Forensic Thanatology

"The Difference between Ordinary and Extraordinary is just that little Extra."

—Jimmy Johnson

Theory

Let's Know the Terms First

Thanatology

- The **study of death**Q in all its aspects

Taphonomy

- The study of the decomposition processes of human remains

Death

- Section 46 IPC
- The word "death" denotes the death of a human being, unless the contrary appears from the context
- The Registration of Births and Deaths Act, 1969
- "Death" means the permanent disappearance of all evidences of life at any time after live-birth has taken place.

Bishop's tripod of life

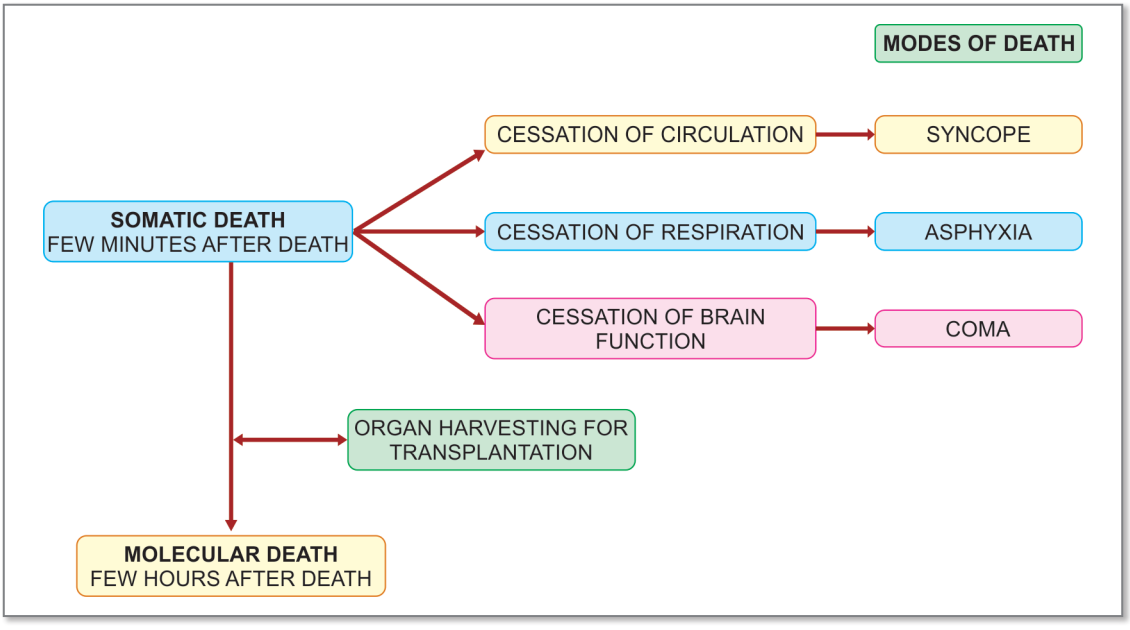
- Three interdependent vital functions of the body
- Respiration, Circulation and Brain function (i.e. lungs, heart and brain)

Sudden death

- When the person is not known to have any disease/injury/poisoning, dies ***within 24 hours*** after the onset of illness (WHO)
- Most commonly due to diseases of CVSQ (45–50%)

TYPES OF DEATH

- Somatic or clinical death
- Molecular or cellular death



APPARENT DEATH/SUSPENDED ANIMATION

(The person appears to be dead but he is not actually dead)

- *The signs of life are reduced to very minimum that it cannot be detected by routine clinical methods.*
- Suspended animation can be produced *Voluntarily*Q and involuntarily.

Mechanism

- During this state, the individual cells utilize the dissolved O_2 in body fluids and remain **viable**.
- Thus the person comes back to life on resuscitationQ.

Conditions Causing Suspended Animation

Mnemonic

Suspended Animation IN MY NEW HD TV

- **In** – **In**sanity/iatrogenic as in cardiopulmonary surgeries and anesthesia
- **M** – **M**esmeric trance, Morphine overdose[Q]
- **Y** – **Y**oga practitioners[Q]
- **N** – **N**ewborn[Q] (Most Common)
- **E** – **E**lectrocution[Q]
- **W** – **W**asting diseases, like cholera
- **H** – **H**eat stroke/Hypothermia[Q]/Hanging
- **D** – **D**rowning[Q]/Drugs like barbiturates
- **Tv** – **T**yphoid

Medicolegal Importance

- Suspended animation should not be mistaken for death.
- If death is declared and certified in this case prematurely, the doctor can be punished *for premature declaration of death.*

Illustrative CASE STUDY

On the fateful morning of 1/12/2017, a 20-year-old woman gave birth to premature twins, who were declared dead by that afternoon and handed over in a plastic bag. The family, on the way to the cremation ground, observed one of the babies making slight movements inside the bag and were shocked to find the baby breathing. They rushed to a nearby nursing home, only to find out that the baby was indeed alive. He was intubated and survived for a week before succumbing to sepsis and multi-organ dysfunction.

The hospital authorities initiated an enquiry against the concerned doctors for alleged negligence. The Delhi government also ordered for a detailed probe in this incident. The government cancelled the license of the said hospital for a series of violations. This unfortunate incident emphasizes the need for extra caution in declaring death in newborns, in whom suspended animation is very commonly encountered.

THOA 1994 (TRANSPLANTATION OF HUMAN ORGAN ACT)—INDIAN PARLIAMENT—(LATEST AMENDMENT 2014)

- This act regulates the removal of organ/tissues from living as well as the dead.
- **Bone marrow is outside the purview** of this Act.
- Declaration of brain death and organ retrieval earlier permitted only in hospitals approved for organ transplantation. But as per the 2014 amendment, any hospital having intensive care facility can register as a retrieval center; to retrieve and transport the organs to the transplant center.

Type of donation	Authorization given in case of	Organs donated
Living donor Living donors are classified as either a near relative or a non-related donor.	• A near-relative needs permission of the doctor incharge of the transplant center to donate his organ. • A non-related donor needs permission of an Authorization Committee.	• Blood, bone marrow[Q], kidney, *part of liver*[Q], *part of pancreas*[Q]
Cadaveric donor (after brainstem death)	• Any person >18 years with sound mind can be a donor and can authorize the removal of organs. • **Person has shown willingness for donation in writing:** ▪ Organ removal can be done after his death, with the consent of near-relative or the person, who is having the lawful possession of the body. • **Person has not shown willingness for donation:** ▪ Organ removal can be done after his death, with the consent of near-relative or the person, who is having the lawful possession of the body. ▪ **Unclaimed/unknown body in hospital or prison:** If the body unclaimed by near-relatives within 48 hours from the time of death, the hospital management or prison or by employee of the hospital or prison authorized by management can authorize the person in charge of the management or control thereof. • **If medicolegal autopsy is to be done in that case**, the treating doctor has to intimate the police. • Approval from autopsy surgeon is needed for organ retrieval in such cases.	• Most organs

Note

Near-relative means spouse, children, grandchildren, siblings, parents and grandparents.

Theory

Who can Certify Brainstem Death?

A medical board (brain death committee) consisting of:

- *Registered Medical Practitioner (RMP) in-charge of hospital where brain death has occurred*[Q]
- *RMP treating the patient*[Q]
- *A Neurologist/Neurosurgeon nominated by panel*[Q]
- *An independent RMP – a specialist*[Q]
  - In case of non-availability of neurologist or neurosurgeon, any surgeon, physician, anesthetist or intensivist, nominated by medical in-charge of the hospital may certify brain death.

