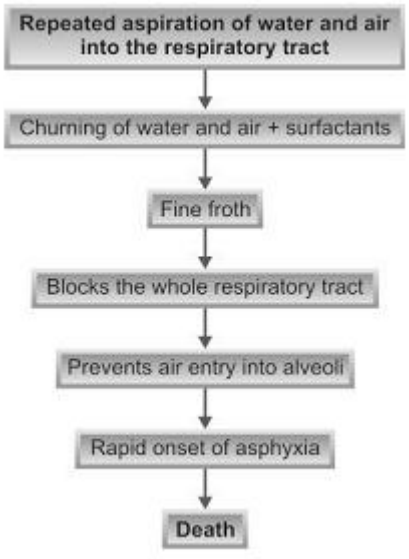
Difference between Fresh Water Drowning & Salt Water Drowning

FEATURE	FRESH WATER DROWNING	SALT WATER DROWNING
Lungs		
Size and weight	Ballooned, but light	Ballooned and heavy
Color	Pinkish	Purplish or bluish
Consistency	Emphysematous	Soft, jelly-like
Shape after removal from body	Retained, do not collapse	Not retained, tend to flatten out
On cut section	Crepitus is heard, little froth and no fluid	No crepitus, copious fluid and froth
Absorption		
Water	Massive	No (reverse occurs)
Salts	No	Considerable
Hemodynamics		
Plasma Concentration	Hemodilution	Hemoconcentration
Blood Volume	Increased	Decreased
RBC Change	Hemolyzed, Decreased	Shrunken, Decreased
Fatal Period	Short (4-5 min)	Long (8-12 min)

Events of Mechanisms of Drowning

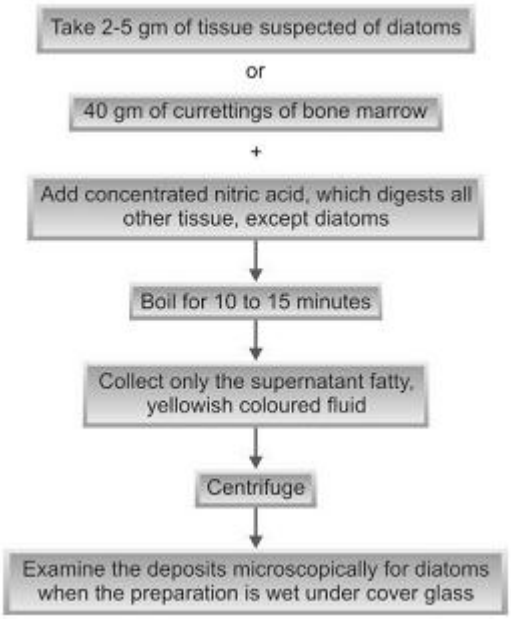


Mechanisms of Froth Formation in Antemortem Drowning



Postmortem Findings in Drowning

1. External Findings
    a. Clothes wet
    b. Skin
        i. Cold, wet, pale
        ii. Cutis anserina (goose flesh skin): puckered and granular appearance of skin
    c. Washerwoman's hand: Prolonged immersion in water leads to maceration of skin due to imbibitions of water.
        i. Immediate: Wrinkling
        ii. 1-12 hours: Bleaching of cuticle
        iii. 12-24 hours: Bleaching, corrugation and soddening becomes pronounced
        iv. 24-48 hours: Cuticle begins to separate from palm and sole
    d. Cadaveric spasm (AM Drowning): Grass, mud, sand etc. may be clinched in hands.
    e. Froth at mouth & nose (AM Drowning)
    f. Rigor mortis come and passes by quickly
    g. PM Hypostasis
        i. Static water: Bright pink in face, head, neck and anterior chest
        ii. Turbulent water: No stasis
    h. Eyes congested, pupil dilated
2. Internal Findings
    a. Changes in lungs
        i. Appearance of lungs *"see difference between fresh water and salt water drowning"*
        ii. Paltauff's subpleural hemorrhages over anterior surface and margins of lungs due to rupture of interalveolar partitions beneath the pleura
        iii. Struggle for life
            - Yes: Emphysema aquosum (lungs feel heavy, doughy, spongy and water lodged)
            - No: Edema aquosum (passively immersed or when unconscious) – No froth formation
        iv. Weight of lungs:
            - Drowned: 600 to 700 gm
            - Non-drowned: 370 to 540 gm.
    b. Hemodynamics *"see difference between fresh water and salt water drowning"*
    c. AM drowning signs *"see difference between antemortem and postmortem drowning"*
3. Laboratory Findings
    a. Microscopy *"see RBC & LUNG from difference between fresh water and salt water drowning"*
    b. Biochemical tests

TEST	IMPORTANCE	SIGNIFICANT VALUES
Getter's test (Cl^- concentration)	Fresh water drowning (Cl- content reduced in left side of heart)	Difference of 25 mg/100 ml of chloride between both sides of heart
Strontium test	Sea water drowning	Difference of 75 µg/L of strontium concentration both sides of heart
Diatom test (unicellular algae, silicon cell walls resisting digestion)	When a living person is drowned in water containing diatoms, many diatoms will penetrate alveolar wall and be carried to distant organs such as brain, kidney, liver, bone marrow etc. • Death was due to drowning • Person was alive when he was submerged in water • Site of drowning can be known by comparing diatom species in body and the source/site where body was found 	

Difference between Antemortem Drowning & Postmortem Submersion

FEATURE	AM DROWNING	PM SUBMERSION
Cadaveric spasm	+	–
Froth over mouth & nostrils	Fine, whitish, copious, leathery, tenacious, increases on chest compression	–
Stomach and intestine	Water may be present. May also present sand, mud, grit, silt etc	–
Respiratory tract	Contains fine froth & algae. May contain mud, sand, vegetations etc	–
Hemorrhage in Middle ear & mastoid air cell	+	–
Biochemical tests	+	–
Cutis Anserina	+	–
Washerwomen hand	+	–
Lungs	Ballooned up	Collapsed

7

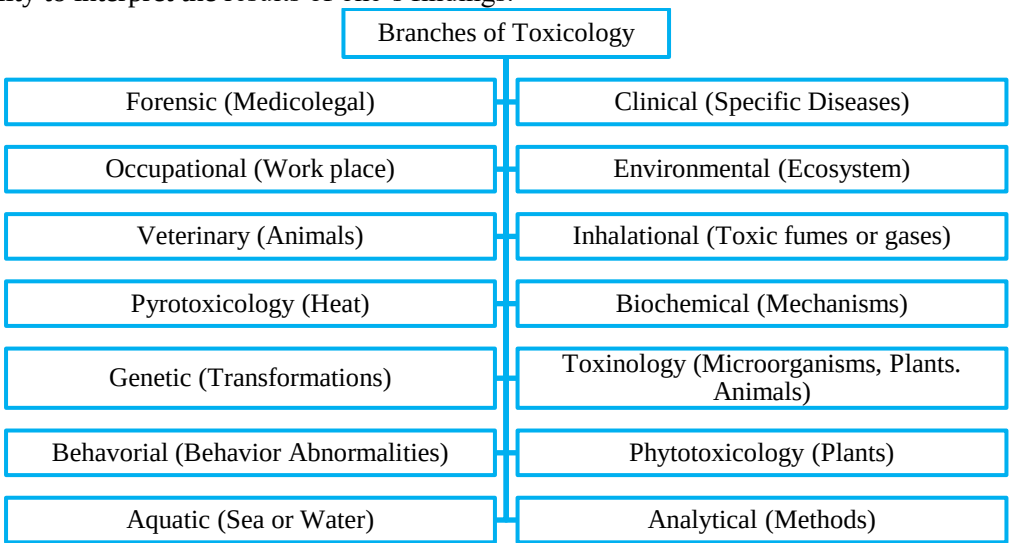
GENERAL TOXICOLOGY

1 SEQ + 3 MCQs = 8 Marks

TOXICOLOGY & BRANCHES

Science dealing with properties, actions, toxicity, fatal dose, detection, estimation, treatment and autopsy findings (in case of death) in relation to the poisonous substances.

Forensic or Medico-Legal Toxicology: It deals with the medical and legal aspects of harmful effects of chemicals on human beings. It involves not only the identification and quantifying of a drug, poison or substance in human tissue, but also the ability to interpret the results of one's findings.



POISON & CLASSIFICATION

Any substance if, taken in any account, by any route, produces harmful effect (i.e. disease, deformity or death, the 3 D's) over the body then it will be called as poison.

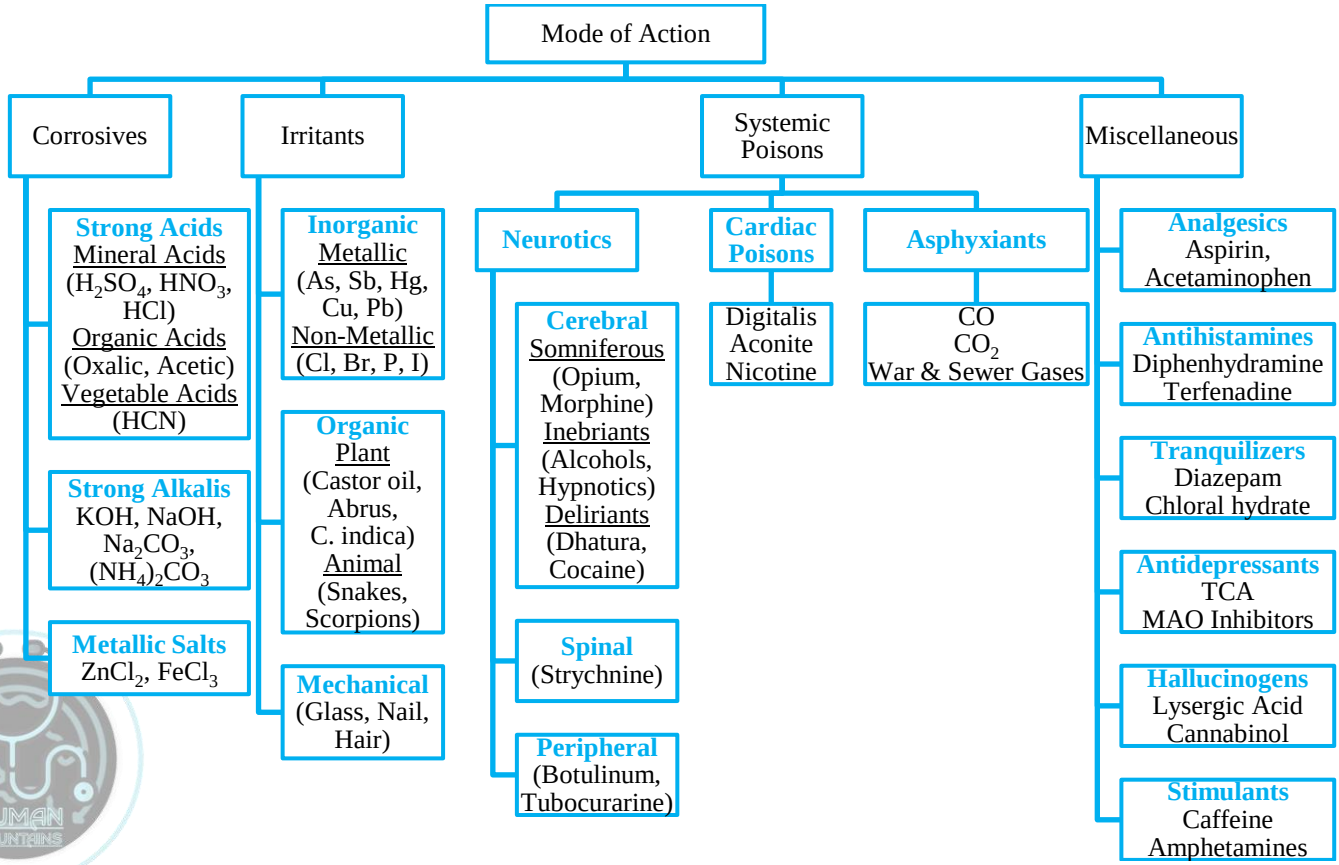
Medico-legal Aspects

i. Section 284 PPC deals with punishment of careless handling of poisonous substances
ii. Section 299, 302, 304A, 306, 307, 309, 324,326, 328 and 498A deals with offences related to administration of such substances.

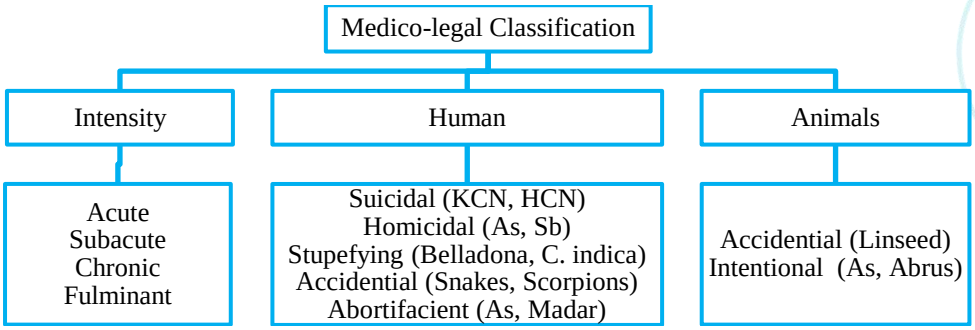
Basis of Classification

i. Origin
   - Exogenous e.g. CO toxicity
   - Endogenous e.g. Retention of Ammonia

ii. Mode of Action



iii. Medico-legal



iv. Keith Simpson's Classification

- Corrosives
- Irritants
- Hypnotics
- Industrial gases
- Analgesics
- Sedatives & Tranquilizers
- Antidepressants
- Stimulants
- Abortifacients

FACTORS MODIFYING ACTION OF POISONS

A. Form of Poison

FORM	DESCRIPTION
Physical State	Lead to different spectrum of reactivity (Gases > Liquids > Solids)
Chemical State	Leads to difference in solubility • In combinations become inert e.g. $AgNO_3$ & HCl • In combinations become poison e.g. Pb_2CO_3, Copper Arsenate • Metals are not poisonous but their salts are e.g. Cu, As
Mechanical State	Leads to change in poison action in combined form e.g. Corrosives with water

B. Method of Administration

- Order of Rapidity of Action: Inhaled in gaseous/vaporous form > IV Route > IM, Subcutaneous & Intradermal injection > Application to a wound > Application to serous surface > Ingestion > Introduction into natural orifices, e.g. rectum, vagina, urethra and sublingual > Application to unbroken skin (e.g. nicotine patch).
- Rough Estimate: If active dose by mouth is considered as one unit, the rectal dose about 1½–2 times and the hypodermic dose is about ¼.

C. Condition of Body

FEATURE	DESCRIPTION
Age	Poisons have greater effect at two extremes of age i.e. child & old due to poor metabolic development & poor general health respectively
State of Health	A healthy person tolerates poisons better than a diseased person. E.g. opium in bronchial asthma or paracetamol in liver disease.
Sleep & Intoxication	Action of poison is delayed
Condition of Stomach	• If stomach is full, action of poison slows down • If contents are fatty in nature, absorption slows down (except phosphorous)
Route of Elimination	• Absorbed Poison (mainly kidneys, also bile, milk, saliva, mucous or serous secretions) • Unabsorbed Poison (Faeces, Vomiting)
Dose Effects	Vomiting, severe irritation or diarrhea e.g. As poisoning
Idiosyncrasy	Unusual reaction of an individual e.g. Aspirin
Allergy	Hypersensitive reactions e.g. Pencillin
Habit	Long term use in small quantity reduces poison effect e.g. Alcohol
Synergism	≥2 poisons' combinations give severe effect e.g. Alcohol & Heroin
Cumulative Effect	Chronic poisoning leads to accumulation e.g. As, Pb, Hg
Antagonism	2 poisons' opposes effect e.g. Opium & Nalorphine

D. Dose or Quantity (Greater the dose, greater the effect)

FATAL DOSE	TOXICITY RATE
< 5 mg/kg	6 (Super toxic)
5 to 50 mg/kg	5 (Extremely toxic)
50 to 500 mg/kg	4 (Very toxic)
500 mg to 5 gm/kg	3 (Moderately toxic)
5 to 15 gm/kg	2 (Slightly toxic)
>15 gm/kg	1 (Non-toxic)

DUTIES OF MEDICAL PRACTITIONER IN CASE OF POISONING

A. Medical Duties

i. Care and treatment to save the life of the patient
ii. Inform relatives of the patient about serious condition of the patient

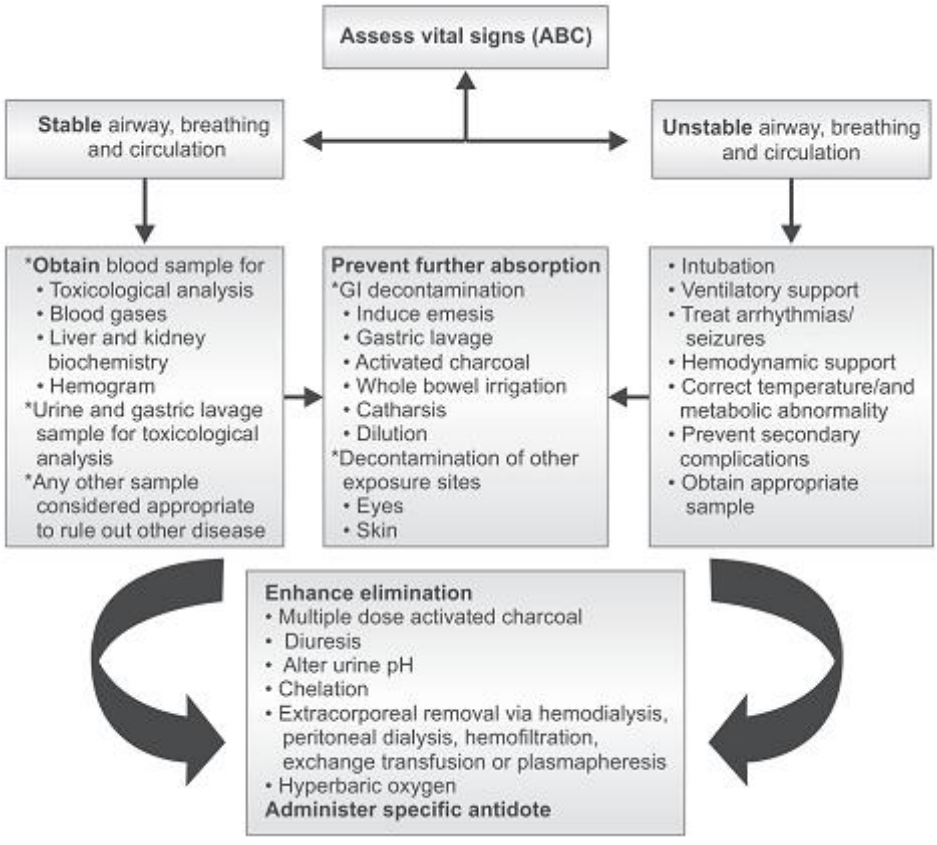
B. Legal Duties

i. Note preliminary particulars of the patient, viz. name, age, sex, occupation, address, date and time, brought by whom, identification marks, and history.
ii. In case of suspected homicidal poisoning, doctor must confirm his suspicion before expressing an opinion. For this he must:
   a. Collect vomitus and urine and submit it for analysis.
   b. Carefully observe and record symptoms in relation to food, any change in color, taste or smell of food/drink, and other persons affected at same time.
   c. Consult in strict confidence a senior practitioner and keep him informed about the case.
   d. Remove patient to hospital. If patient refuses, doctor should engage nurses of his confidence who should administer the medicine and food and allow no one to be with the patient alone.
iii. Any suspected articles of food, excreta, and stomach wash samples should be preserved.
iv. Report to police all cases of suspected poisoning, whether accidental, suicidal or homicidal.
v. Arrange for dying declaration or dying deposition accordingly.
vi. If patient dies, he should not issue a death certificate, but should inform the police.
vii. Opinion about nature of poison should be given only after getting report from forensic laboratory.

C. Clinical Duties

i. Obtain psychiatric history
ii. Consider associated problems
iii. Access the status of hepatic and renal function.

TREATMENT OF CASE OF POISONING



Main Aim of Treatment

a. Help patient to stay alive by attention to respiration and circulation
b. Help patient in getting rid of poison by metabolism or excretion
c. Help patient for controlling symptoms.

Principles of Treatment

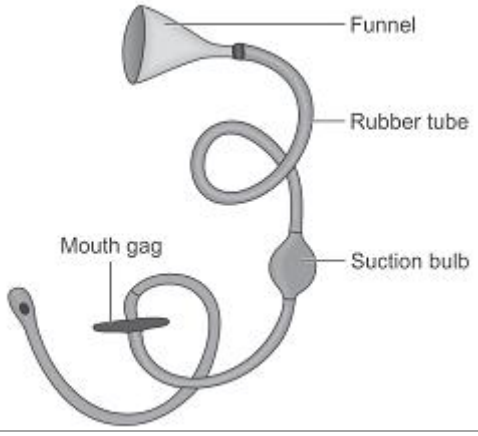
1. **Stabilization and Evaluation**
   a. ABC Maintenance (Maintenance of airway, breathing and circulation)
   b. Assess level of consciousness by Reed Classification of Comatose Patient or Glasgow Coma Scale

REED CLASSIFICATION OF COMATOSE PATIENT	
UNCONSCIOUS LEVEL	**CLINICAL RESPONSE**
Group 0	Arousable
Group 1	Respond to painful stimuli and have intact reflexes
Group 2	Do not respond to painful stimuli — most reflexes are normal
Group 3	Do not respond to painful stimuli — most reflexes are absent
Group 4	Deeply comatose, with respiratory and/or circulatory failure

GLASGOW COMA SCALE *The responsiveness of the patient is expressed by summation of figures.* *Thus coma score (E + V + M) = 3 to 15, Max score = 15 (Conscious);* *Min score = 3 (Deeply comatose)*	
SCORE	**CLINICAL RESPONSE**
E4	**Eye opening:**
4	Spontaneously
3	To speech
2	To pain
1	None
V5	**Best verbal response:**
5	Orientated
4	Confused
3	Inappropriate words
2	Incomprehensible sounds
1	None
M6	**Best motor responses:**
6	Obeys commands
5	Localisation to pain
4	Normal flexion to pain
3	Spastic flexion
2	Extension to pain
1	None

   c. Assess papillary size, light reflexes and eye movements.
2. **Decontamination**
   a. Eye (irrigated with copious water for 15 to 20 minutes)
   b. Skin (washed thoroughly with plain water)
   c. Gut

GASTRIC LAVAGE (STOMACH WASH)



Definition	Process of washing out stomach with various solutions like water and saline

Indications	• Conscious patient • Ingestion of poison within 4 to 6 hour • Baby <6 months old • Aspirin or opiods poisoning (even after 24 hours) • Oral route (except morphine IV)
Contraindications	• Coma/convulsion/unconscious patient • Impaired gag reflex • Corrosive/volatile poison ingestion • Petroleum, kerosene and strychnine poisoning • Marked hypothermia • Esophageal varices • Significant electrolyte imbalance.
Complications	• Aspiration pneumonia • Mallory Weiss tears • Perforation of esophagus/stomach • Laryngospasm • Hypothermia • Electrolyte imbalance.
Apparatus Used	• Ewald tube, Ryle's tube (in children) or Boas tube • Fluids (iodinated water, saline, $NaHCO_3$, Tannic or $KMnO_4$)
Procedure	• Protect airway • Place patient on lateral position • Tube should be passed orally • Lubricate the inserting end of tube • Use mouth gag • The position of tube in stomach should be confirmed • Lavage is carried out with saline or water.
Precautions	• Never begin on procedure as routine • Do not do in non-toxic agent ingestion • Obtain consent and explain procedure

EMESIS

Definition	The action or process of vomiting.
Indications	• Conscious patient • Ingestion of poison within 4 to 6 hour.
Contraindications	• Coma/convulsion/unconscious patient • Impaired gag reflex • Corrosive/volatile poison ingestion • Pregnancy.
Complications	• Aspiration pneumonia • Mallory Weiss tears • Laryngospasm.
Agents Used	• Household emetics ⇒ Warm water (2-3 cups for adults, 1-2 cups for child) ⇒ 1 spoon of mustard powder in 200 ml of warm water ⇒ 2 spoons of NaCl in 200 ml of warm water • Other emetics ⇒ Syrup of ipecac (30 ml for adults, 15 ml for child) ⇒ 1–2 g $ZnSO_4$ in 200 ml of water ⇒ 1–2 g$(NH_4)CO_3$ in 200 ml of water ⇒ 6 mg subcutaneously Apomorphine • Stimulation of posterior pharyngeal wall.

ACTIVATED CHARCOAL

Definition & Action	Activated charcoal is tasteless, black, fine powder. It adsorbs poisons in stomach within its pores, form tight complex and hence decreases systemic absorption of poison.
Preparation	Heating wood pulp at 900 °C and treating at high temperature with a variety of activating agents, such as steam or CO_2, to increase its adsorptive capacity
Dosage	40-80 g (0.5-1gm/kg body weight) is is mixed with water (or sweetener) and this mixture is administered to patient.
Contraindications	• Paralytic ileus • Intestinal obstruction • Perforation of stomach
Complications	• Unpleasant taste • May cause diarrhea/constipation

BOWEL IRRIGATION

Definition	This means washing the gut rapidly.
Agent Used	Non-absorbable polyethylene glycol solution
Indications	• Ingestions of iron, lithium, sustained release or enteric coated drugs, e.g. theophylline, etc, which are not adsorbed by activated charcoal. • Ingestion of drug-filled packets/condoms
Contraindications	• Paralytic ileus
Complications	• Haemodynamic compromise • Obstruction

CATHARSIS

Definition	Catharsis is known to reduce the transit time of drugs in GIT
Agent Used	• Ionic / saline cathartics ⇒ Magnesium citrate ⇒ Magnesium sulphate ⇒ Sodium sulphate • Saccharide cathartic (sorbitol or D-glucitol)
Indications	• Pb, As, P and Hg poisoning
Contraindications	• Strong corrosive • Electrolyte imbalance • Absent bowel sounds • Mg cathartics in renal dysfunction • Na cathartics in CCF

DILUTION

Drinking 5 ml/kg of body wt. of water or any other clear liquid is recommended only after the ingestion of corrosives (acids or alkali).

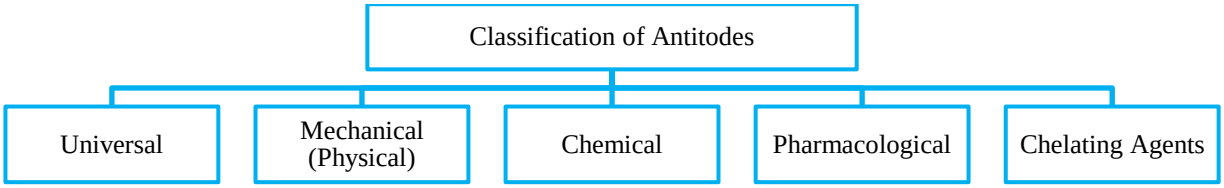
3. **Poison elimination**
   a. Improvement of renal excretion by giving large amount of fluids orally
   b. Forced diuresis and alteration of urinary pH

DIURETIC	ENHANCED EXCRETION
Saline diuresis	Alcohol, Fluoride, Thallium
Alkaline diuresis	Fluoride, Mecoprop, Methotrexate, Phenobarbital, Salicylate
Acidic diuresis	Sympathomimetic (Amphetamines, Cocaine, Tricyclic Antidepressants), Local Anesthetics, Phencyclidine, Quinidine, Quinine, Strychnine

   c. Diaphoretics (sudorifics): Application of heat (blankets or hot water bottles) and administration of warm beverages—alcohol, ipecac, pilocarpine, opium, sweet spirits of nitre and salicylates will cause increased perspiration and speeds up excretion of toxic agents.
   d. Extracorporeal removal
      i. Peritoneal dialysis
      ii. Hemodialysis
      iii. Charcoal or resin hemoperfusion
      iv. Hemofiltration
      v. Plasmapheresis
      vi. Exchange transfusion

4. **Antidote administration**

Substances that act specifically to prevent, inhibit, inactivate, counteract, reverse or relieve action or poisonous effects of a toxic agent, i.e. they are remedies used to counteract the action of poisons.



CLASS	INDICATION/ACTION	EXAMPLE
Universal	• Nature of ingested poison is unknown • Combination of ≥2 poisons	• Powdered Charcoal – 2 parts – (for absorbed alkaloids) • MgO – 1 part – (neutralize acids) • Tannic Acid – 1 part – (precipitate metals)
Mechanical (Physical)	To impede absorption of poisons	• Demulcents (form coat of mucous membrances) e.g. fats, oils, milk, eggs • Bulky food e.g. banana for glass powder • Activated charcoal

Chemical	• Form harmless or insoluble compounds of poisons • Oxidize poisons	• Dilute CH_3COOH (neutralize alkalis) • MgO or CaO (neutralize acids) • Lime (oxalic acid) • $KMnO_4$ (alkaloids & barbiturates) • Tannic Acid (precipitate metals, alkaloids, glycosides) • Tincture iodine (precipitate alkaloids) • Common salt ($AgNO_3$) • Albumin (precipitate $HgCl_2$) • $CuSO_4$ (precipitate phosphorous)
Pharmacological (Physiological)	Produce effects which are opposite to that of poison.	• Naloxone with morphine • Atropine with physostigmine
Chelating Agents	Specific antidotes against some heavy metal poisoning	• **BAL (British anti-lewisite, dimercaprol)** ⇒ For As, Pb, Bi, Cu, Hg, Ag etc, poisoning ⇒ Has two unsaturated –SH groups which combine with metal and thus prevent union of metal with –SH group of the respiratory enzyme system. ⇒ **Dose**: 10% solution in oil, 3–5 mg/kg IM 4 hourly for 2 days, 6 hourly on 3rd day and then 12 hourly for next 10 days. ⇒ **Side effects**: Nausea, vomiting, headache and hypertension. ⇒ **Contraindicated** in liver damage, G-6-PD deficient individuals, and cadmium and iron poisoning • **EDTA (Ethylenediaminetetraacetic acid, calcium disodium versenate)** ⇒ For As, Hg, Pb, Cu, Co, Cd, Fe, Ni poisoning ⇒ **Dose**: 25–35 mg/kg body wt in 250–500 ml of 5% glucose or normal saline IV over a 1–2 h period, twice daily for 5 days and may be repeated after 2–3 days. ⇒ **Contraindication**: Renal damage. • **Penicillamine (cuprimine)** ⇒ For Cu, Pb, Zn poisoning ⇒ **Dose**: 30 mg/kg body wt. upto a total of 2 g/day in 4 divided doses, orally for about 7 days. • **Desferrioxamine** ⇒ For acute Fe poisoning ⇒ **Dose**: 2 g in 5% of laevulose solution given IV and repeated after 12 h. • **Succimer or DMSA (dimercaptosuccinic acid)** ⇒ Similar to dimercaprol ⇒ For Pb, Hg, As poisoning. ⇒ **Dose**: 10 mg/kg orally, every 8 hourly for 10 days.

5. **Nursing care**
6. **Psychiatric care**

8

SPECIAL TOXICOLOGY

2 SEQ + 12 MCQs = 22 Marks

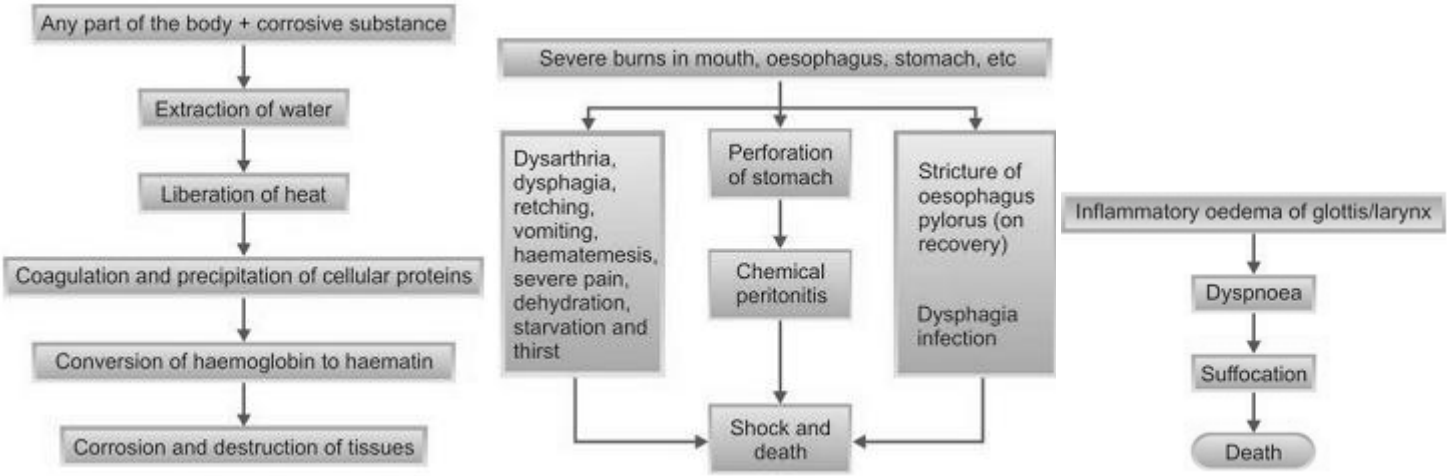
CORROSIVES

INORGANIC ACIDS (MINERAL ACIDS)

FEATURE	SULPHURIC ACID (H_2SO_4)	NITRIC ACID (HNO_3)	HYDROCHLORIC ACID (HCl)
Other Names	Oil of Vitriol	Aqua fortis Red Spirit of Nitre	Muriatic Acid Spirit of Salts
PROPERTIES			
Colour (Pure)	Colorless	Colorless	Colorless
Colour	Black (Charring)	Yellow (Xanthoproteic reaction)	Slightly yellow
Weight	Heavy	Heavy	Heavy
Viscosity	Oily	-	-
Odor	Odorless	Pungent & Choking	Pungent
Taste	Burning taste	Burning taste	Sour & burning taste
Fumes	Non-fuming	Fuming	Fuming
Reaction (H_2O)	Gives Heat	-	-
Chemical Test	$H_2SO_4 + BaCl_2/Ba(NO_3)_2 \rightarrow$ $BaSO_4$ (white ppt)	$HNO_3 + H_2SO_4 + FeSO_4 \rightarrow$ Brown ring at interphase	$HCl + AgNO_3 \rightarrow$ $AgCl_2$ (curdy white ppt)
MODE OF ACTION			
Local	Corrosive	Corrosive Respiratory distress (inhalation)	Corrosive Respiratory tract inflammation
Indirect	Shock, asphyxia Perforation of stomach Chemical peritonitis Esophageal stricture	Pain → circulatory failure	Pain → circulatory failure
FATAL DOSE & PERIOD			
Fatal Dose	5–10 ml	10–15 ml	15–20 ml
Fatal Period	12–18 h	12–24 h	18–30 h
SIGNS & SYMPTOMS			
Erosion of skin, mucous membrane	Over angles of mouth, lips, fingers with blackening, excoriation	Over angles of mouth, lips, fingers with yellow discoloration	Usually no erosion, epidermis may fall off after few days
Teeth	Chalky white, brittle	Yellowish coating, not brittle	No change
Perforation of stomach	More common	Less common	
Abdominal distension	Less common	More common	
Stiffness of abdomen	Present (Perforation)	Present (Distension)	
Tenderness on abdomen	Present		
Oropharynx burns	Present		
Burning pain in throat & epigastrium	Present		
Dysphagia	Present		
Dysphonia	Present		
Dyspnea	Present		
Eructation (burping)	Present		
Vomiting	Present (Strongly acidic, with altered blood & mucous shreds)		
Thirst	Present (Drinking causes more vomiting)		
Constipation	Present		
Tenesmus (rectal pain)	Present		
Nature of stool	Mucus, altered blood		
Urination	Suppressed		
THANATOLOGY			
Cause of Death	• Shock • Perforation of stomach • Peritonitis • Laryngeal spasm • Malnutrition (Stricture)	• Shock • Peritonitis • Laryngeal spasm • Respiratory distress	• Shock • Laryngeal spasm • Pulmonary edema (due to inhalation of vapor)
PM Findings	• Erosion of skin, angles of mouth, lips • Corrosion of trachea & larynx • Blackish charring of stomach, peppery feel • Perforation of stomach • Toxic swelling of liver & kidneys	• Yellow discoloration of skin • Corrosion of skin • Larynx & trachea: congested • Stomach wall is soft, friable and ulcerated	• Not much corrosion of skin • Brownish parchmentization • Inflammation of respiratory passages • Stomach contains brownish fluid

MEDICO-LEGAL IMPORTANCE			
Accidental	Mistaking it for glycerin	Rare	Common
Suicidal	Common	Rare	Common
Homicidal	Rare (Child, Intoxicated)	Rare (Child, Intoxicated)	Rare
Abortifacient	+	–	+
Vitriolage	+	+	+

Appearance of Signs & Symptoms on Skin, GIT & Respiratory Tract



Vitriolage (It is the throwing of any corrosive, not necessarily sulphuric acid, on a person with malicious intent.)

- Substances used
  1. Sulphuric acid (hence named)
  2. Nitric acid
  3. Carbolic acid
  4. Caustic soda
  5. Caustic potash etc
- Characteristics of burns
  1. Discoloration and staining of the skin & clothings (brown or black in sulphuric acid, and yellow in nitric acid).
  2. Trickle marks.
  3. Painless burns with absence of vesication and red line of demarcation.
  4. Presence of chemical substance in the stains.
  5. Repair is slow, and scar tissue causes contractures.
- Treatment
  1. Wash the parts with plenty of water and soap.
  2. Apply thick paste of MgO or carbonate.
  3. Cover raw surface with antibiotic ointment.
  4. For eye burns, conjunctiva and corneal surfaces are anesthetized with topical anesthetic drops irrigated with water for 15 min holding eyelids open. Repeat irrigation using 0.9% saline, till pH is near 7.0.
- Medico-Legal
  1. Grievous Hurt: Fluids are thrown on face with object of destroying vision or causing facial disfigurement
  2. Punishment: 5 to 10 years imprisonment with fine paid to victim

Management

1. Avoid
   a. Gastric lavage as to prevent gastric perforation (exception: organic acids).
   b. Weak bases or dilute alkalizers (milk of magnesia or lime water) as exothermic reaction extend corrosive injury
   c. Strong Alkalis or Carbonates (Na_2CO_3) which can yield CO_2, producing distention and perforation.
   d. Emesis is not attempted for fear of rupture of stomach.
2. Give
   a. Demulcents: milk (canned condensed), egg white(beaten), vegetable oils, starch solution, barley water, etc.
   b. Immediate dilution with milk or water within 30 minutes postingestion for oral ingestions
   c. Airway maintenance and artificial respiration if there is any respiratory distress.
   d. Morphine/pethidine for relief of pain.
   e. Intravenous fluids and electrolytes for dehydration.
   f. Antibiotics for control of infections.
   g. Skin care
      i. Copious saline irrigation
      ii. Topical silver sulfadiazine
   h. Eye care
      i. Copious irrigation with retraction of eyelids for 20-30 minutes.
      ii. Antibiotic eye drops

ORGANIC ACID (OXALIC ACID) – $C_2H_2O_4$ – Acid of Sugar/ Salts of Sorrel

PROPERTIES

- Colorless & Prismatic crystalline substance similar to $MgSO_4$ /$ZnSO_4$

PROPERTIES	OXALIC ACID	$MgSO_4$ /$ZnSO_4$
Taste	Sour and acidic	Bitter
Reaction	Strongly acidic	Neutral
On heating with sodium	Sublimates	–
On heating with bicarbonate	Effervesces	–
On heating with ink stains	Disappears	–

- CONFIRMATORY TESTS: (i) $AgNO_3$ test (ii) Ca^{2+} test (iii) Pb test (iv) Permanganate test
- FATAL DOSE—15-20 mg
- FATAL PERIOD—1-2 hour
- TOXICITY RATING—4
- CHRISTSION'S SAYING:

If a person mentioned after swallowing a crystalline white substance the taste of which is strongly acidic, it seized almost immediately by violent vomiting, pain in stomach, feeble pulse, cold sweat and collapse and dies within one hour or even earlier, there can scarcely be any doubt that oxalic acid had been administrated.

MODE OF ACTION

- LOCAL: Corrosive
- INDIRECT
  - ⇒ Electrolyte → Extracts tissue calcium → Hypocalcaemia
  - ⇒ Cardiovascular system → Shock → Death
  - ⇒ Renal system → Tubular necrosis → Uraemia → Death

SIGNS & SYMPTOMS

FULMINATING

- Oral large doses (15 gm or more) ➞ Sour & acidic taste ➞ Sensation of constriction around throat ➞ Burning pain from mouth to epigastrium (Radiates to abdomen) ➞ Tenderness in epigastrium ➞Nausea ➞ Vomiting (coffee ground coloured) ➞ Severe thirst ➞ Diarrhoea ➞ Electrolyte imbalance➞ Death.

ACUTE

- Hypocalcaemia ➞ Muscle irritability ➞ Tenderness ➞ Tetany & convulsions ➞ Tingling of extremities (Accoucher's hand due to carpopedal spasm) ➞ Coma ➞ Collapse ➞ Death

DELAYED

- Uraemia ➞ Scanty Urine (traces of albumin, blood and enveloped shaped calcium oxalate crystals).

MANAGEMENT

- GIT Cleaning
  - ⇒ Gastric lavage (2 tsps of calcium lactate per lavage)
  - ⇒ Bowel wash by enema and purgatives (castor oil)
- Antidotes
  - ⇒ Lime water, calcium lactate, calcium chloride, chalk suspension in water or milk, etc.
  - ⇒ 10 ml calcium gluconate I/V frequently
  - ⇒ Parathyroid extracts: 100 units I/M
  - ⇒ Demulcent drinks
- Symptomatic measures

PM FINDINGS

EXTERNAL

- No specific findings. However, burns of face and skin rarely seen.

INTERNAL

- Mucosa of the mouth, tongue, pharynx and oesophagus are bleached (whitened/scald/red)
- Stomach changes
  - ⇒ Stomach mucosa is reddened and punctate due to erosions giving "velvety red" or blackish appearance
  - ⇒ Wall of stomach is softened, but no perforations
  - ⇒ Contents: Gelatinous brown (due to acid hematin formation).
- Kidney changes: Swollen and congested (oxalate crystals)
- All other viscera: Congested

MEDICOLEGALS

- Usually accidentally (mistaken for $MgSO_4$)
- Suicidal or homicidal uses are rare (due to sour taste)
- Abortifacient
- Others
  - ⇒ Illegal erasure of signatures
  - ⇒ Commercial (Cleaning or bleaching leather, Removal of iron moulds or ink stains)

ORGANIC ACID (CARBOLIC ACID) - C_6H_4OH - Phenol

PROPERTIES

- Colourless
- Turns pink (on exposure to air)
- Prismatic needle-shaped crystalline form
- Phenolic odour or hospital odour
- Fat-soluble (attack CNS) – also soluble in glycerine, ether, alcohol and slightly in water.
- CONFIRMATORY TEST: (i) Millon's test (ii) $FeCl_3$ test (iii) Bleaching powder test (iv) $NaNO_3$ test (v) Br test
- FATAL DOSE— 5-15 mg
- FATAL PERIOD— 2-12 hours (Rapid death if injected intrauterine)
- TOXICITY RATING— 4

MODE OF ACTION

ABSORPTION

- Intact skin (local or spillage)
- GIT (oral ingestion)
- Respiratory tract (inhalation)
- Per rectum
- Per vaginum.