Criteria to Certify Brain Stem Death

- Deep coma[Q] (due to irreversible brain damage)
- No spontaneous respiration - apnea[Q]
- Absence of brainstem reflexes[Q] (Pupillary, **corneal**[Q], **Gag**[Q], **Cough**, **vestibulo-ocular/caloric**[Q], Oculocephalic/doll's eye)
  - All the tests are to be repeated, after **minimum interval of 6 hours**

Certain conditions can cause reversible comatose situations
First exclude such reversible causes like:

- **Primary Hypothermia- body core temp <35°C**[Q]
- Drugs/Poisons – Depressants, muscle relaxants/alcohol
- **Metabolic/endocrinal disorders**[Q]

Offences & Punishment

Removal of human organ without authority	Ten years imprisonment and with fine up to twenty lakh rupee.	**Removal of name from state medical council: 1st offence: 3 years Repeat offence: Permanent removal**
Commercial dealing with organs	**5–10 years' imprisonment 20 lakhs – 1 crore fine**	

Extra Edge

Other criteria for brain death:

- Philadelphia protocol
- Minnesota criteria
- *Harvard criteria*[Q]

Beating heart donor:

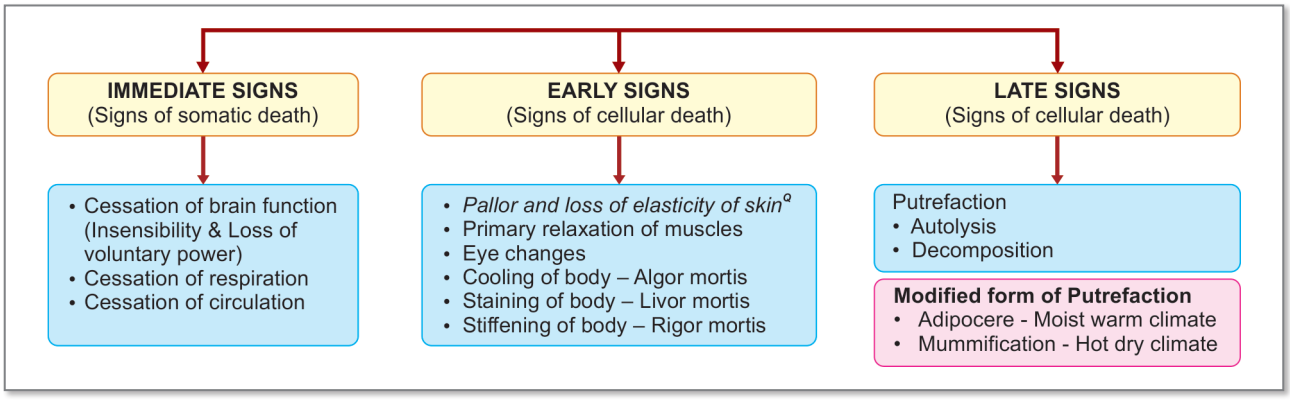
- After the diagnosis of brainstem death, the patient is *retained in ventilator*[Q].
- The **heart will continue to beat**[Q] on its own even in the absence of brain activity.
- This protects the oxygenated status of the organs; thereby improving the success rate of transplantation.

Swap transplantation:

- When a near relative living donor is medically incompatible with the recipient, the pair is permitted to do a swap transplant with another related unmatched donor/recipient pair.
- Swap donation is permitted as per 2014 rules.

POSTMORTEM CHANGES

The signs of death which are helpful in estimating approximate time since death, appear in the following order.



Extra Edge

- **Earliest sign after death: Loss of voluntary movement/ insensibility**
- **Earliest eye sign after death: Kevorkian sign**
- **Earliest sign of decomposition internally: Reddish brown discoloration of aortic intima**
- **Earliest sign of decomposition externally: Greenish discoloration in right iliac fossa**

CHANGES IN THE EYES

- Loss of corneal reflex (unreliable)
- Corneal opacity
- Flaccidity of eyeball
- Pupils
- Retinal vessels
- Vitreous changes

Corneal Haziness

- In 1 hour
- *Deposition of dust and drying*[Q]

Flaccidity of Eyeball

- Normal Intraocular tension = 10–22 mm Hg
- **Within half/2 hrs after death, IOP decreases gradually from 20 mm Hg to 0 mm Hg**
- **Helpful in detecting TSD**

Pupil

- Initially, dilated due to iris muscle relaxation.
- Later, constricted with the onset of rigor mortis.
- *Pupillary state after death is not an indication of their antemortem appearance*

Tache Noire Sclerotica

- **Cause:** *Drying/desiccation, deposition of cellular debris & dust*[Q]
- **Location: Sclera**[Q] & conjunctiva
- **Appearance**: two triangles at each side of the iris (base on the limbus, apex at the outer canthus)
- **Color change:** First yellow[Q], then brown and finally black
- **Time since death**: 4 hours[Q]

Retinal Changes

- Kevorkian sign[Q]/cattle trucking/railway trucking sign[Q] **The earliest sign after death in eye[Q].**
- **Appearance:** Fragmentation or **segmentation of blood columns**[Q] in retinal vessels
- **Cause:** Loss of blood pressure
- Visualized by **ophthalmoscope**[Q]
- **Time since death:** Appears **within seconds to minutes**[Q] after death, persists till 1 hour

Vitreous Changes

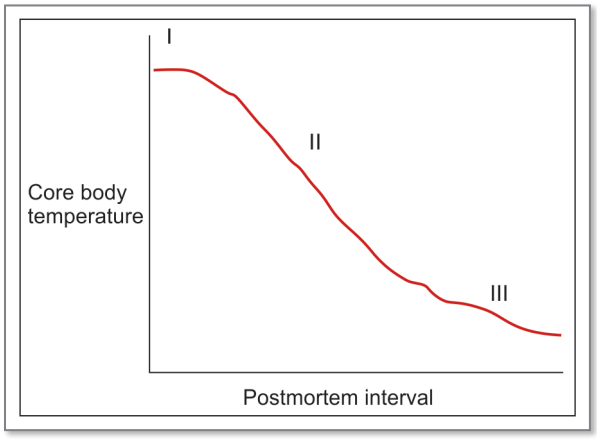
- Linear **increase in the Potassium[Q] & Hypoxanthine** levels seen
- In determination of postmortem interval**, *Potassium level from vitreous is the best one*[Q]. (The main advantage of vitreous potassium method is that it may be carried out up to 4–5 days after death)**
- The rise of potassium concentration per hour is 0.17—0.24 mmol/hour.
- **Madea's formula & Sturner's formula** for postmortem interval form vitreous K^+

ALGOR MORTIS (CHILL OF DEATH)—POSTMORTEM COOLING OF BODY

- After death, the heat production stops due to the inactivity of the heat regulating center after somatic death. Because of which, there is **fall of core temperature of body** after death.
- *Body core temperature*[Q] is measured.
- Algor mortis helps in **determination of time since death**.

Pattern of Algor Mortis

- The curve is **Sigmoid/inverted 's' shaped.**
- Three phases:
  - Phase I: NO decrease in body core temperature for the first 1–2 hours. (isothermic phase)
  - Phase II: Steep decline in BCT at linear pattern (intermediate phase) (0.4-0.7 degree Celsius per hour)
  - Phase III: very gradual decline (terminal phase)
- The III phase of the curve (*terminal phase*) is slightly above the base line due to bacterial activity.



Sites of Measuring Core Body Temperature

- **Rectum** (8–10 cm above anus) – Common site[Q] - Except in the case of sodomy
- **Subhepatic** (inferior surface of liver)
- External auditory meatus (tympanic membrane)
- Nose (cribriform plate)
- Lower end of esophagus

Instrument: Chemical thermometer (**thanatometer**)[Q] or *electronic thermocouple.*

Note

- It is not clinical thermometer, but chemical thermometer, 10–12 inches long with graduation from 0°–50°C is used.
- Reading should be made at intervals to calculate the rate of fall of temperature.
- Environmental temperature is also recorded at the same time.

Mechanism of Loss of heat (Depends on the medium of disposal)

- In Water: Heat loss is by conduction, and convection.
- In Air: Heat loss is partly due to conduction, partly due to convection and partly due to radiation.
- In case of burial: The only means of heat loss of heat is conduction.