ACTION

Enters into loose combination with proteins & penetrates deep into tissue.

- Applied to skin/mucosa → Necrosis & gangrene
- Local nerve endings → Anesthesia
- Also acts on cells of CNS, heart & kidneys

METABOLISM & EXCRETION

- Metabolized mainly in kidneys, into hydroquinone & pyrocatechol and excreted in the urine. They cause a dark smoky green coloration of the urine known as **carboluria**
- It also causes blue black pigmentation in cornea & various cartilages, called **ochronosis**.

SIGNS & SYMPTOMS

CNS

- Headache, giddiness, tinitus
- Pupils dilated

Muscular System

- Muscular spasms and convulsions

GIT

- Vomiting, diarrhoea and pain abdomen

Respiratory

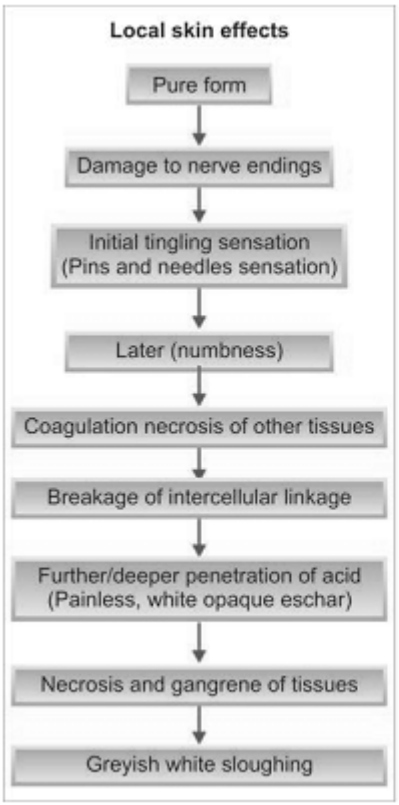
- Stertorous (noisy) breathing with cyanosis

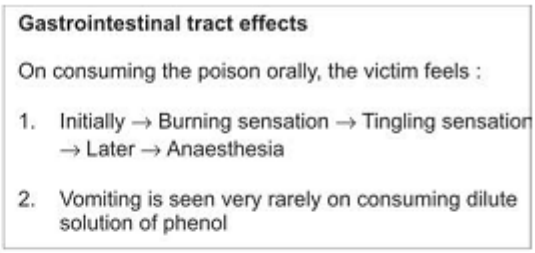
CVS

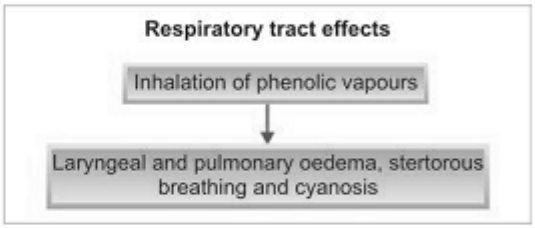
- Collapse—unconsciousness, coma
- Clammy, cold, sweating body

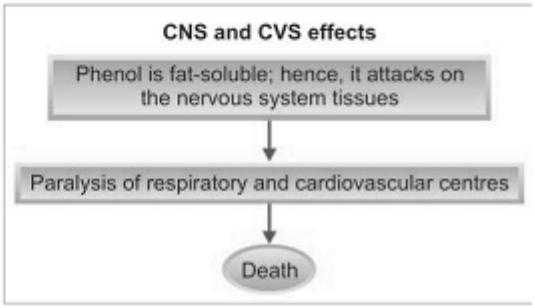
Others

- Carboluria followed by anuria.
- Methemoglobinaemia
- Death (respiratory and circulatory failure)









MANAGEMENT (depends on route of administration)

- Skin Absorption
  - ⇒ Remove contaminated garments
  - ⇒ Cleanse site by mopping with wet cloth and wash with soap and water
  - ⇒ Apply olive oil/ methylated spirit/ 10% ethyl alcohol (prevent further absorption)
  - ⇒ Shift victim to fresh atmosphere and make him breath in fresh air
  - ⇒ Give normal saline + Na_2CO_3 (I/V drip).
- Oral Route
  - ⇒ Gastric lavage (with plenty of lukewarm water containing animal charcoal, olive oil, magnesium or sodium sulphate or saccharated lime, soap solution, 10% glycerine, etc.)
  - ⇒ When lavage is completed, 30 gm of magnesium sulphate or medicinal liquid paraffin should be left in the stomach.
  - ⇒ Give demulcents e.g. egg white, epsom salt/demulcents orally.

- Symptomatic
  - ⇒ Artificial respiration.
  - ⇒ Tracheal aspiration of froth/secretions.
  - ⇒ Glucose saline to induce diuresis.

PM FINDINGS

EXTERNAL

- Greyish or brownish corrosions at angle of mouth, chin tracks, in front of the body, arms and hands (splashes) with phenolic odour.

INTERNAL

- Corrosion of GIT mucosa, laryngeal and pulmonary oedema
- Stomach changes
  - ⇒ Phenolic odour
  - ⇒ Wall of stomach is hardened (leather bottle appearance/leathery stomach)
  - ⇒ Marked corrosion & swelling of mucosal folds with coagulated greyish or brownish silvery mucus on it.
- Kidney changes: Haemorrhagic nephritis
- Vomitus and gastric lavage collection may show partially detached gastric mucosa.
- Brain, lungs and respiratory tract congested.

MEDICOLEGALS

- Accidental (consumption or spillage)
- Suicidal (rare)
- Homicidal (strong phenolic odour)
- Abortifacient
- Others
  - ⇒ Disinfectant and preservative for vaccines and sera.
  - ⇒ Ochronosis

VEGETABLE ACID (HYDROCYANIC ACID) – HCN – Prussic Acid

PROPERTIES

- 2% bluish-white solution of HCN in water
- Colourless gas
- Bitter almond odor (ability to detect it is a sex-linked recessive trait)
- HCN is liberated from cyanide powders by action of HCl in stomach
- FATAL DOSE
  - ⇒ Pure acid: 50–60 mg.
  - ⇒ NaCN and KCN: 200–300 mg.
  - ⇒ Pharmacological preparation: 30 drops.
  - ⇒ Crude oil of bitter almonds: 60 drops or 50–60 beans.
  - ⇒ Airborne concentration: 270 ppm (µg/ml) of HCN for few minutes.
- FATAL PERIOD
  - ⇒ HCN: 2–10 min, sometimes immediate.
  - ⇒ KCN or NaCN: 30 min.

MODE OF ACTION

- CN^- binds & inhibits Fe^{3+} heme moiety form of mitochondrial cytochrome oxidase, carbonic anhydrase and other enzyme systems of cellular respiration.
- Blocks final step of oxidative phosphorylation → Prevents formation of ATP → Arrest of aerobic metabolism → Increased demands of anaerobic glycolysis → Lactic acid production → Severe acid base imbalance → Death from histotoxic anoxia
- Also acts as a corrosive on mucosa.
- Cyanides may become less effective,
  - ⇒ If they are kept too long (they tend to change into carbonates)
  - ⇒ If person suffers from achlorhydria

SIGNS & SYMPTOMS

INHALATIONAL	INGESTION	SKIN	CHRONIC
• Constriction about throat • Dizziness • Loss of consciousness • Coma • Death	• CNS: Headache, anxiety, agitation, dizziness, confusion, convulsions, coma • CVS: Initially bradycardia and hypertension → tachycardia and hypotension, arrhythmias • RS: Tachypnea followed by bradypnea • GIT: Nausea, vomiting, abdominal pain, numbness	• Perspiration • Cherry red color • Bullae	• Headache • Amblyopia • Optic atrophy • Peripheral neuropathy • Ataxia • Deafness • Glossitis • Stomatitis

MANAGEMENT

1. Immediate inhalation of amyl nitrite & IV administration of sodium nitrite promotes formation of MetHb, which binds CN^- ions, forming cyanoMetHb which prevents inhibitory action of CN^- (complex IV of ETC)
2. CyanoMetHb is reconverted to MetHb by treatment with IV sodium thiosulfate, forming MetHB and the less toxic thiocyanate ion (SCN^-) excreted by kidney.
3. MetHb is converted to OxyHb with methylene blue.

PM FINDINGS (same as asphyxia)

EXTERNAL

- Smell of bitter almonds
- Pink PM Lividity
- Fine froth at the mouth.
- Eyes: Bright, glistening, prominent with dilated pupils.
- Rigor mortis appears early and jaws are firmly closed.

INTERNAL

- Cranial cavity should be opened first (as odor of bitter almonds is well marked in brain tissue)
- Brain and meninges: Hyperemic, diffuse cerebral edema with loss of gray-white differentiation.
- Slight corrosion of the mouth
- Eroded blackened mucosa of stomach (due to formation of alkaline hematin)
- Bloodstained froth in the trachea/bronchi.
- Pleura and pericardium may show petechial hemorrhages.

MEDICOLEGALS

- Suicidal mostly (cheap chemical)
- Accidental (common in children & industrial mishaps)
- Homicidal rarely (bitter almond odour)

☠ ASPHYXIANTS ☠

CARBON MONOXIDE - CO

PROPERTIES

- Colorless, tasteless, non-irritative and odorless gas, and lighter than air.
- SOURCES (incomplete combustion of carbon material)
  - ⇒ Tobacco smoke, house fires, automobile exhaust, industrial processes, unvented or faulty heating units (stove gas, water heater, burning fossil fuel or furnace) and fires.
  - ⇒ Coal gas (mixture of CO, methane and hydrogen)
  - ⇒ Endogenous CO
- CONFIRMATORY TESTS: (i) Tannic Acid test (ii) Spectroscopic test (iii) Hoppe-Seyler's test
- FATALITY

CO CONCENTRATION	FATALITY
< 0.001%	Normal
0.2%	4 hours
0.4%	1 hour
10%	½ hour

MODE OF ACTION

- CO has a high affinity for Hb (about 250 times more than O_2).
- CO → combines reversibly with hemoglobin → Carboxyhemoglobin (COHb) → Anemic hypoxia (↓blood O_2-carrying capacity)
- CO → inhibits ETC by blocking cytochrome A3 oxidase and cytochrome P450 → intracellular respiration blocked
- 15% of CO present in extracellular tissues → combines with myoglobin → 'rebound effect' with delayed return of symptoms

SIGNS & SYMPTOMS (depend on duration of exposure and levels of COHb)

COHb%	SIGNS & SYMPTOMS
MILD POISONING	
0–10	No symptoms
10–20	Breathlessness, mild headache, abdominal pain
20–30	Throbbing headache, irritability, emotional instability, buzzing in the ears
MILD – SEVERE POISONING	
30–40	Severe headache, nausea, vomiting, dizziness, dimness of vision, confusion, ataxia
SEVERE POISONING	
40–50	Increasing confusion, hallucinations, rapid respiration, staggering and incoordination—**mistaken for drunkenness**
50–60	Tachycardia, weak thready pulse, cherry red skin, flame-shaped retinal hemorrhages, bright red retinal veins
60-70	Hyperthermia, hypotension, irregular respiration, convulsions, coma and death
> 80	Rapid death from respiratory arrest

MANAGEMENT

- Shift the patient to fresh air immediately.
- Artificial respiration and 100% oxygen using a tight fitting mask or endotracheal tube, until COHb falls to 15 to 20%.
- Antidote: Administration of hyperbaric oxygen (HBO) in patient with COHb level > 25% with CO_2
- Gastric lavage in early stage (helps in preventing aspiration pneumonia)
- Monitor cardiac and respiratory status & keep patient at complete rest for minimum 48 hours.
- Prevent cerebral oedema by
  - ⇒ hyperventilation (PCO 25 to 30 mm Hg)
  - ⇒ head elevation
  - ⇒ infusion of mannitol (0.25 to 1 gm/kg of 20% solution for 30 minutes)
- Diazepam or phenytoin (to control convulsions) & Antibiotics (to prevent lung infection)
- Whole blood transfusion

PM FINDINGS

EXTERNAL

- Cherry red coloration of skin, mucous membranes and PM staining.
- Fine froth at the nostrils/mouth.
- Blisters of skin over dependent areas or bony pressure points such as buttocks, calves, wrists & knees due to cutaneous edema.

INTERNAL

- Cherry red coloration of blood, tissues and internal organs
- Lung: Edema and congestion.
- Heart: Lesions vary from petechial hemorrhages to myocardial necrosis.
- CNS: Neuronal hypoxic injury forming punctiform hemorrhages and softening of cerebral cortex

MEDICOLEGALS

- Usually accidentally (leakage, lime burnings, mine explosions)
- Homicidal (turning on gas or make forcefully to inhale)
- Suicidal (in Europe due to painless death)

CARDIAC POISONS

ACONITE – Mitha Zaher/ Bish/ Blue Rocket

PROPERTIES

- ACTIVE PRINCIPLES: **Aconitine**, pseudo-aconitine, ind-aconitine, picr-aconitine and aconine.
- Colorless, transparent, rhombic crystals.
- Insoluble in water, but readily soluble in benzene and chloroform.
- FATAL DOSE: Root: 1–2 g. & Aconitine: 2–5 mg
- FATALITY: 2–6 hours

MODE OF ACTION

Actions on voltage-sensitive sodium channels of cell membranes of excitable tissues → Stimulates and paralyzes peripheral terminations of sensory & secretory nerves, CNS, and nerves of myocardium, skeletal and smooth muscles.

SIGNS & SYMPTOMS

SYSTEM	SIGNS & SYMPTOMS
GIT	Nausea, vomiting, salivation, pain in abdomen and diarrhea Bitter-sweet taste, severe burning and tingling of oral cavity, followed by numbness
CVS	Hypotension, chest pain, palpitations, bradycardia, sinus tachycardia, ventricular ectopics and ventricular tachycardia/fibrillation. Slow, feeble and irregular pulse
CNS	Vertigo, restlessness, headache, giddiness
MS	Weakness of limb muscles with twitchings and spasms.
RS	Shallow slow labored respiration
Ocular	Pupils alternately contract and dilate (hippus). Diplopia and impaired vision occurs
Others	Temperature is subnormal and skin is cold

MANAGEMENT

- No specific antidote
- Supportive treatment
  - ⇒ Gastric lavage with tannic acid/activated charcoal.
  - ⇒ Inotropic therapy is required if hypotension persists, and atropine (0.5–1 mg IV) should be used to treat bradycardia.
  - ⇒ Antiarrythmics for ventricular arrhythmia is treated with amiodarone and flecainide (first-line treatment). In refractory cases and cardiogenic shock, early use of cardiopulmonary bypass is recommended.
  - ⇒ Symptomatic treatment.

PM FINDINGS

- Not specific, those of asphyxia.
- Organs are congested.
- Stomach: Fragments of root may be found
- Lungs: Hemorrhagic pulmonary edema.
- Heart: Diffuse contraction-band necrosis in myocardium.

MEDICOLEGALS

- Ideal homicidal poison.
  - ⇒ Cheap and easily available.
  - ⇒ Lethal dose is small and the fatal period is short.
  - ⇒ Color can be disguised by mixing it with pink colored drinks.
  - ⇒ Taste can be masked by mixing it with sweets or by giving it with betel (paan) leaves.
  - ⇒ Extremely unstable and destroyed by putrefaction, hence cannot be detected by chemical analysis.
- Accidental poisoning occurs due to:
  - ⇒ Eating the roots mistaking it for horseradish.
  - ⇒ Use of quack remedies.
  - ⇒ Taking of liquor mixed with aconitine to increase intoxication.
  - ⇒ Consumption of herbal decoction made from aconite roots.
- Suicide (not common)
- Others
  - ⇒ Abortifacient
  - ⇒ Cattle and arrow poison

DIGITALIS PURPUREA (Foxglove)

PROPERTIES

- ACTIVE PRINCIPLES: **Digitoxin**, Digitalin, Digitalein, Digitonin
- Roots, leaves and seeds contain several glycosides
- FATAL DOSE:
  - ⇒ Digoxin: 5 mg
  - ⇒ Digitalin: 15–20 mg
  - ⇒ Powdered leaves: 2.5 g
  - ⇒ Digitalis: 2–3 g
- FATALITY: 1-24 hours

MODE OF ACTION

- Glycosides act directly on heart muscle (prolong diastolic period) and improve function of failing heart.
- In toxic doses, excitability is increased with extrasystoles.

SIGNS & SYMPTOMS

SYSTEM	SIGNS & SYMPTOMS
RS	Labored and sighing respiration.
CVS	Bradycardia, extrasystoles, ventricular tachycardia & fibrillation, atrial fibrillation, faintness, precordial oppression, heart block
GIT	Nausea, vomiting, pain in abdomen, burning sensation, diarrhea
CNS	Headache, fatigue, confusion, anxiety, depression, disorientation, drowsiness, hallucinations, delirium
Ocular	Transient ambylopia, blurring, photophobia, scotoma, diplopia, color aberration
Skin	Urticaria

MANAGEMENT

- Gastric lavage is done with a solution of tannic acid.
- Activated charcoal is given.
- Purgatives may be given.
- Atropine is given in a dose of 0.6 mg IV to treat bradycardia.
- KCl may be given to reduce extrasystoles.
- Specific antidote for cardiac arrhythmias
  - ⇒ Lignocaine 100 mg IV
  - ⇒ Novocaine
  - ⇒ Propranolol
- Trisodium EDTA may help to lower serum calcium.
- Symptomatic treatment

PM FINDINGS

- Non-specific changes are seen.
- There may be irritation of gastric mucosa, and digitalis leaves or seeds may be found in stomach.

MEDICOLEGALS

- Accidental poisoning (overdose of medicinal preparation or from eating leaves by mistake)
- Homicidal poisoning (rare)

OLEANDER (Kaner/ Rose Laurel)

FEATURE	WHITE OLEANDER	YELLOW OLEANDER
Other Names	Nerium Odorum, Kaner	Cerbera Thevetia, Pila Kaner
PROPERTIES		
Parts	White, dark red or pink flowers	Yellow bell-shaped flowers with globular fruits, light green in color, about 5 cm in diameter containing a single nut
Active Principles	3 Glycosides (Neriodorin, Neriodorein, Karabin)	**Thevetin**, Thevotoxin (like digitalis), Cerberin (like strychnine), Peruvoside
Fatal Dose	Leaves: 5–15 Root: 15–20 g	Seeds: 8–10 Root: 15–20 g
Fatal Period	24 hours	2-3 hours
MODE OF ACTION		
Action	Similar to that of digitalis (inhibit Na-K ATPase) causing death from cardiac failure. • Neriodorein → Muscular twitching & tetanic spasm • Karabin → heart like digitalis →spinal cord like strychnine	• Thevotoxin (like digitalis) • Cerberin (like strychnine)
SIGNS & SYMPTOMS		
Local	Contact dermatitis	Inflammation
Inhalational	Headache, dizziness, respiratory difficulty, nausea	-
Ingestion	GIT Vomiting, pain abdomen, frothy salivation, difficulty in swallowing and articulation MS Muscular twitchings, tetanic spasms, lock jaw CVS Slow weak pulse, hypotension, fibrillation, AV block RS Respiration is rapid CNS Exhaustion, drowsiness, coma, respiratory paralysis and **death from heart failure**	GIT Burning sensation in mouth, tingling of tongue, dryness of throat, vomiting, diarrhea CVS Rapid, weak and irregular pulse, hypotension, heart block, collapse and **death due to peripheral circulatory failure** CNS Headache, dizziness, dilated pupils, drowsiness and loss of muscular power.
MANAGEMENT		
Treatment	• Gastric lavage (tannic acid) • Administration of an anesthetic • Atropine (AV block) • Phenytoin & Lidocaine (Arrhythmias) • Morphine injection • Electrolyte imbalance corrections • Symptomatic treatment	• Gastric lavage (Single-dose activated charcoal) • Molar solution of sodium lactate IV and 5% glucose to combat acidosis. • Atropine (AV block) • Digoxin-specific antibody fragments (cardiac arrhythmias) • Symptomatic treatment
PM FINDINGS		
PM Findings	• Non-specific • Petechial hemorrhage on heart • Organs are congested	• Non-specific • Signs of GIT irritation • Stomach and duodenum congestion & show fragments of seeds. • Organs are congested
MEDICOLEGALS		
Medicolegals	• Suicide (common among village girls, using it as a paste or decoction) • Abortifacient • Homicide (rare) • Accidental poisoning is sometimes met with when decoction is used: ⇒ Externally to reduce swelling. ⇒ As a remedy for venereal diseases. ⇒ As a love-philter (increases attraction between giver and taker). ⇒ For treatment of cancer and ulcers • Others ⇒ Cattle poison ⇒ Nerium odorum resists heat & can therefore be detected even from burnt remains of dead body.	

NICOTINE - NICOTIANA TABACUM (Tobacco)

PROPERTIES

- ACTIVE PRINCIPLES: Nicotine, Lobeline (Indian tobacco)
- Colorless, hygroscopic oily liquid. Burning acrid taste and disagreeable odor
- All parts of the plant are poisonous, except ripe seeds.
- A cigarette contain 1-3 mg of nicotine.
- FATAL DOSE:
  - ⇒ Nicotine: 60–100 mg
  - ⇒ Tobacco: 15–30 g
- FATALITY: 5-15 minutes

MODE OF ACTION

Block N_N receptors on autonomic ganglia in autonomic nervous system & N_M receptors on somatic neuromuscular junction

SIGNS & SYMPTOMS

SYSTEM	SIGNS & SYMPTOMS	
	ACUTE POISONING (skin contact, inhalational, ingestion, injection)	**CHRONIC POISONING (inhalational & ingestion of cigarette & beedi)**
RS	Tachypnea followed by respiratory depression & collapse.	Cough, wheeze, dyspnea, chronic bronchitis & lung cancer may develop
CVS	Tachycardia followed by bradycardia, hypotension, & arrhythmia	Anemia, palpitations, irregularity of heart, angina pectoris and Berger's disease
GIT	Burning acid sensation, nausea, vomiting, abdominal pain, salivation and odor of tobacco	Anorexia, vomiting and diarrhea
CNS	Headache, restlessness, confusion, vertigo, sweating, convulsions and coma	Impaired memory, blindness, tremors, insomnia, anxiety and headache

MANAGEMENT

- ACUTE POISONING
  - ⇒ Gastric lavage with charcoal, $KMnO_4$.
  - ⇒ Purgatives.
  - ⇒ Cardiac monitoring.
  - ⇒ Atropine to correct hypotension
  - ⇒ Diazepam for convulsions.
  - ⇒ Symptomatic treatment.
- CHRONIC POISONING
  - ⇒ Stoppage of use of tobacco gradually
  - ⇒ Clonidine

PM FINDINGS

- Brownish froth at mouth and nostrils.
- Stomach may contain fragments of leaves or smell of tobacco.
- Dark coloured blood
- Pulmonary edema
- Features of asphyxia are seen.

MEDICOLEGALS

- Accidental poisoning (ingestion, excessive smoking and application of leaves or juice to wound or skin)
- Suicidal/homicidal cases are rare
- Others
  - ⇒ Common drug of addiction.
  - ⇒ For malingering, leaves are soaked in water for some hours and placed in axilla at bed time, poisonous symptoms are seen by next morning.

IRRITANTS

METALLIC IRRITANTS: MERCURY – Hg (Para/ Quick Silver/ Liquid Metal)

PROPERTIES

- Available in inorganic, organic and metallic forms.
  - ⇒ Metallic mercury is heavy and non poisonous (cannot be absorbed from GIT). But it volatilizes at room temperature and inhalation of vapours is toxic.
  - ⇒ Inorganic salts are toxic e.g. **$HgCl_3$(sublimate)**, $HgCl_2$, HgS, $Hg(CN)_2$, HgI_2, HgO
  - ⇒ Organic salts are also toxic but predominantly affects CNS e.g. **methyl mercury**, dimethyl mercury, ethyl mercury & phenyl mercury
- FATAL DOSE
  - ⇒ 10 mg/m³ of mercury vapor
  - ⇒ 1–4 g of $HgCl_3$
  - ⇒ 10–60 mg/kg of methyl mercury
- FATAL PERIOD–3 to 5 days
- TOXICITY RATING–5 or 6 for most of salts.

MODE OF ACTION

ABSORPTION

- GIT and respiratory tract
- GIT: Gets deposited in all tissues, (mainly in liver, kidneys, spleen & bones)
- Inhaled: Maximum in brain

ACTION

Mercury binds with sulfhydryl groups resulting in enzyme inhibition & pathological alteration of cellular membranes

- Metallic & Organic salts; CNS toxic
- Vapours: Pulmonary Irritant
- Inorganic salts: Corrosive & Nephrotoxic

EXCRETION

- Kidney
- Liver
- Faeces

SIGNS & SYMPTOMS

ACUTE POISONING

GIT

Immediate

- Corrosion of mouth, tongue & lips
- Grayish white appearance of mucous membranes
- Metallic taste with throat constriction
- Burning sensation from throat to stomach
- Pain abdomen
- Severe vomiting (long stringy white mucus, with blood)
- Intense diarrhea (with blood)
- Tenesmus

After 2-3 days

- Foul breath
- Increased salivation
- Swollen inflamed gums with loosened teeth
- Ulcerative glossitis
- Erosion & corrosion of large intestines

CVS

- Rapid feeble pulse & Cold clammy skin
- Dilated pupils & Sunken eyes
- Collapse → Labored respiratory movement
- Syncope

CNS

- Convulsions
- General insensibility

Nephrotoxic Symptoms

After 2-3 days → Hematuria & albuminuria → Anuria & uraemia → Death

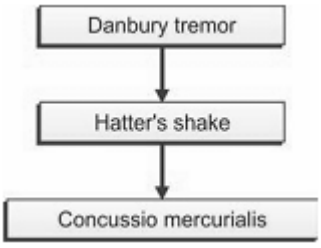
CHRONIC POISONING (Hydrargyrism)

GIT

- Excessive salivation (ptyalism/sialorrhoea)
- Swollen and painful salivary glands
- Metallic taste in mouth
- Glossitis and gingivitis
- Necrosis of jaw
- Blue-black line on gums called **Burtonian line**
- Colicky pain
- Vomiting
- Diarrhea

CNS

- **Hatter's shake** named because mercury is used in hat industry (Mercurial tremors can be detected in early stages with change in handwriting of person as it first affects muscles of finger, followed by muscles of the tongue causing stammering and slurring speech, and finally affecting muscles of face, arms and legs).



- **Mercurial erethism** (personality change resulting in abnormally high degree of irritability or sensitivity or excitability, shyness, amnesia, insomnia, delusions, hallucination, leading to insanity)

Nephrotoxic Symptoms

After 2-3 days → Hematuria & albuminuria → Anuria & uraemia → Death

Others

Mercuria lentis (brownish deposit of mercury through cornea on anterior lens capsule)

MANAGEMENT

ACUTE POISONING

- Gastric lavage (5% solution of sodium formaldehyde sulfoxylate & 100 ml of same may be left in stomach)
- Demulcents like egg albumin.
- Medicinal charcoal with $MgSO_4$
- Specific antidotes: BAL or penicillamine
- Symptomatic therapy

CHRONIC POISONING (Hydrargyrism)

- Removal of person from environment of exposure
- Demulcent.
- Penicillamine
- Oral hygiene
- Saline purgatives
- Symptomatic therapy

PM FINDINGS

- Body looks emaciated (thin or weak)
- **Burtonian line** (only in chronic poisoning)
- GIT: Mucosa shows inflammation, congestion & grayish corrosion. Ulceration of large intestine.
- Kidneys: Acute proximal tubular damage & glomerular degeneration or glomerular nephritis
- Liver: Congested and cloudy swelling or fatty change.
- Heart: Fatty degeneration and subendocardial hemorrhage.

MEDICOLEGALS

- Suicidal and homicidal (rare)
- Abortifacients
- Accidental:
  - ⇒ Ingestion from broken thermometers or antiseptic solutions containing $HgCl_3$(sublimate) and $Hg(CN)_2$.
  - ⇒ Absorption of mercurial preparations applied to skin.
  - ⇒ IV administration of organic mercurials, such as diuretics.
  - ⇒ In children, swallowing the sulfocyanide of mercury tablet, constituent of Pharaoh's serpents, or elemental mercury because of its bright gray appearance.

METALLIC IRRITANTS: LEAD – Pb (Shisha)

PROPERTIES

- Available in inorganic, organic and metallic forms.
  - ⇒ Metallic lead is toxic (absorbed from GIT), heavy, steel-gray metal
  - ⇒ Inorganic salts are less toxic e.g. lead oxides, lead carbonates, lead sulfide, lead acetate
  - ⇒ Organic salts are more toxic as they predominantly affects CNS e.g. tetraethyl lead or tetramethyl lead
- FATAL DOSE
  - ⇒ Tetraethyl lead: 1-2 drops
  - ⇒ Lead acetate: 20 g
  - ⇒ Lead carbonate: 40 g
- FATAL PERIOD–1 to 2 days
- TOXICITY RATING–3 or 4 for most of salts.

MODE OF ACTION

ABSORPTION

- GIT, Respiratory tract & Skin
- Deposits in tissues, (mostly in bones 90%, liver & kidneys)

ACTION

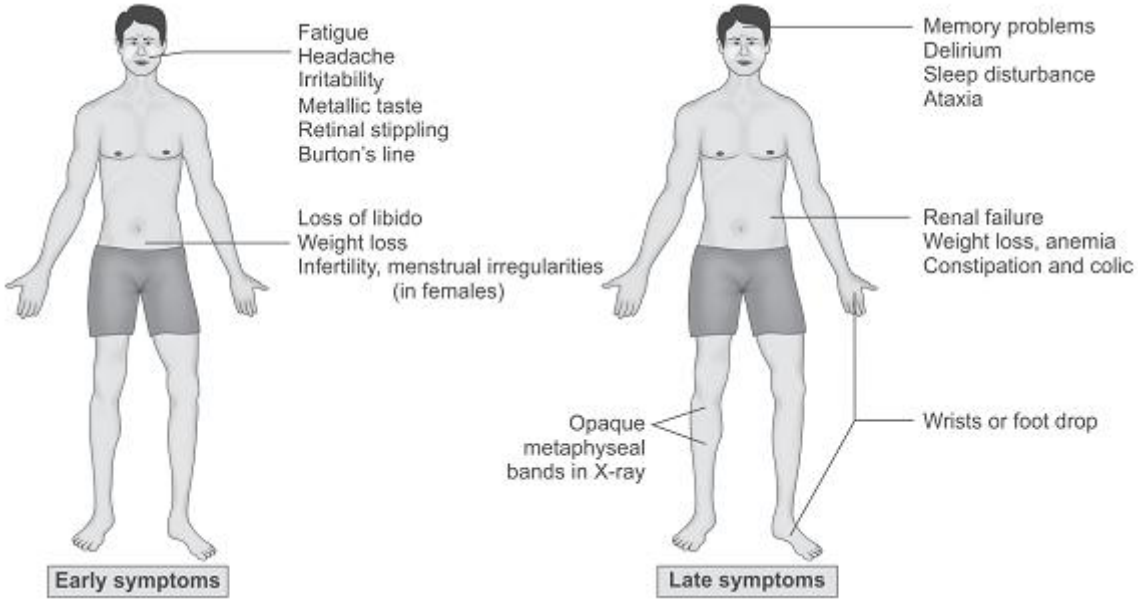
- Lead binds with sulfhydryl groups → interferes with mitochondrial oxidative phosphorylation, ATPases, calcium-dependent messengers → enhances oxidation & cell apoptosis → defective heme synthesis, proximal renal tubular & osteoblast dysfunction.
- CNS → deleterious effects on nerve cells and myelin sheaths → cerebral edema → neuropsychiatric effects

EXCRETION

- Kidney (70%)
- Faeces
- Hair
- Nail
- Sweat

SIGNS & SYMPTOMS

- **ACUTE POISONING**
  - ⇒ GIT: Metallic taste, dry throat, thirst, vomiting, nausea, burning abdominal pain (colic) and blood stained diarrhea → anuria → circulatory collapse.
  - ⇒ MS: Cramps & paralysis in limbs
  - ⇒ CNS: Headache, lethargy, arthralgia, anorexia, insomnia, paresthesia, depression, encephalopathy, coma and death.
- **CHRONIC POISONING (PLUMBISM, SATURISM)**



  - ⇒ Facial pallor (due to vasospasm)
  - ⇒ Hypochromic, microcytic anaemia with reticulocytosis & punctate basophilia (marked basophilic stipplings) in RBCs.
  - ⇒ Burtonian blue-black gum line (due to PbS)
  - ⇒ Lead Palsy = Wrist drop + Foot drop
  - ⇒ Lead Encephalopathy (due to tetraethyl lead)
  - ⇒ Cardiorenal problems (hypertension, arteriolar degeneration)

MANAGEMENT

ACUTE POISONING

- Gastric lavage (1% solution of Mg or Na sulphate)
- Morphine & atropine for colic pain
- Diet rich in milk, calcium & vitamin D for calcium deposition in bones
- Specific antidotes: EDTA or pencillamine
- Dialysis: Using KI or NaI (for renal excretion)
- Symptomatic therapy

CHRONIC POISONING

- Removal of person from environment of exposure
- Specific antidotes: EDTA, EDTA + BAL, or pencillamine
- Symptomatic therapy

PM FINDINGS

- A **blue Burtonian line** on gums in patients with poor oral hygiene, (only in chronic poisoning)
- Paralyzed muscles show fatty degeneration.
- Heart: Hypertrophied and atherosclerosis of aorta.
- Stomach and intestines: Ulcerative or hemorrhagic changes with contraction and thickening.
- Liver and kidneys: Contracted and hard.
- Brain: Pale (almost white), and swollen with flattening of gyri.

MEDICOLEGALS

- Acute and homicidal (rare)
- Chronic poisoning (common)
- Accidental chronic poisoning (people working with lead)
- Abortifacients: Lead oleate or red lead
- Others
  - ⇒ Mixed with arsenic as cattle poison.
  - ⇒ Spinal tap performed on the patients with lead encephalopathy and increased intracranial pressure can precipitate cerebral herniation and death

Mnemonics for signs and symptoms of chronic lead poisoning

i. **A**nemia/**A**norexia/**A**rthralgia/**A**bortion/**A**trophy of optic nerve
ii. **B**asophilic stippling/**B**urton's line
iii. **C**olic/**C**onstipation/**C**oproporphyrin excess in urine/**C**erebral edema
iv. **D**rop (wrist, foot)
v. **E**ncephalopathy/**E**maciation
vi. **F**acial pallor/**F**oul smell of breath/**F**ailure of kidneys/**F**anconi syndrome
vii. **G**onadal dysfunction/**G**out-like picture (*Saturnine gout*)
viii. **H**ypertension/**H**eadache/**H**allucination/**H**yperesthesia
ix. **I**mpotence/**I**nfertility/**I**nsomnia/**I**rritability

Laboratory Diagnosis of Chronic Lead Poisoning

1. Urine Pb levels = >0.08 mg/L collected in 24 hours
2. Blood Pb levels = >0.08 mg/L
3. Increased coproporphyrin level in urine
4. Increased urine and plasma delta-amino laevulinic acid
5. X-ray evidence of increased density or radio opaque bands or lines at the metaphyseal ends of long bones in children. This is also referred to as **lead lines**.
6. Presence of lead as radio opaque material on X-ray stomach and intestines may be seen in children particularly with history of pica (meaning abnormal craving for non-nutritive substances).

METALLIC IRRITANTS: ARSENIC – As (Sankhyal)

PROPERTIES

- Available in inorganic, organic and metallic forms.
  - ⇒ Metallic lead is non-toxic (not absorbed in GIT), black metal.
  - ⇒ Inorganic salts are toxic e.g. **arsenic oxides**, arsenic sulfides, arsenic chlorides etc.
  - ⇒ Organic salts e.g. Cacodylic acid, sodium cacodylate etc
- FATAL DOSE–100 to 200 mg of arsenious oxide
- FATAL PERIOD–2 to 3 days
- TOXICITY RATING–5 for all arsenic salts, except arsenic trioxide, which has a toxicity rating of 6.

MODE OF ACTION

ABSORPTION	ACTION	EXCRETION
• GIT, Respiratory tract, Skin & Parenterally • Deposits in tissues, (mostly in spleen, liver & kidneys.)	• LOCALLY → irritation of mucous membranes • REMOTELY → depression of nervous system • Arsenic binds with sulfhydryl groups → interferes with mitochondrial oxidative phosphorylation (pyruvate dehydrogenase & certain phosphatases) → decreased conversion of pyruvate to acetyl CoA → decreased cellular ATP • Arsenic → Inhibits cellular glucose uptake, gluconeogenesis, fatty acid oxidation • Lung, skin & bladder cancer	• Kidney (70%) • Faeces • Bile • Hair • Nail • Sweat

SIGNS & SYMPTOMS

SYSTEM	ACUTE POISONING	CHRONIC POISONING (Arsenicosis/ Arsenicism)
Skin & Nails	• Delayed hair loss (alopecia)	• Melanosis • **Bowen's disease** facial oedema • Hyperkeratosis • Cutaneous cancer • **Raindrop/ Dewdrop hyperpigmentation** • Nail white **Mees's lines**
CNS	• Vertigo • Headache • Hyperpyrexia • Convulsions • Spasm followed by stupor • Tremors • Coma	• Arsenical Neuritis • Headache • Drowsiness • Polyneuropathy • Tremors • Axonal degeneration
GIT	• Burning pain from throat to abdomen • Dysphagia • Nausea leading to vomiting (stomach contents → bile → mucus with blood) • Mucosal erosions • **Bloody or rice water diarrhea** • Tenesmus • Dehydration	• Nausea & vomiting • Diarrhea • Anorexia • Weight loss
Liver	• Fatty infiltration	• Hepatomegaly • Jaundice • Cirrhosis
Kidney	• Oliguria • Uremia	• Nephritic finding
Haemetologic	• Thrombocytopenia • Impaired folate metabolism	• Bone marrow hypoplasia • Anemia • Leukopenia • Basophilic stippling and karyorrhexis
CVS	• Rapid feeble pulse (sighing respiration) • ST wave abnormalities • Prolonged QT interval • Ventricular fibrillations	• **Blackfoot diseasee** due to platelet activation & hypercoagulability of blood in peripheral arteries is observed in endemic areas of aresenicism
Others	• Crosses placental barrier (teratogen)	• Inflammation of mucosal membranes • Running nose and eyes • Coughing • Voice hoarseness • Bronchial catarrh

MANAGEMENT

ACUTE POISONING

- Gastric lavage (with warm water or milk)
- Demulcents
- Whole bowel irrigation (with polyethylene glycol)
- Specific antidotes: BAL, Succimer or Dimerval
- Hemodialysis & transfusions
- Purgatives (castor oil or $MgSO_4$)
- Glucose salines (to prevent shock)

CHRONIC POISONING

- Removal of person from environment of exposure
- Specific antidotes: BAL
- Vitamin B complex & IV Sodium thiosulfate
- Symptomatic therapy

PM FINDINGS

- Body will be dehydrated
- Skin is pigmented or rarely jaundiced
- Hands and feet cyanosed
- Mee's lines on nails
- Rigor mortis is observed to be unusually longer
- Stomach –Velvety red or brownish, patchy areas with small ulceration seen on stomach mucosa
- Heart – Shows subendocardial haemorrhage.
- Brain – Show acute encephalitis with haemorrhagic spots.
- Other viscera – may show fatty degeneration (liver, kidney and heart).

MEDICOLEGALS

- Homicidal (common)

ADVANTAGES	DISADVANTAGES
▪ Colorless ▪ Tasteless ▪ Odorless ▪ Symptoms simulate those of cholera ▪ Onset of symptoms is gradual ▪ Cheap & easily obtainable ▪ Small lethal dose ▪ Can be administered easily with food, drink or betel leaf (paan)	▪ It retards putrefaction. ▪ It can be detected in decomposed/ buried bodies. ▪ Arsenic can be found in bones, hair and nails for several years. ▪ It can be detected in charred bones or ashes.

- Suicide is rare (cause much pain)
- Accidental (mistakenly in food or well water containing arsenic)
- Abortifacients
- Others
  - ⇒ Occupational (metal foundry, mining, glass production industry)
  - ⇒ Mixed with lead as cattle poison.

NON-METALLIC IRRITANTS: PHOSPHORUS – P

PROPERTIES

- Exist in two forms

FEATURE	WHITE PHOSPHOROUS	RED PHOSPHOROUS
Color	White or yellow	Reddish-brown
Appearance	Crystalline, waxy, translucent	Amorphous or crystalline, opaque
Solubility	Soluble (organic solvents)	Insoluble
Odor & Taste	Garlicky	Odorless & Tasteless
Luminescence	Luminous in dark	Non-luminous
Ignitability	Inflammable (spontaneous at room temperature)	Non-inflammable (ignites only at > 260°C)
Toxicity	Highly toxic	Low toxicity
Uses	Fertilizers, smoke screens & fireworks	On sides of match box

- FATAL DOSE–60–120 mg of white phosphorus
- FATAL PERIOD–24 hours to 2-7 days
- TOXICITY RATING–6

MODE OF ACTION

- REMOTELY:
  - ⇒ Affects cellular oxidation
  - ⇒ Hepatotoxic
  - ⇒ Cardiotoxic
  - ⇒ Fatty infiltration and necrosis of liver and kidney
- LOCALLY: Produces severe irritation or burn injuries of skin and mucosa

SIGNS & SYMPTOMS

- **ACUTE POISONING (3 phases)**
  - ⇒ Primary phase of GIT irritation (from 2-6 hours of ingestion to 3 days)
    - Garlicky taste & garlicky breath odour → severe burning sensation in mouth, throat, retrosternal area & epigastrium → nausea → vomiting (garlicky and may contain blood) → diarrhoea
    - Vomitus and stools ar luminous in dark. This phenomenon is called **phosphorescence**.
    - Stools may give rise to faint fumes constituting **smoky stool syndrome**.
  - ⇒ Secondary symptom-free phase – (last for about 2-6 days or even more after subsidence of primary phase)
  - ⇒ Tertiary phase of systemic effects (original symptoms of primary phase reappear with increased severity)
    - Hepatic damage = Tender hepatomegaly → jaundice → olive green hue → pruritus → bleeding from multiple sites → anaemia → hepatic encephalopathy → stupor and coma → Death
    - Renal damage = Oliguria, haematuria, albuminuria, and acute renal failure → Death
    - Male patients may present with priapism, which is common.
- **CHRONIC POISONING**
  - ⇒ **Phossy jaw' (glass jaw or Lucifer's jaw) - osteomyelitis & necrosis of jaw**
    - Toothache → swelling of jaw → loosening of teeth → necrosis of gums → sequestration of bone in mandible with multiple sinuses discharging foul-smelling pus
  - ⇒ Constitutional symptoms
    - Nausea, vomiting, anorexia, pain in the abdomen, indigestion, purging, loss of weight
    - Pain in joints, weakness
    - Bronchitis
    - Cirrhosis, jaundice
    - Ascitis
    - Anemia

MANAGEMENT

ACUTE POISONING

- Life support measures—airway support & fluid maintenance should be provided.
- External burns should be washed and cleaned
- Gastric lavage ($KMnO_4$ solution)
- Activated charcoal
- Demulcents
- Purgatives ($MgSO_4$)
- Vitamin K 20 mg IV in repeated doses
- Blood transfusion
- Glucose-saline (to prevent shock)
- Peritoneal or hemodialysis
- N-acetylcysteine, ubiquinone & sulfate (to prevent liver damage)

CHRONIC POISONING

- Removal of person from environment of exposure
- Oral hygiene
- Symptomatic therapy

PM FINDINGS

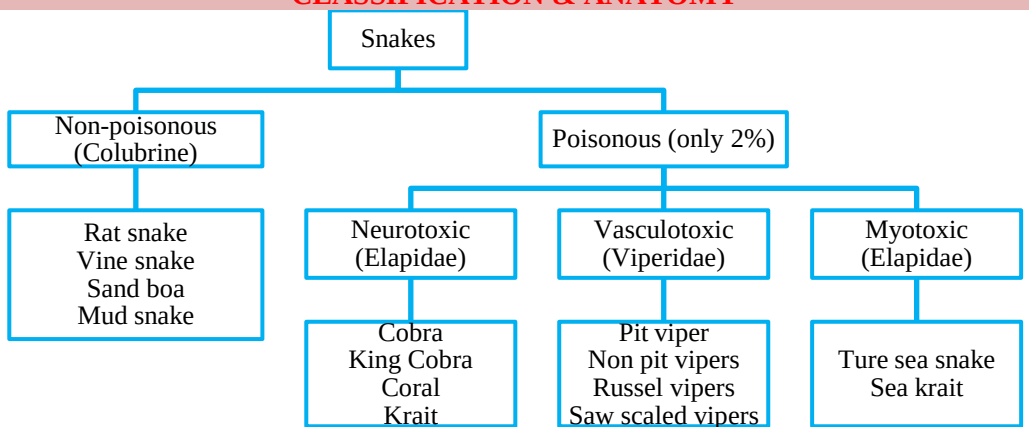
- Petechial hemorrhages may be noted over skin
- Jaundice
- Garlicky odour
- Stomach
  - ⇒ Gastric mucosa is yellowish or greenish-white in colour and is softened
  - ⇒ Gastric contents emits garlicky odour and luminous in dark
- Liver shows necrobiosis. Liver is enlarged, doughy in consistency, uniformly yellow and contains many hemor rhagic areas in parenchyma
- Heart, kidneys and voluntary muscle fibers shows fatty degeneration
- Microscopy, hepatocellular necrosis and cholestasis are seen.