Theory

Formula to calculate time since death (TSD) is:

$$\text{TSD (in hours)} = \frac{\text{Normal body temperature} - \text{Rectal temperature}}{\text{Rate of fall of temperature}}$$

- The fall in temperature starts in *15 minutes to ½ hour*
- The average rate of fall of the body temperature is 0.4°–0.7°C/hr
- The body *attains environmental temperature in 16–20 hours after death.*

Factors Affecting Algor Mortis

- **Environmental temperature (major factor):** Rate of fall is directly proportional to the difference between the temperature of the dead body and the environmental temperature.
- **Humidity:** Cooling is more rapid in a humid rather than in a dry atmosphere, since moist air is better conductor of heat.
- **Media of disposal:** Cooling is earliest in water, and late in buried bodies.
- **Built of cadaver:** Obese bodies cool slowly, and lean bodies rapidly.
- **Age and sex:** Rate of loss of heat is more in children and the elderly. Females retain body heat for a comparatively longer period because of their subcutaneous fatty tissue.
- **Clothings:** A well-covered body retains heat for a longer period.
- **Mode of death:** In case of sudden death in a healthy individual, the body tends to cool slowly.

Extra Edge

Ratio of the rates of fall of temperature in the three media

- **Water: air: soil = 4:2:1.**
- The rate is thus maximum in water, moderate in air and minimum in a buried body.

Postmortem Caloricity

- Body temperature **remains elevated** for the first 2 hours after death.
- Normally, there is a steady decline in body temperature after death.
- But in this state, the body temperature **does not fall in the initial few hours** after death.

Mechanism (Increased Endogenous Heat Production During Death)

- *Disturbed regulation of heat production before death* – **Heat stroke**[Q]**, Pontine hemorrhage**[Q]
- *Heat production due to muscle convulsions* - **tetanus, strychnine poisoning**[Q]
- *Heat production due to excessive bacterial activity*, as in **septicemic**[Q] conditions, cholera and other **fevers**[Q].

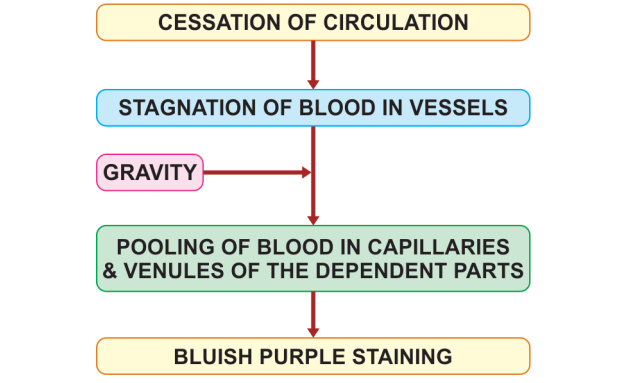
LIVOR MORTIS – POSTMORTEM STAINING

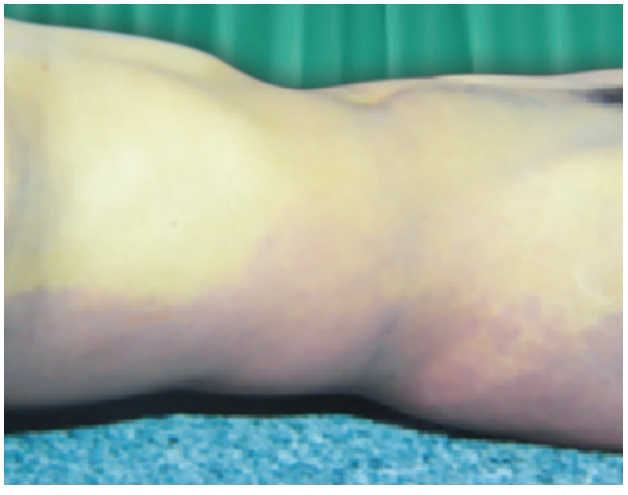
Synonyms

- *Lividity*
- *Hypostasis*
- Cadaveric lividity
- Suggillation[Q]
- Cogitation

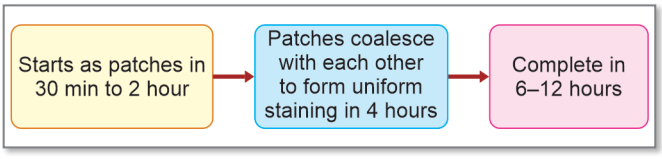
- Bluish purple discoloration in the **dependent parts**[Q] of the body after death
- Staining is in the superficial layers of the *dermis (rete mucosum)*

Mechanism





Development of Livor Mortis



Fixation of Livor Mortis: 6–12 hours[Q]

After complete formation of the postmortem staining, if the body is undisturbed, the staining gets 'fixed' and persists until putrefaction sets in.

	Applying pressure	Moving the body
Before fixation	**Blanching** (Livor mortis disappears & reappears on release of pressure)	Lividity disappears and reappears according to the new position ***(secondary lividity).***
After fixation	**No blanching** (Livor mortis Persists)	Lividity pattern does not change

Fate of Livor mortis: **Merges** with putrefactive color change[Q]

Illustrative

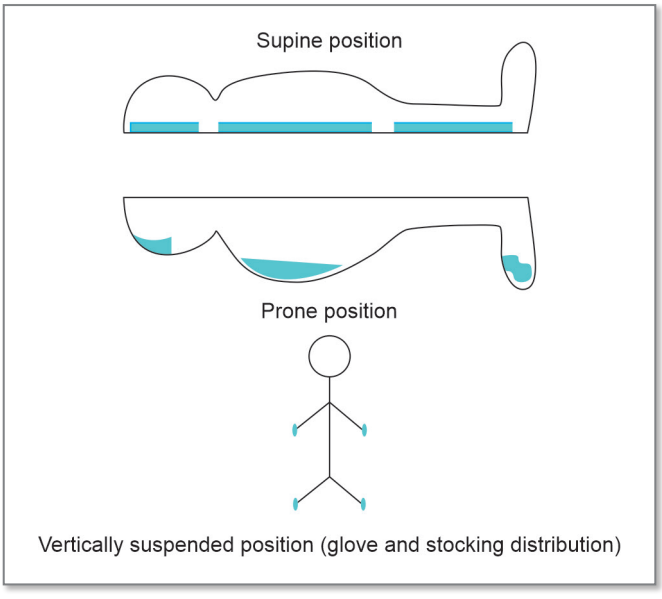
A 45-year-old man driving in a car died on the spot after hitting a tree on roadside.

While recovering the body from the driver seat within few hours, lividity was noted as patches in lower limb, lower abdomen with contact pallor over gluteal region.

His body was pulled out laid supine in mortuary. But during autopsy, the lividity was evident uniformly over back with the usual butterfly pattern of contact pallor.

If the body is moved within few hours of death (before fixation of lividity), patches of lividity will disappear and new one will form in the dependent parts **(secondary lividity)**

Distribution of PM Staining – Depends on the Position of the Body (Dependent Parts)



Vertically suspended position (glove and stocking distribution)

Position of the body	Pattern of livor mortis
Supine	Appears in the neck, and entire back (exception: areas directly pressed on the ground)
Prone	Lividity is seen in front
Suspended vertically (as in hanging)	Legs, and external genitalia, lower parts of forearms and hands **(Glove and stocking)**[Q]
Submersion in water (drowning)	Face, upper part of the chest, hands, lower arms & feet, as they are the dependent parts
• Running water (drowning in river) (as the position of the body constantly changes) • Severe anemia • Severe hemorrhage	**No lividity**[Q]

Color of Livor Mortis

- The color of livor mortis depends on the type of hemoglobin
- Normally, the lividity is bluish or purple due to the presence of deoxyhemoglobin.