MEDICOLEGALS

- Accidental (mistakenly chewing fireworks or rat pastes)
- Suicide is rare (cause much pain)
- Homicidal
  i. Symptoms resemble acute liver disease.
  ii. There is delay in the appearance of symptoms.
  iii. The poison is oxidized in the body, hence cannot be detected.
  iv. Death occurs after few days.
- Abortifacients

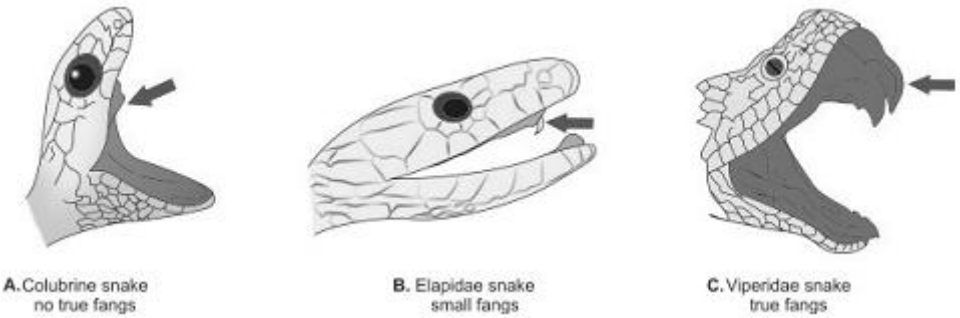
ORGANIC IRRITANTS (ANIMALS): SNAKES – (Ophidia)

CLASSIFICATION & ANATOMY

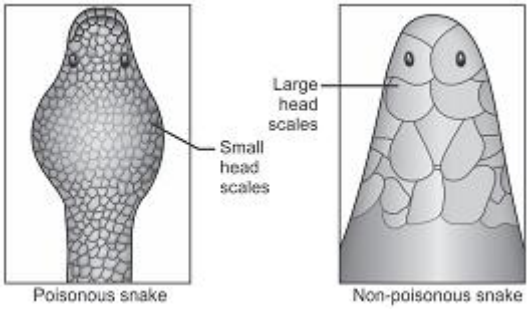


FEATURE	NON-POISONOUS SNAKES	POISONOUS SNAKES
Fangs	Short & solid	Long & canalized, like hypodermic needle
Head scales	Large mostly	Small (vipers) Large (pit viper, cobra, kraits)
Head	Round	Triangular
Pupil	Round	Vertical
Belly scales	Small, & do not cover entire breadth	Large & cover entire breadth
Scales distal to anal plate	Double row	Single row
Tail	Not markedly compressed	Compressed
Habits	–	Nocturnal
Bite marks	Number of small teeth marks in a row	Two fang marks, ± small marks of other teeth

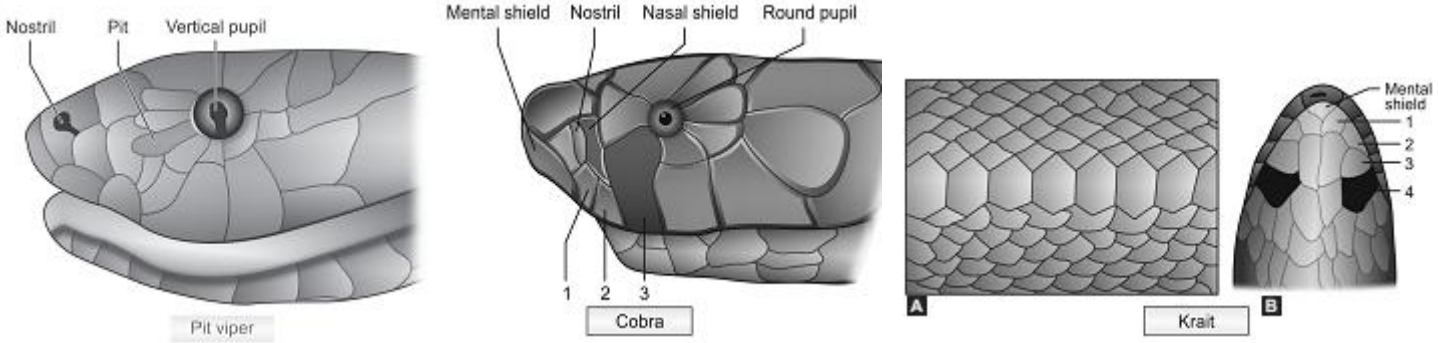
Fangs



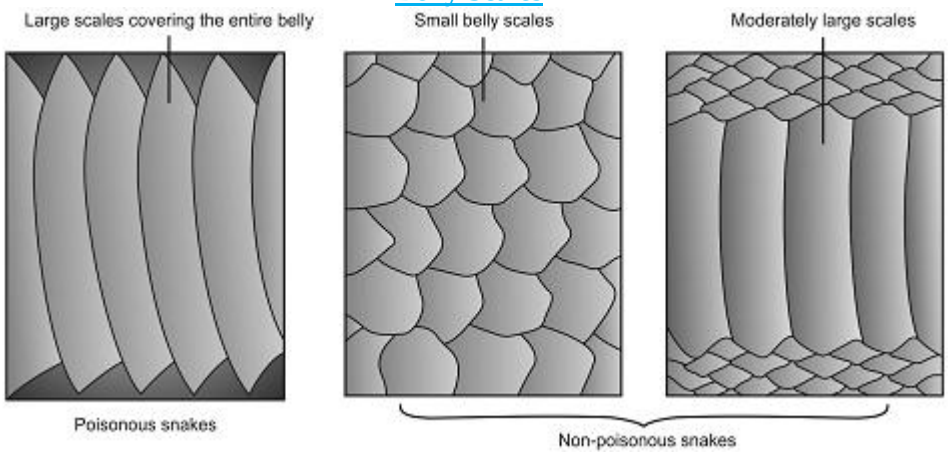
Head Scales



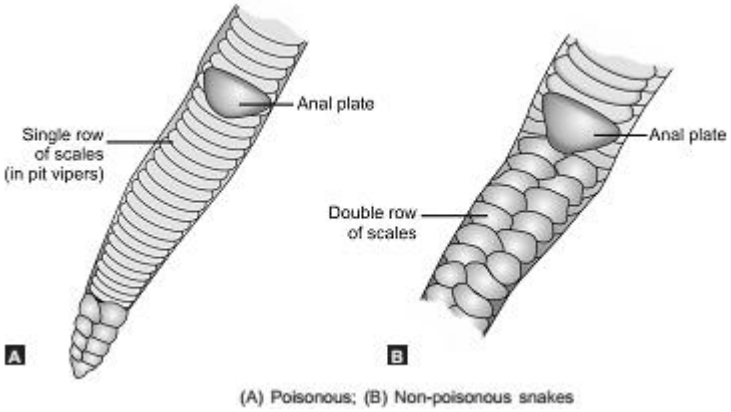
Large Head Scales (Poisonous Snakes)



Belly Scales



Scales distal to Anal Plate



(A) Poisonous; (B) Non-poisonous snakes

FEATURE	POISONOUS SNAKES		
	ELAPIDS	VIPERS	ELAPIDS (SEA SNAKES)
PROPERTIES			
Fangs	Short, fixed, grooved	Long, moveable, canalized	Short, fixed
Head	Head width = Neck width	Head is wider than neck	Small
Pupil	Round	Vertical	Round
Length	Long	Short	Intermediate
Venom	Neurotoxic	Vasculotoxic	Myotoxic
Active (Toxic) Principles	PHYSICAL APPEARANCE Faint transparent yellow & viscous, when fresh. TOXIC PRINCIPLES Proteinous in nature, most of which are glycopolypeptides & are enzymatic in action. About 80–90% of viperidae and 25–70% of elapidae venom consists of enzymes. • Neurotoxins (elapid venom) • Cholinesterase (elapid venom) • Hemolysins (viper venom) • Thromboplastin (viper venom) • Fibrinolysins • Proteolysins • Agglutinins • Cardiotoxins • Coagulase • Hyaluronidase • Phospholipase • Lecithinase		
Fatal dose (dried forms)	• Cobra 15 mg • King cobra 12 mg • Common krait 2.5–6 mg • Banded krait 10 mg	• Russell's viper 40 mg • Saw-scaled viper 8 mg	-
Fatal period	0.5-24 hours Or immediately (due to shock)	1-4 days Or immediately (due to shock)	-

MODE OF ACTION OF VENOM			
Site	Acts on motor nerve cells & resembles curare	Acts on endothelial cells of blood vessels, and red cells hemolysis	Muscles
Action	Causes muscular weakness of legs & paralysis of muscles of face, throat and respiration	Causes enzymatic destruction of cell walls & coagulation disorders	Generalized muscular pain ending in respiratory failure
SIGNS & SYMPTOMS			
Local	<u>Minimum (triple response)</u> Severe burning at bite site ↓ Rapid edema ↓ Inflammatory changes ↓ Oozing of serum	<u>Severe</u> Severe pain at bite site ↓ Swelling, ecchymosis, cellulitis ↓ Severe haemorrhage (oozing of blood) ↓ Blisters formation	<u>Minimum</u> Pain ↓ Swelling
Systemic	<u>Severe</u> From 15-30 min to 2 hours ↓ Giddiness, weakness, lethargy, muscle weakness ↓ Coma ↓ Bulbar or central paralysis beginning in legs & ascending to head by way of trunk ↓ Respiratory paralysis ↓ Death *Cobra produces convulsions & paralysis, while krait causes only paralysis*	<u>Minimum</u> Hemolytic effect on heart & blood vessels ↓ Cardiovascular collapse ↓ Death **OR** If patient survives suppuration ↓ Sloughing with infection at site of bite ↓ Haemorrhage from mucosa of rectum & other natural orifice, etc. ↓ Gangrene of parts involved	<u>Severe</u> Myalgia ↓ Muscle stiffness ↓ Myoglobinuria ↓ Renal tubular necrosis ↓ Respiratory failure ↓ Cyanosis ↓ Death
Others	• Hyper-salivation • Nausea & Vomiting • Paralysis of eyelids muscles • Staggering gait • In-coordination of speech • Limbs paralysis • Drooping of head • Complete paralysis of all voluntary muscles	• Abdominal pain, tenderness & vomiting with blood • Shock (cold, clammy skin) • Consumption coagulopathy • Spontaneous hemorrhages in organs & tissues • Acute necrosis	• Ptosis • Brown urine (myoglobin) • Hyperkalemia (muscle weakness)
DIAGNOSIS			
Snake bite Diagnosis	1. Finding the fang marks 2. Assessing the signs & symptoms of snake bite 3. Laboratory diagnosis		
	• 15 min single breath counting test (15 SBCT) – Abnormal speaking voice at maximal respiration is positive test • Cholinesterase detected	• 20 min whole blood clotting test (20 WBCT) – Clotted venous blood is positive test • Thromboplastin detected • Fibrinolysin detected	• Renal function test • Hyperkalemia is detected in ECG

MANAGEMENT

1. <u>Shift victim to medical aid center</u>
2. <u>Allaying anxiety and fright (to prevent shock)</u>
   - ⇒ Not all snakes are poisonous
   - ⇒ Even poisonous snakes are not charged with poison all the time
   - ⇒ Even poisonous snake fully charged with poison does not always inject a lethal dose.
3. <u>Prevention of spread of venom (through first aid measures)</u>
   - ⇒ Immobilization
   - ⇒ Application of tourniquet
   - ⇒ Cleaning the wound
   - ⇒ Local emetine injection

⇒ Incision and suction at the site
⇒ Position of affected limb below the level of heart

4. Hospital Management

⇒ *Antivenin & other antitoxic therapies:* They are prepared by hyper immunizing horses against venoms of four common poisonous snakes which have following dosage pattern in 70 kg adult person.

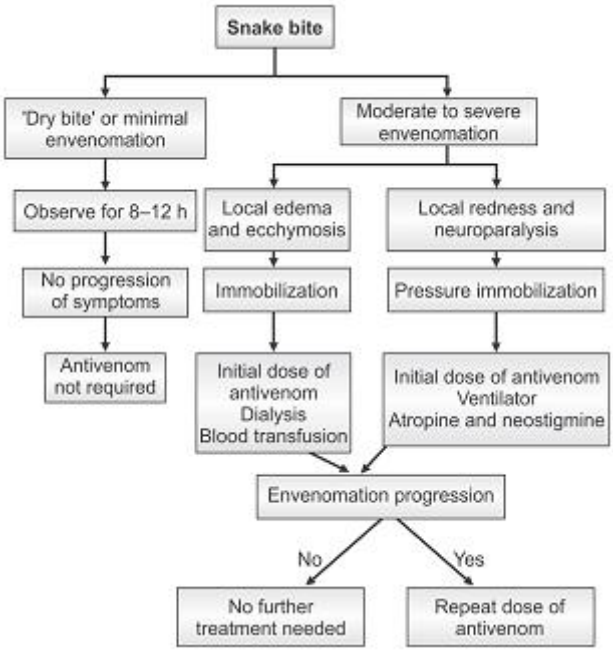
i. Cobras – 8 hours (12 minutes to 120 minutes)
ii. Bungarus caeruleus – 18 hours (3 to 63 hours)
iii. Vipera russelli – 3 days (5 minutes to 264 hours)
iv. Echis carinatus – 5 days (25 hours to 41 days)

The indications are as follow:

i. Deranged coagulation profile
ii. Spontaneous bleeding
iii. Rapidly progressive and severe local swelling
iv. Persistent hypotension
v. Neurotoxic or myotoxic features
vi. Depressed consciousness
vii. Laboratories abnormalities

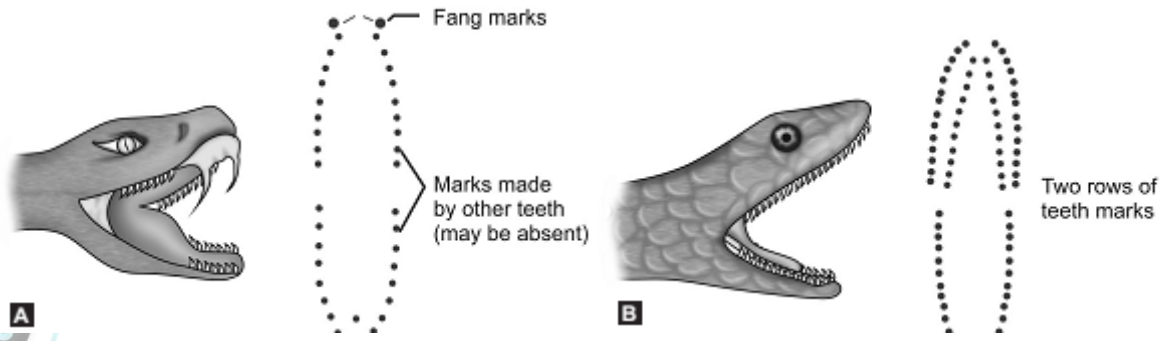
⇒ *Supportive measures*

i. Neostigmine + Atropine (Elapids)
ii. Heparin + Fibrinogen (Vipers)
iii. IV Adernaline (paralytic cases)
iv. Streroids (antivenin caused allergy)
v. Antihistamines
vi. Aspirin & short acting barbiturates
vii. Antibiotics
viii. Artificial respiration
ix. Blood transfusions (haemorrhages)
x. Dialysis (renal problems)



PM FINDINGS

- Fang marks in (A) Poisonous snakes (2.5 cm deep) (B) Non-poisonous snakes (1-1.5 cm deep)



- Viperine bite
  - ⇒ Discoloration, swelling and cellulitis about mark
  - ⇒ Hemorrhages occur from puncture site, mucous membranes, lungs, kidneys and bowel.
  - ⇒ Petechiae are also found in mucosa of the urinary bladder, stomach and intestines.
  - ⇒ Regional lymph nodes are swollen and hemorrhagic.
  - ⇒ Kidneys are inflamed, and show tubular necrosis, cortical necrosis and interstitial nephritis.
  - ⇒ Internal organs are congested.
- Elapidae bite
  - ⇒ Site of bite contains fluid and hemolyzed blood causing staining of vessels
  - ⇒ No definite appearances indicating cause of death, except signs of asphyxia

MEDCIOLEGALS

- Whether or not antivenom is given, any patient with signs of envenomation should be observed in hospital for at least 24 h.
- Accidental (common)
- Homicide (murder is committed by throwing a poisonous snake on bed of sleeping person)
- Suicide (rare)
- Cattle are sometimes poisoned by snake venom.

☠ ANALGESICS ☠

ASPIRIN – Acetylsalicylic Acid

PROPERTIES

- Non-narcotic analgesic and antipyretic
- White, odorless, crystalline powder, having a slight acid taste
- FATAL DOSE–5 to 10 gm
- FATAL PERIOD–Few minutes to few hours

MODE OF ACTION

ABSORPTION	ACTION	EXCRETION
• GIT (stomach & intestines)	Inhibits respiratory center →↓ respiration→↑pCO_2→ **respiratory acidosis** (↓ pH, ↓ HCO_3–, normalization of pCO_2) plus inhibition of Krebs cycle and severe uncoupling of oxi. phosphorylation (↓ ATP) →**metabolic acidosis**, hyperthermia, and hypokalemia	• Liver (metabolism) • Kidney

SIGNS & SYMPTOMS

SYSTEM	SIGNS & SYMPTOMS
GIT	Burning pain in throat and abdomen, nausea, vomiting, thirst, hematemesis and melena (black stools)
CNS	Ataxia, vertigo, tinnitus, headache, confusion, convulsion, coma—known as 'salicylate jag' secondary to hyperthermia and altered glucose metabolism.
CVS	Tachycardia.
Hepatic	Reye's syndrome.
RS	Initially, tachypnea and hyperpnea, followed by Kussmaul's breathing secondary to metabolic acidosis, pulmonary edema.
Electrolyte	Dehydration, hypokalemia, hypo-/hypernatremia, hypo-/hyperglycemia.
Hematologic	Hemorrhagic tendency.
MS	Rhabdomyolysis, tetany.
Others	Hyperpyrexia, dilated pupils, rapid and irregular pulse.

DIAGNOSIS

- Urine sample + $FeCl_3$ = Brown purple colour (if salicylic acid present)
- Assessment of salicylic acid level of blood

MANAGEMENT

- Decontamination
  - ⇒ Gastric lavage (activated charcoal should be left in stomach)
  - ⇒ Whole bowel irrigation (polyethylene glycol)
- Fluid and electrolyte management
  - ⇒ Crystalloids (for dehydration)
  - ⇒ Alkalization of urine (enhances renal salicylate excretion) and treatment of acidosis
  - ⇒ 10% calcium gluconate (for hypocalcemic tetany)
  - ⇒ diazepam or phenobarbitone (for seizures)
  - ⇒ Vitamin K
  - ⇒ Positive pressure ventilation (if develops respiratory failure)
- Hemodialysis

PM FINDINGS

- EXTERNAL: Pupils are dilated. Skin rashes may be present.
- INTERNAL
  - ⇒ Stomach: Congested and petechial hemorrhages
  - ⇒ Lungs: Congested, subpleural petechial hemorrhages, edematous and collapsed.
  - ⇒ Liver: Congested, hepatitis
  - ⇒ All organs are congested and show petechial hemorrhages.
  - ⇒ If the patient survives for few days, myocardium, liver and kidneys are usually soft, dirty in appearance and greasy to touch.

MEDICOLEGALS

- Accidental (idiosyncrasy or overdosage)
- Suicidal (common)

‹100›

PARACETAMOL (PCM) – Acetaminophen

PROPERTIES

- Non-narcotic analgesic and antipyretic
- FATAL DOSE
  - ⇒ Adults: 10–15 g (20–30 tablets).
  - ⇒ Children: 150 mg/kg body wt.
- FATAL PERIOD–2 to 4 days

MODE OF ACTION

ABSORPTION	ACTION	EXCRETION
• GIT	• PCM → inhibits prostaglandin synthesis. • Accumulation of a toxic intermediate metabolite: N-acetyl-p-benzoquinone → decreased hepatic glutathione → Liver damage through • Also causes renal tubular necrosis.	• Liver (metabolism)

SIGNS & SYMPTOMS

STAGE	TIME OF INGESTION	SIGNS & SYMPTOMS
I (Initial)	0–24 hours (h)	Nausea, vomiting, diaphoresis, malaise, pallor.
II (Middle)	24–72 h	Discomfort disappears, giving a false sense of relief. Upper abdominal pain
III (Hepatic)	72–96 h	Vomiting, jaundice, hepatic pain, bleeding, confusion, coma, asterixis (flapping tremor), hepatic encephalopathy, cardiac arrhythmia, hemorrhagic pancreatitis, DIC.
IV (Recovery)	> 5 days	Resolution of liver function occurs in about 2–3 months.

Death usually occurs in stage III. If not, then patient passes into stage IV

DIAGNOSIS

- Emergency measurement of blood levels (by enzyme immunoassay & high performance liquid chromatography)
- Marked elevation of liver enzymes (peak alanine transaminase > 1000 IU/l)
- Increased PT

MANAGEMENT

- Gastric lavage (activated charcoal) within 1-2 hours of ingestion
- Antidote: N-acetyl cysteine (NAC), Oral methionine
- Supportive measures
  - ⇒ Intravenous electrolytes
  - ⇒ Rehydration
  - ⇒ Vitamin K for bleeding
  - ⇒ Mannitol for cerebral edema

PM FINDINGS

- EXTERNAL: Jaundice, petechiae in skin.
- INTERNAL
  - ⇒ Congestion of GIT
  - ⇒ Centrilobular hepatic necrosis
  - ⇒ Acute tubular necrosis
  - ⇒ Myocardial necrosis
  - ⇒ Cerebral edema

MEDICOLEGALS

- Accidental (over-dosage)
- Suicidal (common)

NEUROTICS

SOMNIFEROUS POISONS (Analgesia & Sleep) – OPIUM (Morphine/ Afim)

PROPERTIES

- Opium is dried extract of poppy plant (Papaver somniferum) - annual plant with white or red flowers growing on a central bulbous pod
  - ⇒ Crude opium: Characteristic odor & bitter taste
  - ⇒ Toxic part: Unripe fruit capsule, latex juice
  - ⇒ Non-toxic part: Seeds (Khaskhas)
- ACTIVE PRINCIPLES (alkaloid groups)
  - ⇒ Phenanthrene derivatives (main narcotic constituents) – morphine, codein, thebaine, dionin, heroin etc.
  - ⇒ Benzyl-isoquinolone derivatives (mild analgesic effects) – papaverine, narcotine etc.
- FATAL DOSE
  - ⇒ Codeine: 50 mg
  - ⇒ Morphine: 200 mg
  - ⇒ Opium: 2 g
- FATAL PERIOD–6 to 12 hours
- TOXICITY RATING–5 or 6

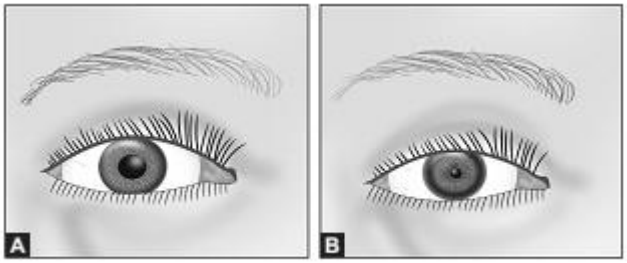
MODE OF ACTION

- ABSORPTION: Snorting, smoking, intravenously, subcutaneously, mixed with cocaine (speed balling)
- ACTION: Binds opioid receptors (4 types: mu, kappa, delta and recently recognized OFQ/N) on neurons distributed throughout nervous system and immune system →Inhibition of synaptic neurotransmission in nervous system
- METABOLISM: Hepatic conjugation to inactive compounds or stored in body (e.g.propoxyphene)
- EXCRETION: Metabolic products are then excreted in urine

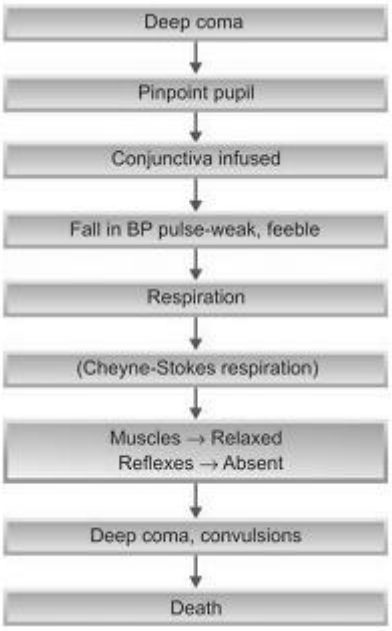
SIGNS & SYMPTOMS

- **ACUTE POISONING** (3 stages)

STAGE OF EXCITEMENT (short)	STAGE OF STUPOR	STAGE OF NARCOSIS/ COMA
Euphoria	Strong tendency to sleep from which patient can be aroused by painful stimuli	Patient passes into deep coma from which he cannot be aroused
Increased sense of well-being, freedom from anxiety, talkativeness, laughter, hallucinations	Headache, nausea, vomiting, weakness, heaviness in limbs, giddiness, drowsiness, diminished sensibility &.	Muscles: Flaccid and relaxed Reflexes: Absent Sphincter tone: Increased
Flushing of face	Face and lips are cyanosed	Pale face
Conjunctival injection (suffusion)	Pupils are contracted	Conjunctiva congested **Pupils constricted to pin-point**
Hypertension (rare)	Normal blood pressure	Hypotension + Hypothermia
Normal pulse	Normal pulse	Weak, feeble pulse Cold skin with profuse perspiration
Normal respiration	Normal respiration	Slow, steatorous respiration (4–6 breaths/ min)



(A) Normal pupil, (B) Pinpoint pupil



- **CHRONIC POISONING** (Addiction, Morphinomania, Morphism)
  - ⇒ Opioid dependence (mainly morphine and heroin) is seen among patients with chronic pain syndromes, and physicians, nurses and pharmacists because of its easy access.
    - i. Due to illicit drug (contaminants): Peripheral neuropathy, amblyopia, degeneration of globus pallidus, Parkinsonism and transverse myelitis.
    - ii. Due to intravenous use: Skin infections, thrombophlebitis, AIDS, hepatitis, pulmonary embolism, endocarditis, osteomyelitis, pneumonia, septicemia and tetanus.

MANAGEMENT

- Support vitals through respirator and other emergency procedures.
- Decontamination: Gastric Lavage (1:5000 $KMnO_4$ leaving some solution in stomach)
- Activated charcoal—**method of choice** (decontamination following ingestion)
- Enema with 30 g of Na_2SO_4 twice daily.
- Whole-bowel irrigation
- Specific Antidote: Narcotic antagonist **naloxone** in an initial dose of 0.4–2 mg IV/IM repeated every 2–3 min upto 10 mg, if no response occurs.
- Strong coffee
- Maintain body warmth

PM FINDINGS

- EXTERNAL
  - ⇒ Smell of opium.
  - ⇒ Face/body is bluish, deeply cyanosed or blackish.
  - ⇒ Postmortem staining is purple or blackish.
  - ⇒ Pink froth at nostrils.
  - ⇒ Pupils are constricted, can be dilated also.
  - ⇒ Allergic reactions to IV heroin may be seen.
  - ⇒ Needle tracks are found occasionally, depending on route of intake.
- INTERNAL **(Specimen of choice includes: ROUTINE VISCERA + BLOOD, BILE, BRAIN)**
  - ⇒ Diffuse cerebral edema.
  - ⇒ All organs are congested
  - ⇒ Trachea contains frothy secretions.
  - ⇒ Blood is dark and fluid.
  - ⇒ Stomach may show presence of small, soft brownish lumps of opium, and smell of drug may be perceived.

MEDICOLEGALS

- Drug abuse
- Accidental death due to drug overdose
- Suicide may be attempted for painless and peaceful death
- Homicide — rare
- Cattle poison
- Infanticide
- Others
  - ⇒ Doping for horse race
  - ⇒ Used in euthanasia

Opium Abstinence (Withdrawal) Syndrome or Cold Turkey Syndrome

Withdrawal symptoms gradually increase in intensity, reaching a maximum at 36 to 72 hours for heroin and morphine, and subside gradually over 5-10 days

EARLY SYMPTOMS	INTERMEDIATE SYMPTOMS	DELAYED SYMPTOMS
Yawning	Mydriasis	Involuntary muscle spasm
Lacrimation	Piloerection	Fever
Rhinorrhoea	Flushing	Nausea
Sweating	Diaphoresis	Intestinal discomfort
	Tachycardia	Diarrhoea
	Twitching	Vomiting
	Tremors	Spontaneous ejaculation or orgasm
	Restlessness	Increased blood sugar
	Irritability	
	Anorexia	

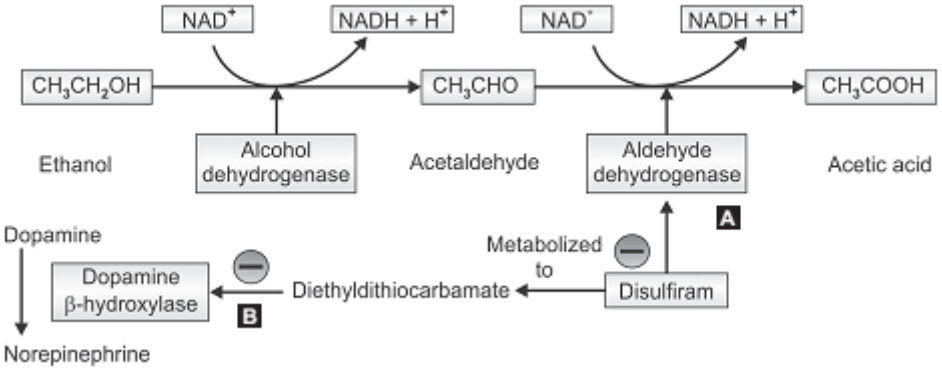
CLASSICAL INEBRIANTS (Excitement & Narcosis) – ALCOHOL (Ethanol)

PROPERTIES

- Transparent, colorless, volatile liquid having a characteristic odor and a burning taste with a specific gravity of 0.79
- White, odorless, crystalline powder, having a slight acid taste
- FATAL DOSE
  - ⇒ Non-Addict Adult: 150–250 ml of absolute alcohol consumed in 1 hour
  - ⇒ Non-Addict Child: 60 ml of absolute alcohol consumed in 1 hour
- FATAL PERIOD–12 to 24 hour
- TOXIC RATING– 2

ABSORPTION & METABOLISM (DETOXIFICATION)

- After absorption from GIT, 90% alcohol is metabolized in liver & remaining 10% is excreted by kidneys and lungs.



- Absorption is enhanced by
  - ⇒ Femaleness
  - ⇒ Empty stomach
  - ⇒ Drugs: Cholinergic agents, parasympathomimetic agents, aspirin, erythromycin, metoclopramide, H2-receptor antagonists
  - ⇒ Gastric resection, gastric ulcers, gastritis
  - ⇒ Carbonated drinks
- Absorption is decreased by
  - ⇒ Maleness
  - ⇒ Full stomach
  - ⇒ Drugs: Anticholinergic agents, sympathomimetic agents, nicotine or caffeine, tricyclic antidepressants, amphetamines,
  - ⇒ opiates
  - ⇒ Malignant gastric neoplasm, pyloric stenosis
  - ⇒ Fatty foods
- Non-habituated persons metabolize ethanol at 13-25 mg/dl/h. In alcoholics, this rate increases to 30–50 mg/dl/h.

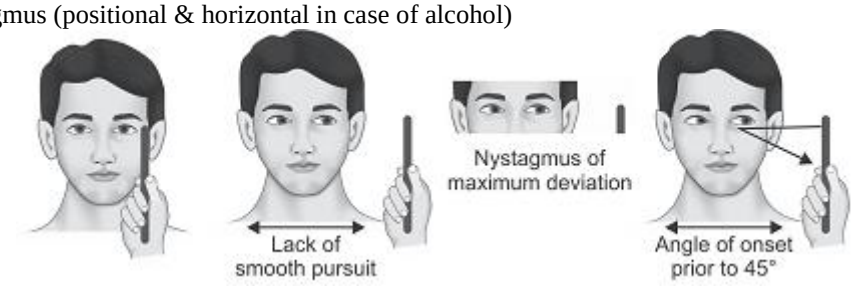
ACTION

- Ethanol → CNS → Depressant of specialized & sensitive cells of cerebral cortex (centers regulating conduct, judgment and self-criticism) → Release of inhibitory tone, leading to unrestrained behavior → Depression of vital centers of medulla → Coma → Death.
- Hypnotic (sleep-inducing)
- Diaphoretic (inducing perspiration)
- In small doses, an appetizer.

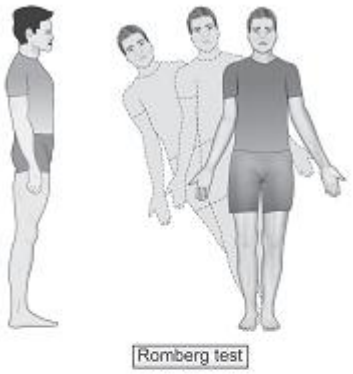
DIAGNOSIS OF DRUNKENNESS

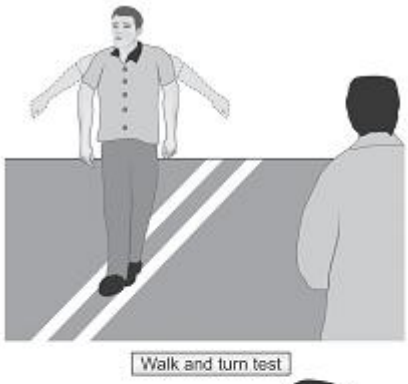
- **Preliminary data**
- **History**
- **General Examination**
  - ⇒ Whole body exam for injuries
  - ⇒ Manner of dressing (proper/improper)
  - ⇒ Posture & balance
- **Specific Examination**
  - ⇒ Face (redness in indicative of drunkenness)
  - ⇒ Tongue (dry in case of alcohol & moist in case of alcohol mixed in water)
  - ⇒ Ears (any balance problems)
  - ⇒ Signs of vomiting and salivation
  - ⇒ Smell of alcohol
  - ⇒ Handwriting

⇒ Eyes
   i. Conjuctiva (suffusion due to vasodilatory effect of alcohol)
   ii. Response to light (delayed or non-reacting in case of alcohol)
   iii. Nystagmus (positional & horizontal in case of alcohol)



⇒ Body reflexes (depressed in case of intoxication)
⇒ Drug abuse signs (needle marks, shivering, yawning, rhinorrhea, gooseflesh, lacrimation)
⇒ CVS exam (pulse, blood pressure, temperature and heart sounds)
⇒ Respiratory exam (hurried, slow, shallow, deep, stertorous, sighing or gasping, any added sounds)
⇒ GIT exam (soft, tender, bowel sounds, enlarged liver or spleen, ascites)
⇒ Speech test (normal, thick, slurred, stuttering, confused, incoherence, unintelligible, aggressive, offensive or over precise)
⇒ Gait test on moving straight & turning (unsteadiness, staggering, bumping into people or furniture)
⇒ Orientation test by asking date, day, time
⇒ Memory test by asking any past incident of life
⇒ Behavior test (noisy, jovial, boastful, rude, emotional, talkative, excited, nervous or uncontrollable)
⇒ Coordination test (unbutton his shirt, dressing, undressing or handling objects like picking up a pen, standardized field impairment tests)


Romberg test


Walk and turn test


One leg stand test


Finger nose test

- **Laboratory Examination**
  ⇒ Sample collection
     i. Dead: Blood, CSF, Viterous humour, Urine, Breath
     ii. Living: Blood, Urine, Breath
  ⇒ 1.33:1 ratio of urine alcohol to blood alcohol is generally used
  ⇒ Widmark's formula for urine and blood

a = (x)pr

a = total amount of alcohol (in grams) absorbed in body
x = c = concentration of alcohol in blood (in g/kg)
x = ¾ q = concentration of alcohol in urine (in g/L)
p = weight of the person (in kg)
r = constant (0.68 in men and 0.5 in women)

  ⇒ Kozelka and Hine method or Cavett method: It involves aeration/distillation or diffusion of alcohol under low pressure.
  ⇒ Gas liquid chromatography
  ⇒ Alcohol dehydrogenase test (most accurate)

ACUTE ALCOHOL POISONING (Alcoholic Intoxication/Alcohol Overdose)

SIGNS & SYMPTOMS

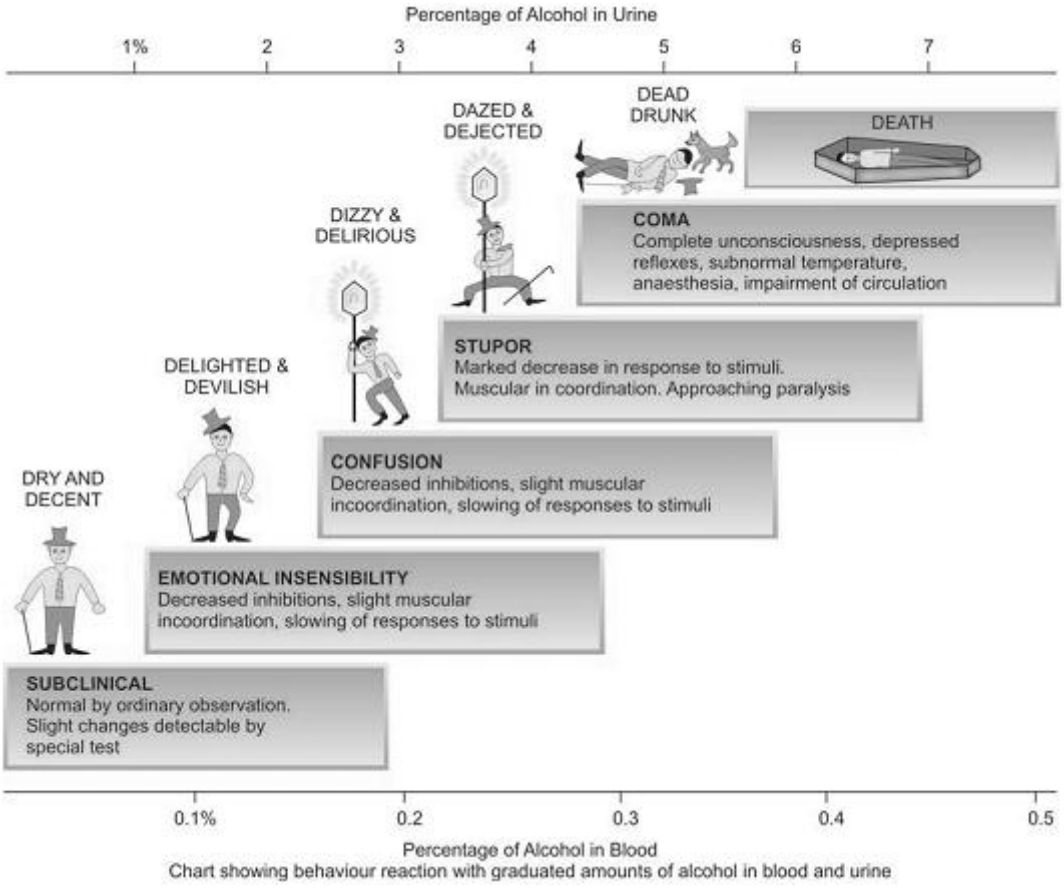
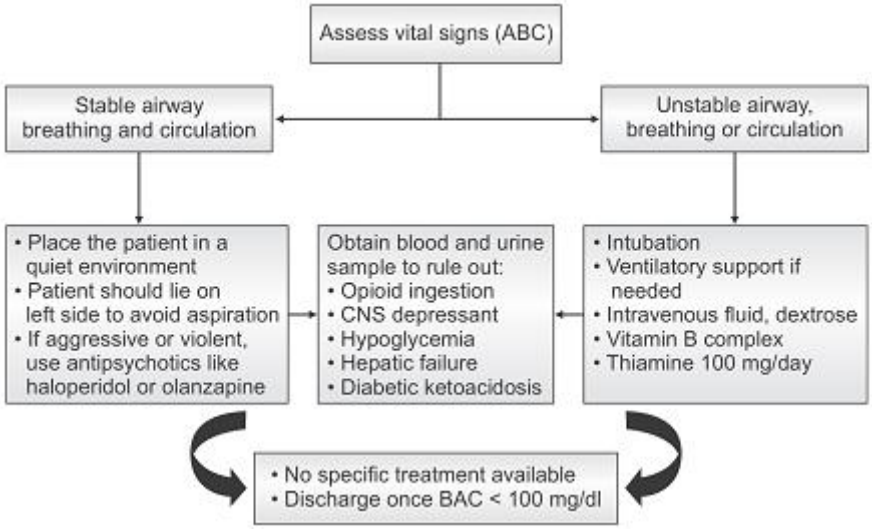


Chart showing behaviour reaction with graduated amounts of alcohol in blood and urine

BLOOD ALCOHOL (BAC)mg/100ml	GENERAL STAGES	7D' STAGES		SIGNS & SYMPTOMS
		NAME	BEHAVIOUR	
0-50	**Excitement** (cortex depressed)	Dry/decent	Sobriety	• No influence apparently—Behaviour almost normal
50-100		Delighted/ devilish	Euphoria	• Sense of wellbeing, sociability, talkativeness • Greater self-confidence, decreased inhibitions • Diminution of attention, judgment, and control • Loss of efficiency in finer performance tests
100-150	**In-coordination** (Motor centre & basal ganglia depressed)	Delirious/ dizzy	Excitement	• Emotional instability, decreased inhibitions • Loss of critical judgment • Impairment of memory and comprehension • Decreased sensory response, increased reaction time • Some muscular in-coordination
150-200		Dazed	Confusion	• Disorientation, mental confusion, dizziness • Exaggerated emotional state, such as fear and anger • Disturbance of eye sensations (diplopia, etc.) • Decreased pain sense • Impaired balance, muscular incoordination, staggering gait, slurred speech
200-300		Dejected	Stupor	• Apathy, general inertia, approaching paralysis • Markedly decreased response to stimuli • Marked muscular incoordination, inability to stand or walk • Vomiting, incontinence of urine and faeces • Impaired consciousness, sleep or stupor
300-500	**Narcosis (Coma)** (Vital medulla centers depressed)	Dead drunk	Coma	• Complete unconsciousness, coma, anaesthesia • **Macewan's sign** *(Constricted pupil dilates on pinching neck/face & then comes to original size + Lateral nystagmus)* • Depressed or abolished reflexes • Incontinence of urine and faeces • Subnormal temperature • Embarrassment of circulation & respiration (possible death)
> 500		Dead	Death	• Death from respiratory paralysis

MANAGEMENT



- Gastric lavage (alkaline solution within 2 hours of intoxication)
- Hemodialysis
- Purgatives
- Artifical respiration
- IV 5% glucose isotonic salines
- IV glucose hypertonic solution (prevent shock)

PM FINDINGS

- Odor of alcohol around the mouth and nose.
- Congestion of conjunctiva.
- Rigor mortis is prolonged and decomposition is retarded.
- Acute inflammation of the stomach with coating of mucus.
- All viscera are congested and smells of alcohol.
- Blood is fluid and dark.