Conditions	Color of lividity	Type of hemoglobin
Normal	Blue/purplish	Reduced Hemoglobin
Carbon monoxide burns	**Cherry red**[Q]	Carboxy hemoglobin and increased oxygen content in blood (**Anemic anoxia**)
Cyanide	**Bright red**[Q]/ **Brick red**[Q]	Cyanide inhibits cytochrome oxidase and decreased O_2 utilization by tissues. (**histotoxic anoxia**) Increased Oxygen content in blood
Hypothermia/ Refrigeration	**Bright pink**[Q]	Oxygen retention in cutaneous blood by cold air
NaCl/Nitrite/ Nitrate/Aniline/ Potassium chlorate/ phosphorus/ Bromates	**Chocolate Brown**[Q]	Methemoglobin (**meth Hb**)
Aniline	Deep blue	*In some cases*
Septic abortion	Bronze	Due to *Cl. perfringens*
Hydrogen sulfide	**Bluish Green**[Q]	**Sulfhemoglobin**
Mummified bodies	**Brown to black**	—

! Attention:

Questions about the type of poisoning from the color of lividity are frequently asked.

Extra Edge

Lividity is more intense in

- *Asphyxial deaths*[Q]
- Sudden deaths

(Wherever the blood is more fluidic)

Lividity is less intense in

- **Lobar pneumonia**[Q]
- **Anemia**[Q]
- Hemorrhage[Q]

(Wherever the blood coagulates quickly or reduced amount of hemoglobin)

Areas of Pallor in Lividity

- **"Contact pallor/Pressure pallor"**
  - *Parts of the body which are in **tight contact with the ground** do not show staining:*
  - Examples: occipital area, shoulder blades, buttocks, posterior aspects of thighs, calves and heels
  - Butterfly-shaped pattern over back

- **Vibices**
  - Often, skin under collar band, waist bands and belts remain pale due to tight contact and seen as pale stripes or bands known as vibices.

Medicolegal Importance

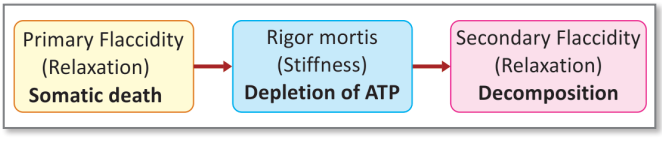
- Helps in estimating the **time of death**
- Indicates the **posture of the body** at the time of fixation and death
- Indicates the moving of the body to another position
- Color of lividity may indicate **the cause of death** – poisoning

Differences between Lividity and Contusion

Lividity in its early stages as patches simulates contusion

Criteria	Lividity	Contusion
Mechanism	Stagnation of blood in capillaries & venules	Blunt trauma rupturing the vessels causing extravasation of blood
Site	**Dependent parts**[Q]	Anywhere
Appearance	**No elevation**	Swollen & elevated
Epidermis	Normal	**Abraded**
Margin	**Well defined**[Q]	**Ill defined**[Q]
Color	Bluish purple, uniform	**Color change with healing**
Pressure effect	**Blanching seen**[Q]	Blanching not seen
Cut section	Blood confined within the vessel, **can be washed away easily with water**[Q]	**Extravasation of blood**[Q], **cannot be washed away with water**
MLI	Time of Death Position of the body	Nature of injury Weapon used

MUSCULAR CHANGES AFTER DEATH



- In primary relaxation, muscles become flaccid, but the muscular fibers are still alive and respond to electric stimulus and reaction is alkaline.
- Relaxation of sphincters occurs.

RIGOR MORTIS—POSTMORTEM STIFFENING OF MUSCLES

Synonyms
- Cadaveric Rigidity
- Postmortem Rigor
- Postmortem Rigidity
- Postmortem Stiffening

- The state of the muscles becoming stiff or rigid in a dead body.
- Due to **depletion of ATP stores** after death.

Mechanism

- Postmortem, there is continuous and progressive hydrolysis of the ATP. Once the ATP stores are exhausted, the muscle goes into a state of contraction.
- The reduction of ATP causes stiffness and rigidity.
- Rigor mortis **begins in 1 -2 hours**[Q] after the period of primary relaxation.

Muscular Involvement

- Rigor mortis involves both voluntary & involuntary muscles (**involuntary muscles earlier than voluntary muscles**[Q])
- *Rigor mortis involvement is independent of nervous innervation* (RM is noted **even in hemiplegic limb**).

Order of Appearance of Rigor Mortis

- Rigor **involves myocardium initially within 1 hour**[Q]. Then it spreads externally.

- **Nysten's rule** (1811) states that rigor mortis usually develops sequentially - proximodistal (descending pattern).
- **Shapiro's rule** (1950)

RM is a biochemical process which occurs simultaneously in all the muscles.
- In small muscles, rigidity appears earlier
- In larger muscles, rigidity appears later

Nysten's Rule (1811)

Sequence of Rigor Appearance

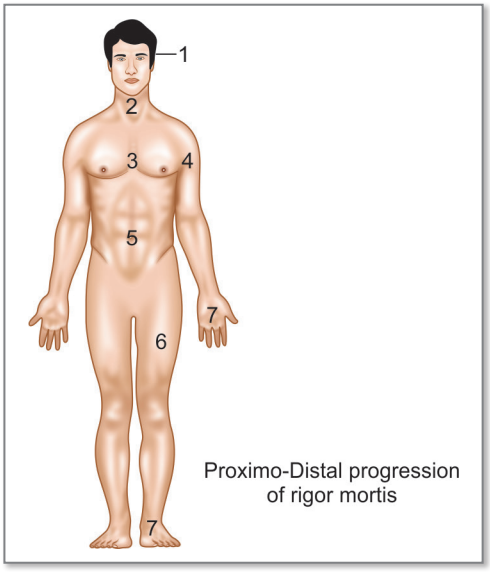
Myocardium, eyelids, neck and lower jaw, then face, chest muscles, upper limb, abdomen, lower limb and lastly fingers and toes

Sequence of Disappearance

- Rigor mortis disappears in **the same order**[Q] **of appearance** in which it develops.
- **Rigor mortis** begins in 1–2 hours, progress in 3–4 hours and complete in 6–12 hours

Rule of 12

- *It takes roughly 12 hours to appear,*
- *Persists for another 12 hours*
- *Disappears in another 12 hours*



Proximo-Distal progression of rigor mortis

!Attention:

Read the question carefully whether it is external or internal. If the site is specified as external, then the option is eyelids.

- The **first site** of RM involvement is Myocardium[Q]
- The **first external site** of RM involvement is **eyelids.**[Q]

Factors/Conditions influencing Rigor Mortis Onset and Duration

Rigor mortis does not occur in a fetus *<2 months old.*

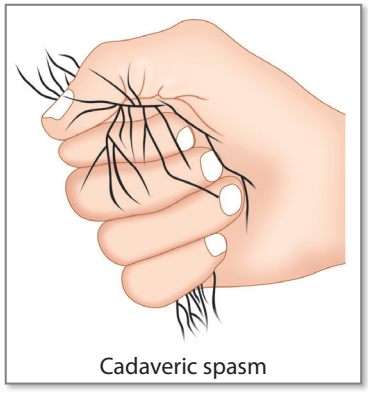
Early onset (usually short duration)	Late onset (usually longer duration)
Muscle fatigue/convulsions and exhaustion before death[Q] **Racing, Strychnine, Tetanus**	Muscles that are healthy[Q] and at rest before death
Deaths from wasting diseases[Q] **Cholera**, TB	Asphyxia, hemorrhage, pneumonia
Hot weather	Cold weather
OPC poisoning[Q], HCN,	CO poisoning

CONDITIONS SIMULATING A (LOOKING LIKE) RIGOR MORTIS

- Cadaveric spasm (unknown mechanism, may be neurogenic)
- Heat stiffening (due to *muscle protein coagulation*)
- Cold stiffening (due to *solidification of subcutaneous fat*)
- Gas stiffening (due to gas accumulation evolved from putrefaction)

Cadaveric Spasm (Instantaneous Rigor)

- The **group of voluntary muscles**[Q] which were at strenuous work just before death goes into a sudden state of stiffening, instead of passing to primary flaccidity after death.


Cadaveric spasm

Salient features of cadaveric spasm:

- Seen **immediately**[Q] after death with **no primary relaxation phase**[Q]
- Involves **only a group of voluntary muscles**[Q] (which were in contraction before death)
- Exclusively **Antemortem**[Q] in nature and it **cannot be produced artificially**[Q].
- **Great force**[Q] is required to overcome the stiffness.
- Cadaveric spasm passes into rigor mortis without interruption and disappears when rigor disappears.
- **The attitude/last act of the person at the time of death is preserved**[Q]. The cause and manner of death can be determined.
- **Mechanism:** *Unknown*[Q], Neurogenic

Conditions: Firearm in the hands of victims in suicidal gunshot injuries, plants and weeds in the hands of victims in drowning, the weapon in the hands of victims in cut throat injuries suggesting the manner of death.

Heat Stiffening

If the body is subjected to heat exposure at > 65°C, Stiffness is produced.

Synonyms

- Pugilistic attitude
- Boxers attitude
- Fencing attitude
- Defence attitude

Theory

Mechanism

Muscle protein coagulation[Q] due to heat.

Conditions

- **Burns**[Q]
- High voltage electric shock

Attitude

- The legs are flexed at the hips and knees, the arms are flexed at the elbows and held out in front of the body and the fingers are hooked like claws.

Fate

- The stiffening remains until decomposition.
- ***The normal rigor mortis does not occur***[Q] *in heat stiffening.*

Cold Stiffening

- If a body is exposed to freezing temperatures, the tissues becoming frozen and stiff, simulating rigor.

Mechanism

- Freezing of body fluids
- **Hardening of the subcutaneous fatty tissue**[Q].

Fate

- On exposing the body to warm atmosphere, cold stiffness disappears, followed by *normal rigor mortis occurring rapidly and passes off quickly.*

PUTREFACTION—LATE CHANGES

Process by which complex organic body tissue breaks down into simpler inorganic compounds or elements

- Autolysis: without bacterial involvement
- Decomposition: with bacterial involvement

Autolysis: ('auto': self; 'lysis': breakdown) – (by Lysosomal Enzymes)

- After death, cell membranes become permeable with the release of proteolytic enzymes into cytoplasm.
- The *earliest autolytic changes occur in glandular tissues, and in the brain.*
- In dead born, ***maceration***[Q]**—aseptic autolysis of dead fetus in utero is seen**.

Decomposition

Bacteria involved:

- Derived mostly from **GIT**[Q], sometimes from injuries (open wounds)
- ***Clostridium welchii***[Q]**,** *Staphylococcus*, non-hemolytic Streptococcus, diphtheroids, and *Proteus* are the important ones involved.
- Among these bacteria, *Clostridium* is the **chief destructive agent**[Q] as it produces '**LECITHINASE**[Q]' enzyme.

Functions of Lecithinase

- Hemolysis
- Liquefaction of post-mortem clots, fresh thrombi and emboli
- Disintegration of tissue
- Gas formation in blood vessels and tissue spaces
- Adipocere formation

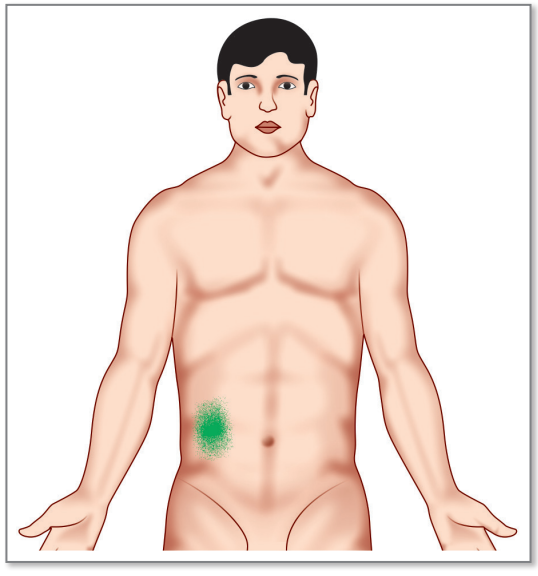
Decomposition: Involves 3 stages

- Color changes
- Production of gases
- Colliquative Liquefaction of tissues (5-10 days after death[Q])

Color Changes

- **First external sign of putrefaction is the greenish discoloration in right iliac fossa.**
- *Internally, first site of reddish brown discoloration is aortic intima and then the under surface of liver*

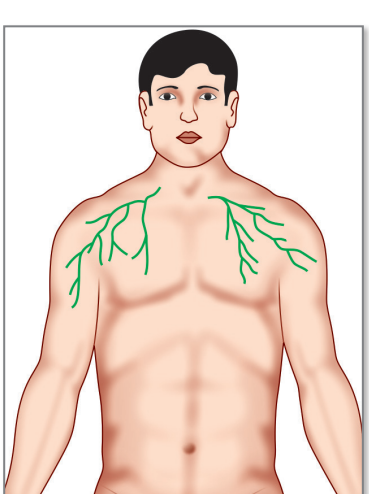
Why green color?	• Hydrogen sulfide is produced by bacteria in large intestine. • Green color results from the conversion of hemoglobin of blood into **sulfhemoglobin**[Q] by the hydrogen sulfide
Why first noted externally in right iliac fossa?	• Caecum lies superficially • The contents of the bowel are more fluid and full of bacteria.



- *Time of appearance: The color appears in 12–18 hours in summer*[Q] *& in one to two days in winter.*
- The discoloration gradually spreads all over the abdomen, external genitalia, face, neck and thorax, and lastly on the limbs.

Marbling (marbled patterns on the Skin[Q]*)*

- **Areas noted**: Shoulder, roots of the limbs, thighs, sides of abdomen, chest and neck
- **Time**: 36–48 hours[Q].



Mechanism

- In decomposition, bacteria spread all over the body through the blood vessels; using the proteins and carbohydrates of the blood as culture media
- Their passage is marked by the conversion of hemoglobin to **sulfmethemoglobin**[Q] in the blood vessels.
- This results in ***greenish staining of inner walls of the vessels***[Q], a **marbled** (***road map***) [Q] appearance of the skin.

Effects of Gas Formation

- Gases formed: Ammonia, carbon dioxide, hydrogen sulfide, phosphorated hydrogen and methane.
- **Principal gas: Hydrogen sulfide**[Q]

Effects	Timeline
Skin Blisters First seen on the lower surface of trunk and thighs	18–24 hours[Q]
Abdomen gets distended due to accumulation of gases in the intestines (**Gas stiffening**[Q])	18–36 hours
Postmortem purge[Q]: *Diaphragm is pushed up compressing the lungs and heart;* ***blood-stained frothy fluid exudes from the mouth*** *and nostrils*	18–36 hours
Foamy liver/honey comb liver The liver assumes a '**honey comb**[Q]' ('foamy' or 'Swiss cheese') appearance due to formation of air bubbles. (Note: Nutmeg liver is seen in chronic venous congestion)	24–36 hours
Skin slippage Anus and uterus prolapsed **Hair and nails become loose and may be taken out easily**	2–3 days
Skin of hand and feet may come off in a '**glove and stocking**' manner[Q]	3–5 days[Q]
Separation of skull sutures in children	3–5 days

Postmortem blisters

Colliquative Putrefaction (Liquefaction)—5–10 Days[Q]

Putrefactive changes of organs in the following order:

- **Larynx and trachea (Earliest organ)**[Q]
- Stomach, intestines and spleen.
- Liver
- **Brain**
- **Heart**
- Kidney and bladder
- **Prostate, uterus**[Q]
- Skin, muscle and tendon
- **Bones & Teeth**[Q]

MNEMONIC

Sequence of putrefaction of organs-for middle order

SISter LILLy's Brittle Heart

- ***S****ISter- Stomach, Intestine, Spleen*
- ***Lilly – Liver***
- ***Brittle – brain***
- ***Heart***
- *In general,* ***Bone is the last organ to putrefy.***
- But among the visceral organs, prostate and nulliparous uterus are the last to putrefy.