MEDICOLEGALS

- Routine use of BAC is controversial because it is unlikely to affect management in a patient who is awake and alert.
- Patient with altered mental status is simply considered intoxicated without consideration of other possible causes.
- Hemodialysis should be used, especially in the presence of metabolic abnormalities.
- There should not be any delay in waiting for laboratory tests (to confirm the presence of alcohol) before starting treatment.

CHRONIC ALCOHOL POISONING (Alcohol Addiction, Alcoholism, Ethanolism)

SIGNS & SYMPTOMS

- PHYSICAL
  - ⇒ Lack of personal hygiene
  - ⇒ Loss of appetite
  - ⇒ Chronic gastroenteritis
  - ⇒ Wasting
  - ⇒ Peripheral neuropathies
  - ⇒ Iimpotence & sterility
  - ⇒ Fatty changes in liver and heart, cirrhosis
  - ⇒ Tremors & insomnia
  - ⇒ Red eyes
  - ⇒ Intermittent infections
- MORAL (crimes which addict commits to get his drink)
- SYSTEMIC

SYSTEM	SIGNS & SYMPTOMS
CNS	Delirium tremens, Alcoholic hallucinosis, Korsakoff's psychosis, Wernicke's encephalopathy, Alcoholic paranoia, Alcoholic seizures
CVS	Cardiomyopathy, Beriberi heat disease, Hypertension, Arrhythmias
Metabolisms	Hyperlipidemia, Hyperuricemia, Hypoglycemia, Obesity
Endocrine	Pseudo Cushing Syndrome
MS	Myopathy
GIT	Acute gastritis, Pancreatitis, Liver disease
Blood	Macrocytosis, Thrombocytopenia, Leukopenia
Bones	Osteomylacia, Osteoporosis

MANAGEMENT

- Sudden withdrawal of alcoholic drinks.
- Antabuse (disulfiram) is given as an aversion technique – blocks metabolism of alcohol at acetaldehyde stage
- Citrated calcium carbimide (Temposil), metronidazole, nitrafezole and methyltetrazolethiol instead of antabuse
- Nutrients, vitamins and gradual return to a normal balanced diet
- Symptomatic treatment

PM FINDINGS

- Gastric mucosa is deep reddish-brown with patches of congestion or effusion and is hypertrophied.
- Liver is congested and shows fatty infiltration, enlarged or cirrhotic or contracted.
- Kidneys show granular degeneration.
- Heart is dilated and shows fatty degeneration.
- Brain with shrinkage of cerebral cortex (grey matter)

WITHDRAWAL SYMPTOMS IN CHRONIC ALCOHOLICS

SYMTOMS	MANIFESTATIONS & TREATMENT
Common abstinence syndrome (within 6 to 8 hours)	• Tremors in hands, legs, and trunk • Extreme emotional disturbance (agitation) • Sweating • Nausea • Headache • Insomnia CLONIDINE 0.2 mg several times a day for 4 day period
Alcoholic hallucinosis (within 24 to 36 hours)	• Seeing objects with distorted shape • Seeing objects with their shadows moving. • Hearing someone shouting at him or snatches of music, etc. CHLORPROMAZINE 100 mg, 8th hourly
Alcohol seizures (Rum fits) (within 6 to 48 hours)	• Clonic-tonic movements, with or without loss of consciousness • Self-limited multiple seizures Do not require any longterm anticonvulsant therapy
Alcohol ketoacidosis	• Sudden withdrawal → Gastritis or pancreatitis → Ketoacidosis • Drowsiness & confusion • Tachycardia & tachypnea, progress to Kussmaul's breathing & coma • Hyperglycemia • Hyperketonemia • Hypokalaemia • Hypochloraemia NORMAL SALINES + THIAMINE + POTASSIUM SUPPLEMENTS
Delrium tremens (DT) (3 to 5 days)	• Causes: Sudden withdrawal, Shock, Acute infections • Clouding of consciousness, disorientation & amnesia • Agitation, restlessness, shouting, tremor, ataxia & insomnia • Vivid hallucinations — mostly visual or sometimes auditory in nature • Autonomic disturbances — sweating, fever, tachycardia, hypertension and dilated pupils REASSURANCE + DIAZEPAM + THIAMINE + REHYDRATION + ELECTROLYTE CORRECTION
Wernicke's encephalopathy	• Drowsiness, disorientation & amnesia • Ataxia • Peripheral neuropathy • Horizontal nystagmus & diplopia due to ophthalmoplegia THIAMINE + REHYDRATION + ELECTROLYTE CORRECTION
Korsakoff's Psychosis	• Profound anterograde amnesia & milder retrograde amnesia • Impairment in visuo-spatial, abstract and conceptual reasoning THIAMINE + REHYDRATION + ELECTROLYTE CORRECTION

MEDICOLEGALS

When a person is in delirium tremens, he/ she is not held responsible for any act done for the reason that one is considered to be mentally unsound during delirium tremens state.

HYDROCARBONS INEBRIANTS (Excitement & Narcosis) – KEROSENE

PROPERTIES

- Hydrocarbon containing C, H & S, petroleum distillate, liquid at room temperature
- FATAL DOSE–10-50 ml
- FATAL PERIOD–Few hours to 1 day

MODE OF ACTION

- LOCAL: Irritant
- REMOTELY: Neurotoxic, nephrotoxic and respiratory depressing effects.

SIGNS & SYMPTOMS

SYSTEM	SIGNS & SYMPTOMS	
	ACUTE POISONING (Ingestion/ Inhalational)	CHRONIC POISONING (handling)
Local	Irritation of oral mucosa and kerosene taste	Chronic dermatitis, redness, itching, inflammation
GIT	Sensation of burning in throat, nausea, vomiting, colicky pain, diarrhea; breath, vomit and urine smells of kerosene	Weakness, Weightloss
RS	Coughing, choking, cyanosis, bronchopneumonia, pulmonary edema, slow and shallow respiration	-
CNS	Giddiness, headache, lethargy/drowsiness, restlessness, weakness, muscle twitchings, seizures, coma	Diziness, nervousness, pain in limbs, peripheral numbness, paraesthesia
Others	Pyrexia, arrhythmias, hemolytic anemia, acute renal failure, hepatotoxicity, bone marrow suppression	-

- *Death is due to respiratory failure*

MANAGEMENT

- Supportive therapy (oxygen, continuous positive airway pressure & mechanical ventilation)
- Cutaneous exposure – Decontamination (remove clothing + thoroughly washing skin with soap and water)
- Inhalation (remove patient to open air + artificial respiration + symptomatic therapy)
- Ingestion
  - ⇒ Supportive measures + Observe patient for at least 24 h in hospital
  - ⇒ Gastric lavage and emesis are contraindicated except
    - i. When patient presents within 1 hour of ingestion or large amount has been ingested (> 1 ml/kg).
    - ii. When patient is in coma.
    - iii. When kerosene is mixed with pesticides, heavy metals and other toxic substances.
    - iv. In no case, should it ever be done without intubation, as there is a risk of aspiration.
  - ⇒ Activated charcoal has a limited role in management of kerosene ingestion
  - ⇒ Antibiotics are indicated in limited situations, like malnutrition or immunocompromised state. If fever occurs, give specific antibiotic.
  - ⇒ Corticosteroids are not recommended, except when administered concurrently at time of aspiration.
  - ⇒ Bronchodilators are used for chlorinated or fluorinated solvent intoxication.
  - ⇒ Oxygen therapy is given in hypoxemia.

PM FNDINGS

- Acute gastroenteritis and kerosene odor may be observed on opening the chest and abdominal cavity.
- Stomach: Petechial hemorrhages with congested mucosa.
- Lungs: Petechial hemorrhages, congested, edematous and bronchopneumonia.
- Congestion of all organs
- Signs of asphyxia
- Degenerative changes in the liver and kidneys and hypoplasia of bone marrow occur after prolonged period of inhalation.

MEDICOLEGALS

- Accidental (children, infants)
- Accidental aspiration (during attempt to siphon off gasoline)
- Self-immolation & suicidal purpose
- Homicidal (dowry deaths)
- Inhalation abuse in adolescents and young adults (for recreation, similar to drugs and alcohol)

INSECTICIDE INEBRIANTS (Excitement & Narcosis) – ORGANOPHOSPHATES

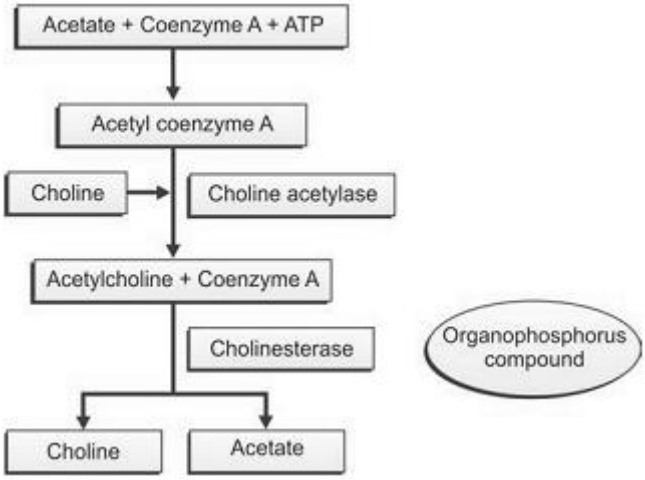
CLASSIFICATION & PROPERTIES

- OPCs
  - Chemical Composition
    - Alkyl phosphates: Tichlorfos, Dimefox, HETP, TEPP, Malathion
    - Aryl phosphates: Parathion (Follidol), Paraoxon, Chlorthion, Diazinon (Tik-20)
  - Toxicity
    - Agriculture insecticide (highly toxic): TEPP, Parathion
    - Animal insecticide (moderately toxic): Trichlorfon, Ronnel
    - Household insecticide (low toxicity): Malathion, Tik-20

- Used as insecticides, herbicides, antihelminthics, ophthalmic agents, in chemical industry, & as nerve gas in chemical warfare.
- FATAL DOSE
  - ⇒ Malathion & diazinon: 1 g (TOXIC RATING = 4)
  - ⇒ Parathion & TEPP: 100 mg (TOXIC RATING = 6)
- FATAL PERIOD
  - ⇒ Treated cases: 10 days
  - ⇒ Untreated cases: 0-6 hours

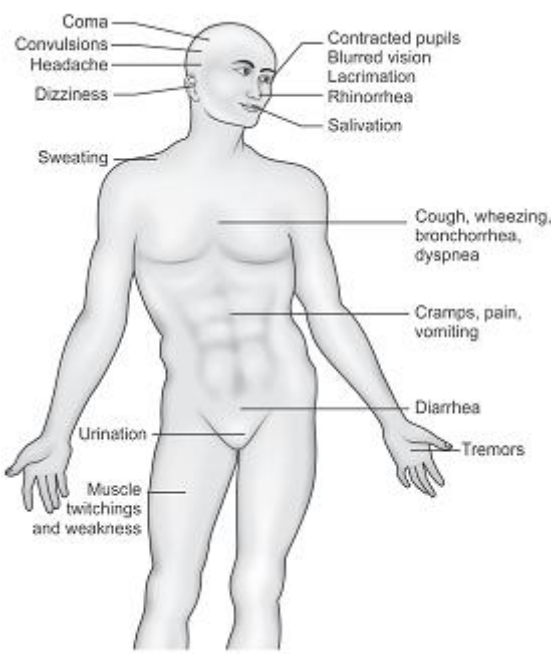
MODE OF ACTION

- ABSORPTION: Transdermal, transconjunctival, inhalational, across GIT and through direct injection.
- ACTION: Organophosphate intoxication leads to characteristic end-plate abnormalities that reflect the degree of AchE inhibition and increase in Ach concentration at the neuromuscular junction.



- METABOLISM: Most OPCs are hydrolyzed by enzymes, the A esterases or paroxonases which are not inhibited by it.
- EXCRETION: Metabolic products are then excreted in the urine.

SIGNS & SYMPTOMS



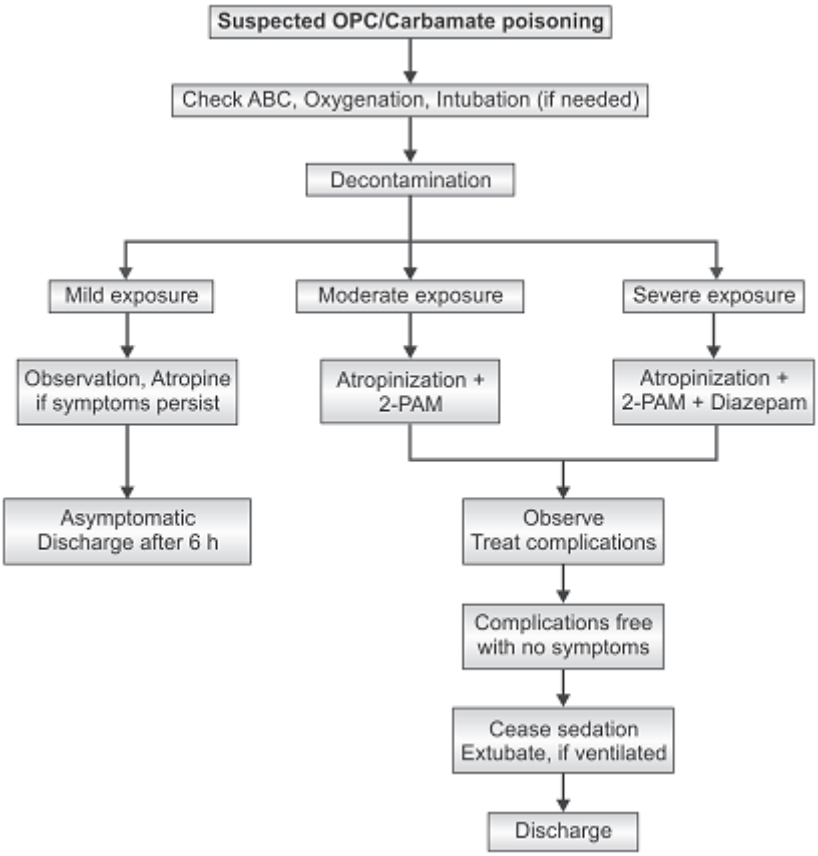
- ON BASIS OF EXPOSURE

SYSTEM	MILD EXPOSURE	MODERATE EXPOSURE	SEVERE EXPOSURE
-	-	**SLUDGE** (Salivation, Lacrimation, Urination, Diarrhea, Gastrointestinal distress & Emesis)	
GIT	Nausea, anorexia, cramping	-	-
CNS	Fatigue, headache, dizziness, tremors of tongue & eyelids, anxiety	Anxiety, confusion, lethargy, incoordination	Convulsions, coma, loss of sphincter tone, paralysis, autonomic dysfunction
MS	Minimal muscle weakness	Tremors, muscle fasciculations, followed by flaccid paralysis	-
OCULAR	Miosis, decreased visual acuity	-	-
RS	-	Respiratory muscle weakness	Insufficiency, pulmonary edema
CVS	-	-	Bradycardia, heart block

- ON BASIS OF RECEPTORS & CNS

SYSTEM	MUSCURANIC EFFECTS	NICOTINIC EFFECTS
GIT	Increased salivation, nausea, vomiting, retro-sternal pain, abdominal cramps, diarrhea, fecal incontinence	-
CVS	Bradycardia, hypertension	Tachycardia, Hypertension, Pallor
RS	Rhinorrhea, bronchospasm, bronchorrhea, cough, wheezing, dyspnea	Areflexia, respiratory failure
Ocular	Blurred vision, miosis	Mydriasis
Glands	Increased lacrimation, red tears (accumulation of porphyrin in lacrimal glands), rhinorrhea, sweating	
MS		Muscle fasciculations, cramps & weakness, twitchings & diaphragmatic failure
CNS	Restlessness, emotional lability, headache, tremors, drowsiness, confusion, slurred speech, ataxia, generalized weakness, Cheyne-Stokes respiration, delirium, coma, absent reflexes, seizures, psychosis & death	

MANAGEMENT



1. Stabilize the patient vitally **ABC.**
2. Decontamination: Contaminated clothes should be removed and exposed skin should be washed with Na_2CO_3 solution.
3. Atropine 2 mg is given IM or IV at once and repeated every 15 min till mydriasis, tachycardia and dry mouth occurs.
4. Specific cholinesterase reactivator, Pralidoxime 1 gm in 100 ml normal saline or 5% glucose is given by IV infusion and repeated as indicated by patient's condition. It should be given as early as possible in order to be effective.
5. Artificial respiration with positive pressure device may be needed.
6. Airway should be kept clear as there is bronchoconstriction and excessive bronchial secretion. Endotracheal intubation or tracheostomy with suction may be required.
7. Diazepam may be needed for convulsions.

DIFFERENTIAL DIAGNOSIS

- Gastroenteritis
- Asthma, Influenza, Pneumonia, CO Poisoning
- Heat prostration, Exhaustion
- Hypoglycemia, Ketoacidosis
- Sepsis, Meningitis, Encephalitis
- Reye's syndrome

PM FINDINGS

- EXTERNAL
  - ⇒ Kerosene-like smell from nostrils and mouth.
  - ⇒ Cyanosis of lips, fingers and nose.
  - ⇒ Deep postmortem staining.
  - ⇒ Congested face.
  - ⇒ Frothy discharge, often bloodstained from nose and mouth.
- INTERNAL
  - ⇒ Stomach: Mucosa of stomach and intestine is congested. Stomach content may give kerosene-like smell.
  - ⇒ Respiratory passages & lungs are congested, contain frothy hemorrhagic exudates.
  - ⇒ Petechial hemorrhage may be present subpleurally.
  - ⇒ Edema and congestion of visceral organs
  - ⇒ Edema of brain

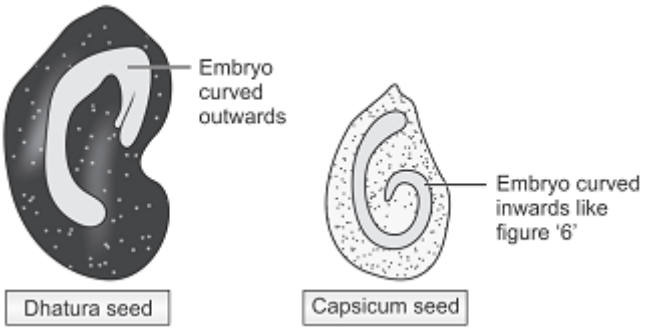
MEDICOLEGALS

- Hospitalizing all symptomatic patients for at least 4–6 days following resolution of symptoms is recommended, because of the risk of development of respiratory depression after resolution of an acute crisis.
- Accidental poisoning (manufacturers, packers, sprayers and in children)
- Suicidal poisoning (common)
- Homicidal poisoning (rare due to detectable smell of the diluents, and signs and symptoms appear rather early)

DELIRIANTS (Confusion) – DHATURA (Thorn apple/ Jimson seed/ Hell's Bells)

PROPERTIES

- Fruits are spherical and have sharp spines
- All parts of these plants are poisonous & seeds resemble chilli seeds



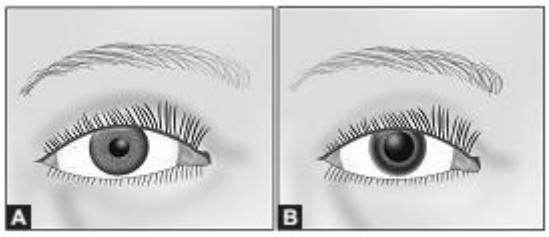
- ACTIVE PRINCIPLES (belladonna alkaloids)
  - ⇒ Hyoscine (scopolamine)
  - ⇒ Hyoscyamine
  - ⇒ Atropine
- FATAL DOSE
  - ⇒ Seeds: 75–125 (stupefying dose: 40–50 seeds)
  - ⇒ Hyoscine: 15–30 mg
- FATAL PERIOD–4 to 24 hours
- TOXICITY RATING–
  - ⇒ Seeds: 3
  - ⇒ Atropine: 5

MODE OF ACTION

- ABSORPTION: Mucous membrane of GIT and respiratory tract, and through skin and conjunctiva
- ACTION:
  - ⇒ Atropine and hyoscine block acetylcholine receptor and produces sympathomimetic or parasympatholytic actions.
  - ⇒ CNS stimulant in early phase, but later CNS depression occurs, especially of respiratory center.
  - ⇒ Vagolytic action resulting in stimulation of heart.
- METABOLISM: Atropinase in liver
- EXCRETION: Metabolic products are then excreted in urine

SIGNS & SYMPTOMS (9 D's)

- **Dryness** of mouth, nausea, vomiting (due to inhibition of salivation)
- **Dysphagia** (due to inhibition of salivation)
- **Dysarthria** (due to inhibition of salivation)
- **Diplopia** (due to dilated pupil) – blind as a bat



(A) Normal pupil, (B) Dilated pupil

- **Dry, hot skin** (due to inhibition of sweat secretion & stimulation of heat regulating center) – hot as a hare
- **Dilation of cutaneous blood vessels** (flushed face & congested conjunctiva) – red as a beet
- **Drunken gait** (Giddiness, confusion, restlessness, agitation)
- **Delirium** (Mutters indistinct words, typical pill-rolling movements, pulls imaginary thread from fingertips, picks at clothes, tries to run away from his bed, visual and auditory hallucinations, cannot recognize relatives and friends) – mad as a wet hen
- **Drowsiness** leading to coma
- **Others**
  - ⇒ Diminished bowel sounds.
  - ⇒ Distention of urinary bladder due to urinary retention.
  - ⇒ Rapid pulse (120–140/min), full and bounding, but later becomes weak and irregular.
  - ⇒ Increased respiration.
  - ⇒ Scarlatiniform rash over body.
  - ⇒ Amnesia

MANAGEMENT

- Supportive care
- Decontamination: Gastric lavage (1:5000 $KMnO_4$ solution
- Activated charcoal in multiple doses
- Prostigmine 0.5 mg injection subcutaneously
- Pilocarpine nitrate
- Chloraldehyde or a slow-acting barbiturate (do not give morphine).
- Physiological antidote: **Physostigmine** should be reserved for severe hallucinations and agitation cases only.
- Symptomatic treatment

DIFFERENTIAL DIAGNOSIS

- Drunkenness
- Heat stroke

PM FINDINGS

- EXTERNAL (signs of asphyxia)
- INTERNAL
  - ⇒ Seeds may be detected in the stomach and small intestines. It resists putrefaction and may be found even in a decomposed body. Identification of ingested seeds can be diagnostic of tropane alkaloid poisoning.
  - ⇒ Stomach: Mucosa may show inflammation.
  - ⇒ Lungs: Edematous and congested.
  - ⇒ Heart: Petechial hemorrhages in endocardium.