Extra Edge

- Prostate and uterus being the last visceral organs to decompose, they help to identify the sex of the dead bodies in **advanced state of decomposition.**
- **Pink teeth**: Seen in *putrefaction*[Q] as a result of hemolysis of extravasated blood in dental tubules.
- **Postmortem luminescence**
  - Usually due to contamination by bacteria, like *Photobacterium fischeri*
  - Light comes from the bacteria.
  - *Luminescent fungi, Armillaria mellea*, are other sources of light.

Conditions Influencing Putrefaction Process

(Generally, moisture and bacteria enhance the putrefactive process)

Theory

Putrefaction is retarded by
- Temperature <0°C
- Temperature >48°C
- Hot dry air
- Wasting diseases like anemia
- Certain poisons

Putrefaction is enhanced by
- Summer
- Anasarca
- Peritonitis
- Septicemia

Casper's Dictum

- **A body decomposes in air twice as rapidly as in water and 8 times as rapidly as in earth.**
- In other words, at a given temperature one week of putrefaction in air is equivalent to two weeks in water and eight weeks buried in soil.

1 week of putrefaction in air = 2 weeks in water = 8 weeks in soil.

Poisons Inhibiting Putrefaction

MNEMONIC

State Medical Council (SMC)
- ***S**trychnine*[Q]
- ***M**etallic poisons like Arsenic, Zinc chloride, thallium, antimony*
- ***C**yanide, CO, Carbolic acid (Phenol)*[Q]

Poisons Produced during Putrefaction

- Alcohol
- CO
- Cyanide
- *Ptomaine*

Floatation of a Dead Body on Water

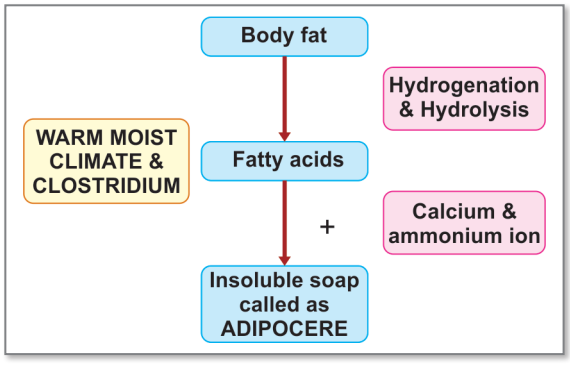
- The time of floatation of body varies greatly.
- The body floats in about 12–18 hours in summer, and 18–36 hours in winter in India.

MODIFIED PUTREFACTION

Adipocere (Saponification)

- Commonly seen in **bodies immersed in water**[Q] or in damp warm environment
- In this, the fatty tissues of the body change into a substance known as adipocere
- It is also called **grave wax**[Q] (Latin *adipo:* fat, *cire:* wax)

Mechanism: (Hydrolysis & Hydrogenation of Fats)



Higher fatty acids in adipocere
- **Palmitic (most important)**
- Oleic
- Stearic
- Hydroxystearic acid

Distribution

- **Any site, where fatty tissue is present**[Q]
- Face, buttocks, breast and abdomen are usual sites.

Properties:

	Adipocere (hydrolysis and hydrogenation of fats)	Mummification (drying and dehydration of the body)
Odour	• Sweetish smell[Q] • Rancid butter smell	• *Odorless*
Requirements	• Warm moist anaerobic climate[Q] • Lecithinase enzyme[Q] produced by clostridium perfringens[Q] • Intrinsic lipases **Note:** *The process starts under the influence of intrinsic lipases, and is continued by the bacterial enzymes of the clostridia group, mainly Cl. perfringens, as the bacteria produce lecithinase, which facilitates hydrolysis and hydrogenation*	• Absence of moisture • **Hot dry climate**[Q] • Free circulation of air
Duration	• Shortest duration noted in 3 days as well. • Complete conversion in an adult limb requires at least 3 months	• 3 months to 1 year[Q]
Medicolegal Importance	• Cause of death[Q] – injuries are preserved • Time since death[Q] • **When involves face, the features are well preserved, helps to establish the identity**	• **Cause of death – injuries are preserved**[Q] • **Time since death**[Q] • **Helps to establish the identity**

Extra Edge

- Adipocere starts in subcutaneous fat.
- Fetuses *<7 months do not show* adipocere formation.
- In running water, Adipocere formation is not seen as the electrolytes are washed away from the surface of the body.

Illustrative CASE STUDY

A body of 32-year-old woman, who was missing for 44 days was found in a nearby well.

Postmortem examination was held on the following day. The body was well preserved, no disagreeable smell. Saponification had taken place in the soft tissues of the trunk, breast and extremities. There was an incised wound measuring four by two inches across and right side of neck cutting the larynx. Brain liquefied, lung decomposed. The abdominal fat, mesentery and liver were saponified.

The injury and the identity were appreciated because of adipocere. Cause of death was reported as cut throat injury.

Mummification (Drying & Dehydration of the Body)

- It is the rapid *dehydration and shriveling of the dead body*[Q] from evaporation of water.
- Begins in *exposed parts of the body*[Q] – face, limbs then extends to the entire body including internal organs.
- The entire body loses weight, becomes thin, stiff, brittle and odorless. (**more than 70% weight is lost**[Q])

Chemicals Favoring Mummification

- *Arsenic poisoning*
- *Antimony poisoning* [Q]
- Concentrated salt - NATRON

EMBALMING: THANATOPRAXIA

- It is the treatment of the dead body with antiseptics and preservatives to stop putrefaction and preserve the body.
- Embalming a body *within 6 hours*[Q] - satisfactory result.
- It produces a *chemical stiffening*[Q] *similar to rigor mortis.*
- **Embalming rigidity is *permanent and normal rigor does not occur*[Q].**

Constituents of a typical embalming fluid

- Preservative—Commonly a mixture of formaldehyde, glutaraldehyde. Methanol is used to hold the formaldehyde in solution.
- Germicide – Phenol
- Humectant (to preserve the moisture) – Glycerin
- Buffer (to maintain the pH) – Sodium borate/sodium bicarbonate.
- Anticoagulants-Sodium citrate/sodium oxalate
- Dyes (to restore the body's natural coloration) – eosin
- + Perfume – wintergreen
- Vehicle – water up to 10 L

Note: Ethanol is not a constituent of embalming fluid.

Methods of Injection

- Continuous injection and drainage
- Continuous injection and disrupted drainage
- Alternate injection and drainage
- **Discontinuous injection and drainage - Best method of injection**[Q]
- **Injection done in High pressure & Low flow**[Q]

Disadvantages of Embalming

- *Difficult to interpret injury/diseases*[Q].
- *Alteration of appearance of the body*[Q]
- Detection of poisons/drugs very difficult.
- Dislodgement of thrombi/emboli.

Color of embalmed bodies in Jaundice cases is green. In jaundice embalming, the use of formaldehyde as the primary preservative initiates a chain of events that causes yellow-green color reaction to occur in most cases

Note

- *Autopsy must be done prior to embalming*[Q] (in view of the alteration of appearance of bodily injuries and diseases, destruction of poisons)
- **If embalming is done prior to autopsy in poisoning cases**, that amounts to destruction of the evidences (poisons) and **liable to be punished under section 201 IPC**[Q].

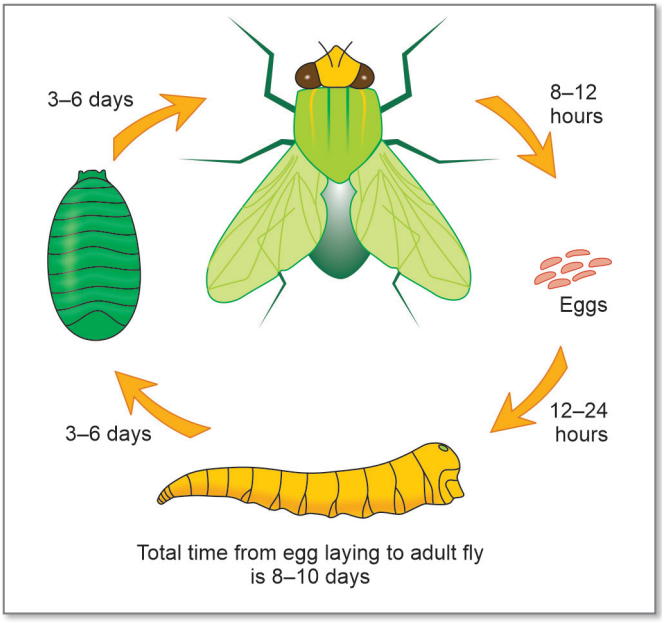
FORENSIC ENTOMOLOGY

- **The study of insects**[Q] **and other arthropods, which infest dead bodies.**
- Myiasis – infestation of the body by maggots.
- The larvae of the flies are called maggots.