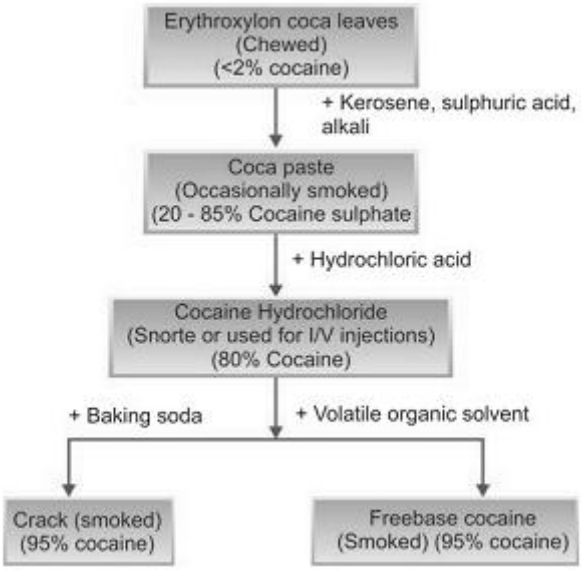
MEDICOLEGALS

- Accidental (mistaken for chilly seeds)
- Suicide – rare
- Homicide
- Datura seeds are used as stupefying agent to rob people. (Robbers usually mix datura seeds with food or drinks and offer to travelers in train. Once the passengers are stupefied, they robbed them. Thus datura gains popularity as **railroad poison**.)

DELIRIANTS (Confusion) – COCAINE (Snuff, Rock, Crack, Coke, White lady)

PROPERTIES

- Alkaloid obtained from the dried leaves of coca plant (Erythroxylon coca)
- Colorless, odorless, crystalline substance with bitter taste and slightly soluble in water, but freely soluble in alcohol



- FATAL DOSE– 20 mg IV; 500 mg to 1.2 g orally
- FATAL PERIOD–Few minutes to 1-2 hours

MODE OF ACTION

- ABSORPTION: Chewing, snorting, smoking, IV (rapidly absorbed from mucous membranes and subcutaneous tissues)
- ACTION:
  - ⇒ Produces a hyperadrenergic state → Increases synaptic concentrations of monoamine neurotransmitters dopamine, norepinephrine & serotonin by binding to transporter proteins in presynaptic neurons and blocking uptake
  - ⇒ Local anesthetic, (blocks initiation and conduction of nerve impulse by decreasing axonal membrane permeability to sodium ions)
  - ⇒ Stimulates cortex for a short time, followed by depression.
- METABOLISM: Spontaneous by hydrolysis or Enzymatic metabolism by esterases in liver and plasma
- EXCRETION: Urine

SIGNS & SYMPTOMS

- **ACUTE POISONING** (2 stages)

SYSTEM	SIGNS & SYMPTOMS	
	STAGE OF EXCITEMENT	STAGE OF DEPRESSION
Local	Feeling of numbness or tingling at place	-
Face	Flushed.	-
Skin	Pale.	-
GIT	Bitter taste, dryness of mouth, vomiting, diarrhea, hyperactive bowel sounds.	-
CNS	Mydriasis, headache, bruxism, feeling of well-being, euphoria, restlessness, excitement, talkativeness, delirium, maniacal, hallucinations, nonintentional tremors (e.g. twitching of small muscles, especially facial and finger) and tonic-clonic seizures. Reflexes are exaggerated.	Coma, areflexia, pupils fixed and dilated, flaccid paralysis and loss of vital support functions.
RS	Tachypnea, dyspnea, cyanosis.	Cheyne-Stokes respirations, apnea, pulmonary edema, cyanosis, respiratory failure.
CVS	Tachycardia, hypertension, ventricular arrhythmias.	Ventricular dysrhythmias result in weak, rapid, irregular pulse and hypotension, circulatory failure and cardiac arrest.
Temperature	Hyperthermia.	-
Ocular	Pupils are dilated resulting in blurred vision.	-

- **CHRONIC POISONING** (Addiction, Cocainomania, Cocainophagia, Cocainism)
  - ⇒ Emaciation
  - ⇒ GIT: Anorexia, digestive disturbances
  - ⇒ Reproductive: Significant loss of libido, impotence, gynecomastia, galactorrhea and major derangements in menstrual cycle in women—amenorrhea and infertility.
  - ⇒ Facial: Face is pale, shifty gaze, sunken eyes, dilated pupils, tongue and teeth are black, and ulceration of nasal septum.

⇒ Degeneration of CNS with hallucinations, convulsions and delirium
- **Magnan's Syndrome/Cocaine Bugs** – Type of *tactile hallucination* in which there is a feeling as if grains of sand are lying under the skin or small insects are creeping on the skin giving rise to itching sensation (formication).

MANAGEMENT

- No specific antidote
  - ⇒ Injected: apply tourniquet above part
  - ⇒ Applied to nose or throat: wash-out with warm water or saline
  - ⇒ Ingested: Gastric lavage should be done with $KMnO_4$ and/or activated charcoal.
- Diazepam (to control seizures)
- Dysrhythmias should be treated according to standard advanced cardiac life support (ACLS) protocols.
- Propranolol (for ventricular arrhythmia)
- Short acting, direct vasodilator (esmolol) and short acting beta-blockers (for tachycardia and hypertension)
- Thiamine
- Airways are kept clean, artificial respiration and O_2 inhalation as required.

DIFFERENTIAL DIAGNOSIS

- Lithium toxicity
- Cyclic antidepressants toxicity
- Neuroleptic malignant syndrome
- Acute withdrawal from sedatives or ethanol
- Thyroid storm

PM FINDINGS

- Non-specific findings.
- Patients may have linear excoriations, ‘crack pipe’ burns of fingers or thumbs, thermal burns of face and upper airway.
- Track marks in usual sites such as the antecubital fossae, and at unusual sites such as under tongue and on top of feet may be seen.
- Intense asphyxial signs, and cardiac dilatation may be seen.
- **Samples to be preserved:**
  - ⇒ **Blood (preserved by adding fluoride)**
  - ⇒ **Brain**
  - ⇒ **Skin from injection site**
  - ⇒ **Swab from nasal mucosa**

MEDICOLEGALS

- Drug of abuse
- Body may get decompose rapidly
- Accidental (overdose or adulteration)
  - ⇒ Provoke users for violent behaviour. Acute intoxication may cause person to be aggressive and paranoid.
  - ⇒ Prostitutes may place cocaine solution into vagina to produce local constriction and causes intoxication.
  - ⇒ **Body packer syndrome**: persons engaged in smuggling of cocaine fill the drug in balloon or condom or polythene bag and swallowed to conceal the contraband. This act is called as body packing. The packets may cause intestinal obstruction. Sometime, sudden death may be caused due to rupture of the bag or condom within GIT.
  - ⇒ **Body stuffer syndrome**: person who smuggled cocaine, on verge of being arrested for possessing cocaine, swallows the drug to conceal evidence. This act causes cocaine poisoning.

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DELIRIANTS (Confusion) – CANNABIS INDICA (Marijuana, Marihuana, Hashish)

PROPERTIES

- Derived from plant Cannabis sativa or hemp plant
- Colorless, odorless, crystalline substance with bitter taste and slightly soluble in water, but freely soluble in alcohol
- ACTIVE PRINCPLES:
  - ⇒ Not an alkaloid, but a fat-soluble oleoresin, cannabinol (active form tetra hydro cannabinol THC)
  - ⇒ Benzopyrene (carcinogen)
- PREPARATIONS:

NAME	ACTIVE PRINCIPLE	DERIVATION	USE
Bhang	15%	dried leaves & fruit shoots of plant	beverage
Majun	15 – 25%	sweet prepared with any of mentioned preparation added	Sweet production
Ganja	25%	flowering tops of female plant	mixed with tobacco and used in hookah & cigarettes
Charas (Hashish)	25 – 40%	from resinous exudates of plant	smoked with tobacco in pipe or hookah

- FATAL DOSE:
  - ⇒ Bhang: 10 g/kg body wt
  - ⇒ Charas: 2 g
  - ⇒ Ganja: 8 g
- FATAL PERIOD–12 hours

MODE OF ACTION

- ABSORPTION: GIT (mixed with milk) or Respiratory tract (Smoking or vapors)
- ACTION:
  - ⇒ THC + anandamide receptors in brain → stimulant, sedative or hallucinogenic actions depending on dose and time after consumption
  - ⇒ Catecholamine release (resulting in tachycardia)
  - ⇒ Inhibition of sympathetic reflexes (resulting in orthostatic hypotension)
- METABOLISM: Cannabinol is activated to THC in liver
- EXCRETION: Urine, feaces, bile

SIGNS & SYMPTOMS (2 STAGES)

- **ACUTE POISONING** (2 stages)

STAGE OF EXCITEMENT	STATE OF NARCOSIS
Feeling of euphoria, detachment, well-being/grandiosity, dreaminess, subjective sense of slowing of passage of time, increased self-confidence, rapidly changing emotions, talkativeness & laughing ↓ Impairment of thinking and short-term memory, decreased concentration, disorientation, illusions, visual hallucinations, altered sexual feelings, impaired judgment, and perceptual and psychomotor dysfunctions resulting in impaired driving and motor vehicle accidents. ↓ Increased appetite (‘**munchies**’) and thirst, nausea, headache, conjunctival injection (bloodshot eyes), dizziness, dry mouth, slurred speech, orthostatic hypotension, tachycardia and increased urinary frequency.	Giddiness, incoordination, confusion, ataxia & paraesthesias ↓ Person passes into deep sleep and wakes up without depression/nausea/hangover. ↓ Drowsiness ↓ Respiratory failure ↓ Coma ↓ Collapse ↓ Death (due to cardiac arrest or apnea).

- **CHRONIC POISONING**
  - ⇒ Cannabis Addiction:
    - Anorexia → loss of weight, weakness, tremors → impotence → moral deterioration
    - Lethargic, apathetic, disinterested to work, & suffer from poor concentration → **amotivational syndrome**
  - ⇒ Hashish Insanity:
    - Addiction → mental disorders (hallucinations & delusions of persecution nature) → presentation with an irresistible desire to destroy life & property willfully or commit homicide out of sexual jealousy of which there will be no recollection afterwards
    - A condition called ‘**Run Amock**’ is rarely reported with continued use or sudden consumption of cannabis, characterized by a frenzied desire to commit murders. After intake of drug, person kills a number of individuals,
      i. First few being those against whom he or she has some enmity (real or imaginary)
      ii. Followed by others who are just in way, until homicidal tendency lasts.
      iii. Person may finally commit suicide or surrender himself or herself to police

MANAGEMENT

- Supportive measures
- Gastric lavage (with warm water)
- Strong tea/coffee.
- Artificial respiration.
- Saline purgatives.
- 100 ml of 50% glucose or dextrose, 2 mg naloxone and 100 mg thiamine IV.
- Diazepam
- Haloperidol (to control psychotic manifestations)

DIFFERENTIAL DIAGNOSIS

- Lithium toxicity
- Cyclic antidepressants toxicity
- Neuroleptic malignant syndrome
- Acute withdrawal from sedatives or ethanol
- Thyroid storm

PM FINDINGS

- Non-specific findings.
- Mostly features of asphyxia are seen
- **Samples to be preserved mainly is blood**

MEDICOLEGALS

- Accidental or due to overindulgence (mainly)
- Majum and charas are sometimes used by thieves to stupefy persons to facilitate robbery.
- Others
  - ⇒ Taken by criminals before committing a criminal act to strengthen nerves.
  - ⇒ Aphrodisiac (increase coitus)
  - ⇒ Used in chocolates causes intense craving among children for its euphoric effects.

SPINAL POISON – STRYCHNINE (Nux Vomica/ Poison Nut/ Kuchila)

PROPERTIES

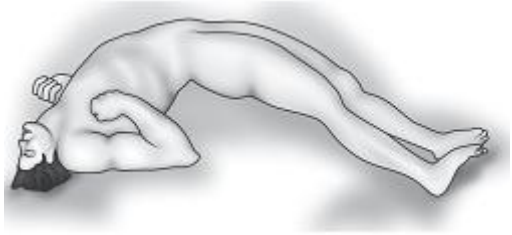
- Ripe fruit contains seeds are poisonous
- ACTIVE PRINCIPLES:
  - ⇒ Strychnine—Alkaloid
  - ⇒ Brucine—Alkaloid
  - ⇒ Loganin—Glucoside
- FATAL DOSE– 1 crushed seed OR 15–50 mg Strychnine
- FATAL PERIOD–1 to 2 hours

MODE OF ACTION

- ACTION:
  - ⇒ Action is particularly in anterior horn cells (especially in Renshaw cells of the spinal cord).
  - ⇒ Competitively antagonizes inhibitory neurotransmitter glycine (blocking its post-synaptic uptake by brainstem & spinal cord receptors) → reduced inhibiting effect of glycine → nerve impulses are triggered with low neurotransmitters levels → motor neurons do not stop their stimulus → victim will have constant muscle contractions ('release excitation')
  - ⇒ GABA neurotransmitter for presynaptic inhibitory neurons is not affected by strychnine.
- METABOLISM: Liver
- EXCRETION: Urine

SIGNS & SYMPTOMS

- Epigastric pain initially → Stiffness in muscles with onset of the typical strychnine convulsions which are of two types (i.e. clonic intermittent initially and tonic sustained later) → Affect both flexor and extensor muscles of body simultaneously resulting in:
  - ⇒ Facial muscles get fixed in a "grin" clinically called—**risus sardonicus**
  - ⇒ Prolonged spasm of the jaw muscles producing "lock-jaw" called **trismus**
  - ⇒ Other muscles of the body may contract and get fixed in one of following postures
    - i. **Opisthotonus**— body is bent backwards (hyperextension of spine) making it rest on occiput & heels like a bow



    - ii. **Emprosthotonus**— body is bent forwards
    - iii. **Pleurothotonos**— body is bent laterally (to left/right)
- Other findings
  - ⇒ Cyanosis
  - ⇒ Dilated pupils
  - ⇒ Frothy salivation
  - ⇒ Respiratory distress and failure leading to death.
  - ⇒ Consciousness is retained clearly till very end, resulting in an agonising death

MANAGEMENT

- Treat the patient in a quiet and dimly lit room.
- Diazepam or barbiturates for convulsions.
- If they are not effective, give general anesthesia or neuromuscular blockade after connecting the patient to a ventilator.
- Oxygen—artificial respiration.
- Succinylcholine chloride may be helpful
- Gastric lavage with tannic acid after controlling the convulsions

DIFFERENTIAL DIAGNOSIS

- Tetanus or Hypocalcemia
- Epilepsy
- Hysteria
- Dystonic drug reactions
- Picrotoxin exposure
- Neuroleptic malignant syndrome or Malignant hyperthermia

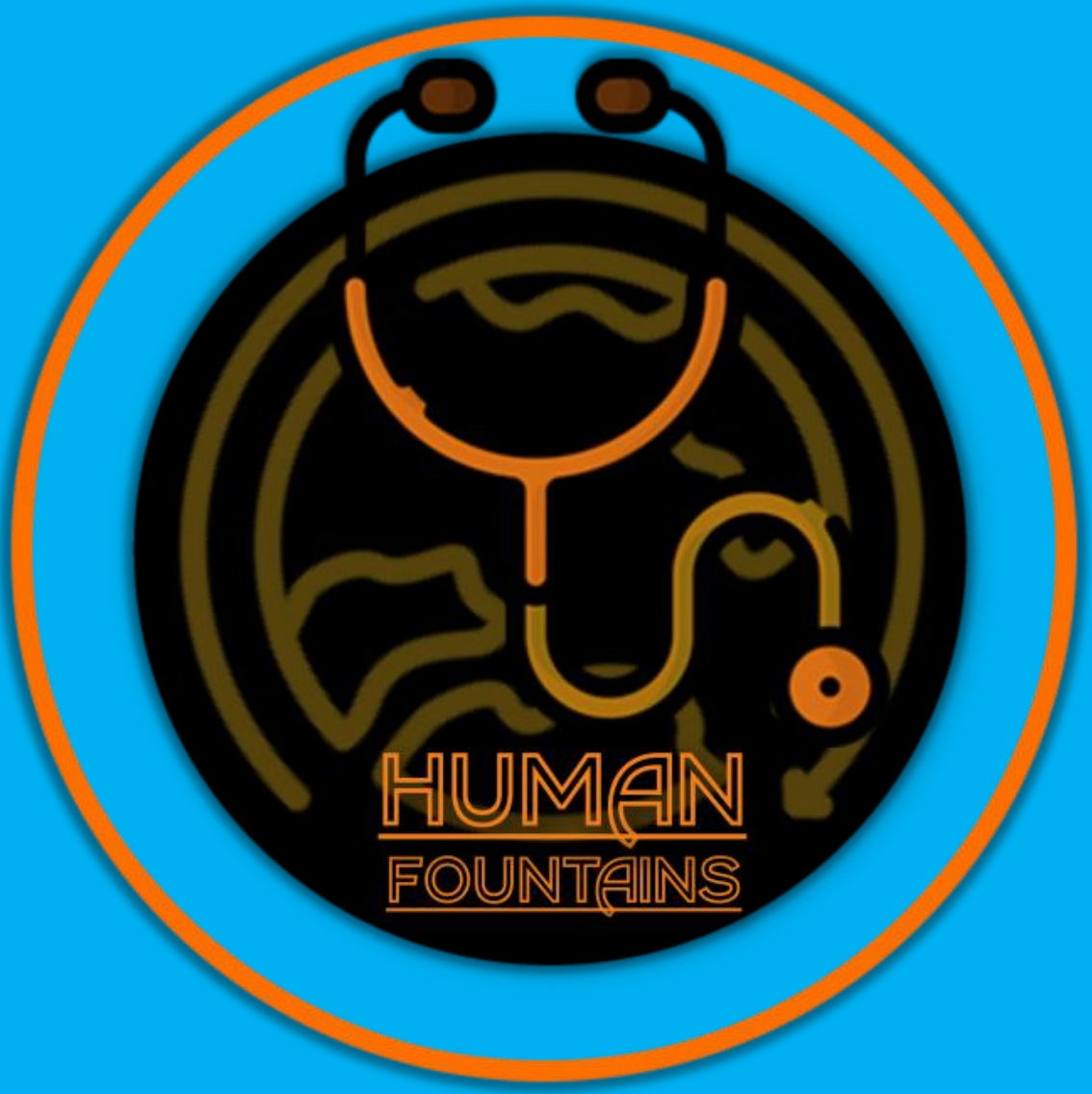
PM FINDINGS

- Not characteristic.
- Rigor mortis appears early.
- Signs of asphyxia.
- Extravasated blood may be found in muscles.

- Viscera are congested.
  - ⇒ **Samples to be preserved: Blood, Urine, Gastric fluid, Bile, Fixed liver and kidney samples**
  - ⇒ ***Frog test—inject suspected solution into dorsal lymph sac of frog. Frog develops tetanic convulsions, if solution has strychnine in it.***

MEDICOLEGALS

- Can be detected easily even in a decomposed body
- Accidental (overdose, exposure to rodenticide, quack remedies and poison mistaken for some other harmless drug, or in children eating seeds)
- Suicide & Homicide (rare due to bitter taste)
- Others
  - ⇒ Aphrodisiac (increase sexual coitus)
  - ⇒ Cattle and arrow poison
  - ⇒ To kill dogs and rats


HUMAN
FOUNTAINS