Important Species of Flies Involved

- Blue bottle fly (*Calliphorida vomitarie*)
- House fly (*Musca domestica*)
- Flesh fly (*Sarcophagidae*)

Lifecycle of a Fly



Medicolegal Significance of Entomology

- **Time since death – from the larval stage**[Q]
- Place of body disposal – from the predominant species of fly
- Cause of death (poisons) – from chemical analysis of larva

- Chemical analysis of maggots is helpful in *determination of poisoning cases* (called **Forensic Entomotoxicology)**
- **Accumulated degree hour technique** – a *more technical & precise method* for estimating TSD
- **Maggots** should be preserved in boiling *absolute alcohol or hot 10% formalin*

Illustrative CASE STUDY

A 19-year-old female "x", a commercial sex worker was found dead along a highway in a southern Indian state. Multiple stab wounds were noted on the body. Case was registered as unnatural death and body brought for autopsy. During autopsy, body was in advanced decomposed state with maggots crawling around the injuries and natural orifices. The maggots were collected, analyzed and identified as belonging to sarcophagi species, and the time since death was calculated on the basis of the stage of development and environmental factors to be 4–6 days.

This helped to arrest the suspect (whom she was seen last with), a retired army person who had murdered for financial altercations.

AUTOPSY (NECROPSY, POSTMORTEM EXAMINATION)

- First autopsy in *India* was conducted by *Dr. Edward Buckley* on the body of Mr. Wheeler in *1693.*

Types of Autopsies

Medicolegal Autopsy
- In unnatural/suspicious death
- **Police authorization mandatory**[Q]
- **Consent from relatives not required**[Q]

Clinical/Pathological Autopsy
- In natural/hospital deaths, where cause of death is uncertain
- **Consent**[Q] **from legal guardian mandatory**

Vitropsy
- *Virtual autopsy*[Q]
- Using imaging techniques, like CT & MRI scan
- *Noninvasive/minimally invasive procedure*[Q]

Psychological Autopsy
- Usually in *suicidal cases*[Q]
- **Done by questionnaire**[Q] **and** interviews with survivors of the deceased-families, friends
- To assess the person's state of mind prior to death

Negative Autopsy
- All findings negative
- *Cause of death unknown*[Q]
- *Negative opinion* (No definite opinion can be given even after complete examination and other tests)
- 2–5% of all autopsies are negative.

Types of Skin Incisions

- **I-shaped incision:**
  - Incision extending from the chin straight down to the symphysis pubis.
  - *Most common method followed*[Q].

- **Y-shaped incision:**
  - Two incisions each starting from acromion processes, meet in the midline near xiphisternum and then extend downwards straight to pubis.
- **Modified Y-shaped incision:**
  - An incision is made in midline from suprasternal notch to symphysis pubis.
  - It then extends from suprasternal notch to the mastoid processes on each side.
  - It is used when a *detailed study of neck organs is required, like in hanging or strangulation*[Q].
- **T-shaped or 'bucket handle' incision:**
  - A transverse incision in the neck is opened from acromion to acromion process (bisacromial) along the line of clavicles.
  - Then a single midline incision is made down the anterior body wall, avoiding the umbilicus, to pubis.
- **X-shaped incision:**
  - This incision is made over the back (incision extends from one side acromion to opposite side gluteal region)
  - To demonstrate the deep bruises in *custodial death cases.*

References:

1. Essentials of Forensic Medicine & Toxicology, by KS Narayan Reddy, OP Murty (35th edition).
2. Review of Forensic Medicine & Toxicology: Including Clinical and Pathological Aspects, by Gautam Biswas, 5th edition.

Techniques of Autopsy

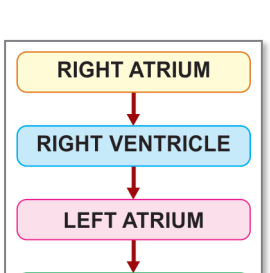
Virchow's Technique
• Individual organs ***removed one by one***[Q] • Anatomical relations not preserved
Ghon's Technique
• **Organ blocks**[Q] & organ dissection • Cervical, thoracic, abdominal and urogenital system are removed as organ block (separate blocks)
Lettule's Technique
• Cervical, thoracic, abdominal and pelvic organs are removed as **en-masse**[Q] (all together) and organ dissection • **Anatomical relationships preserved and can be studied** • **Rapid technique**
Rokitansky's Technique
• **In situ dissection**[Q] of organs • **Fetal brain dissection**[Q] • Infectious diseases, like HIV, Hepatitis B • **Radiation hazards**[Q]

Important Individual Organ Dissection

- Hollow structures, such as blood vessels and GI tract (esophagus, stomach and intestines) is cut opened in order to reveal the pathology present inside.
- For solid organs, many parallel cuts, in a fashion similar to slicing a loaf of bread ('**bread-loafing**') is done.

Heart Dissection: Inflow Outflow Method[Q]

- Following the direction of blood flow.
- First, the right atrium is opened, followed by the tricuspid valve, and then the pulmonic valve.
- Next, the left atrium is opened, followed by the mitral valve and the aortic valve.



Brain

- In most autopsies, **the brain is examined in the fresh state**[Q].
- In select cases, the brain is 'fixed' and then examined.
- The **best routine fixative is 10% formalin**[Q] and requires *2–3 weeks for satisfactory fixation.*
- In fetuses and infants, *acetic acid to be added* to the fixative solution

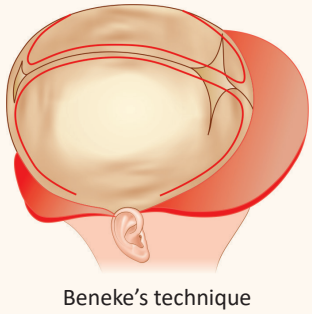
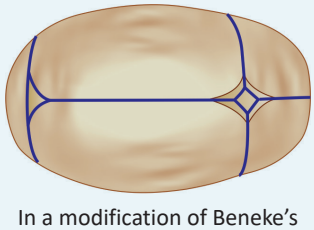
Spinal Cord

- **Routinely spinal cord is not opened**[Q].
- In cases of suspected spinal injury, spinal cord is opened by **posterior approach**[Q].

Posterior approach	Anterior approach
Best approach[Q]	Simple and quick; and does not require turning the body over
Easy exposure of the uppermost cervical spine and allows direct visualization of the craniocervical junction; *Thus recommended in cases in which neck injuries are suspected*[Q]	*Nerve roots, dorsal ganglia and peripheral nerve can be visualized*[Q].

Removal of Skull in Infants

- In fetuses and infants, removal of skull is different from that of adult; as the sutures are not closed and skull bones are soft.

Beneke's technique	Modification of Beneke's method
	
Beneke's technique The skull and dura are cut parallel to the midline from the lateral edge of the anterior fontanelle	In a modification of Beneke's method the skull is incise lightly along the cranial sutures and at the fontanelles

Stomach Dissection (Double Ligation Method)[Q]

- Two ligatures are applied at the cardiac end of the esophagus and two ligatures below the pyloric end of the stomach. The stomach is removed by cutting between the double ligatures at both ends.
- Then the stomach wall is opened along the greater curvature.
- The status of mucous membrane and the content is examined.

Collection of samples during autopsy

- **Blood: Femoral vein (best site)**[Q]
- *Urine: Suprapubic puncture or directly* from bladder
- CSF: Lumbar or cisterna magna puncture

DEATH CERTIFICATION

- All births/deaths shall be reported within 21 days of their occurrence to the concerned Registrar/Sub Registrar of the jurisdiction. (Registration of Birth and Death Act, 1969)
- It is the duty of the medical officer to give information to the registrar in case of hospital deaths.
- Death certificate should be issued by the **doctor without charging any fee**[Q].
- If the *cause of death is not sure, death certificate should not be issued*[Q] and body should be forwarded for autopsy.
  - Death Certificate must not be withheld for pending professional fees from the deceased patient.
  - Refusal to issue a legitimate Death Certificate is a punishable offence.

PRESUMPTION OF SURVIVORSHIP AND PRESUMPTION OF DEATH

Presumption of survivorship	Presumption of death
• If 2 persons from same family die in common disaster, it may be necessary to know who died earlier and who died later. • In that situation, the case is decided based on facts and evidence available, like age, sex, nature and severity of injuries and the mode of death. • This may be vital for property inheritance. • **Commotiorentis**[Q]: Persons who died together on same occasion, where it cannot be ascertained who died earlier.	• This is a legal issue for a person missing for a long period (when the individual is alleged to be dead and body is not found) • This may be necessary for inheritance of property or for claiming insurance money • Dealt by Sec 107 & 108 IEA **Sec. 107 IEA** States that a person is presumed being alive, if there is nothing to suggest the probability of death within 30 years. **Sec. 108 IEA**[Q] States that, if it is proved that the said person has not been heard of for 7 years by them, who are expected to hear about him, if he would be alive, then death is presumed.

Illustrative CASE STUDY

Presumption of Death

Sec 107 IEA
Burden of proving death of a person to have been alive within thirty years.
Explanation:
Let us consider an imaginary person called Sanjay. This person has not been seen alive for the past thirty years

- A case has been filed that Sanjay has gone missing.
- If some person 'Rajiv' comes and says that Sanjay is dead, then the onus of proving it lies with Rajiv.
- Rajiv must provide the facts and circumstances, which led to the death of Sanjay, and then only the judiciary can approve it.
- If simply one comes and says that he is dead, the court will not accept it without providing evidence.

Sec 108 IEA Burden of proving that person is alive who has not been heard of for seven years

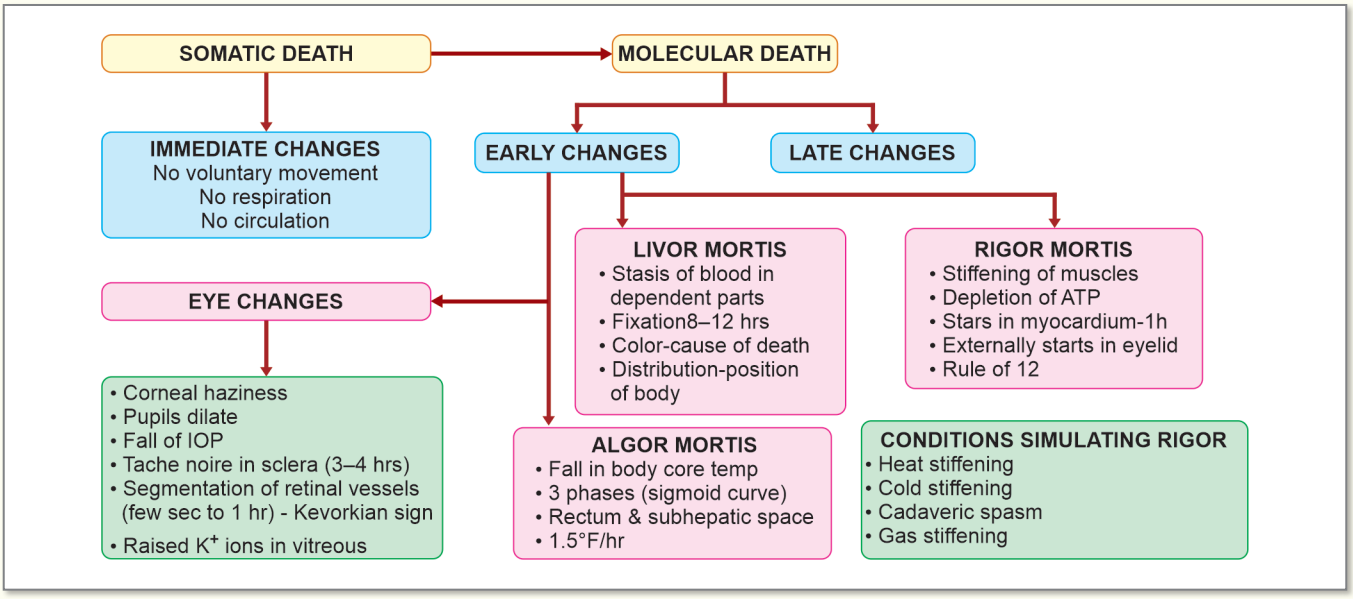
- If Sanjay went missing for 7 years, nobody has got any information regarding him.
- If someone named 'Rajiv'comes and tells before the court of law that he saw him; then Rajiv is responsible to prove with facts and circumstances that he is alive.
- Section 108 deals with proving that a person is alive who has not been heard of for the past 7 years

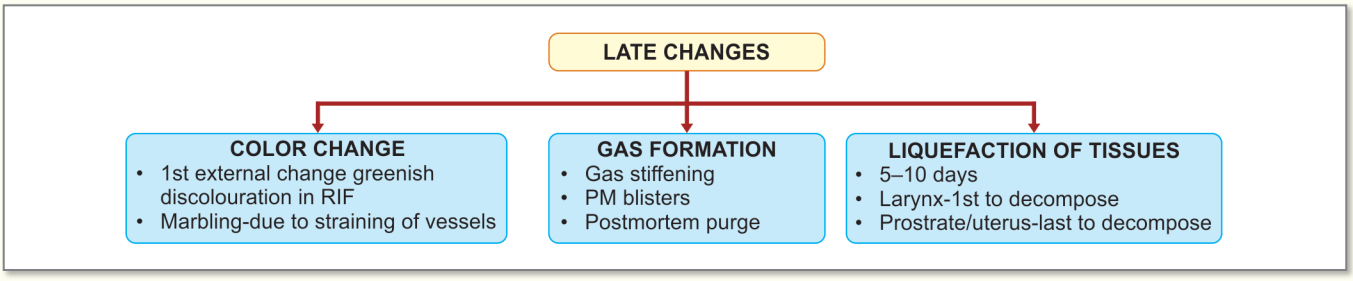
RECENT ADVANCES

Estimation of time since death:

- **Cell death proteins (mRNA expression of proteins):**
  - A positive linear correlation was found between the mRNA expression of PTEN and FasL proteins and the time since death.
- **Degradation of cardiac troponin I (cTnI):**
  - The degradation-banding pattern of tissue cTnI is useful in the determination of the early postmortem (pm) interval (0-5 days)
- **From vitreous potassium concentration:**
  - Madea's formula: TSD = 5.26 × $[K^+]$ – 30.9
  - Sturner's formula: TSD = 7.14 × $[K^+]$ – 39.1
- Histological changes in the gingival tissues after death.
- **From lividity:**
  - The color of lividity fades over time, and there is a linear relationship between the fading (paleness) and the time during the first 24 hours (demonstrated by VANEZIS)

Chapter at a Glance





Frequently Asked Concepts—Last-Minute Habits

Theory

- Thanatology is the study of death in all its aspects; Taphonomy is the study of the decomposition processes of human remains.
- Somatic death is unresponsiveness, loss of voluntary movement, cessation of circulation and respiration; Molecular death is death of individual cells and tissues.
- The earliest change after somatic death is loss of voluntary movement
- The earliest sign of cellular death is Pallor and loss of Elasticity of Skin.
- Medicolegal autopsy done in unnatural deaths (authorization from Investigating officer)
- Clinical autopsy done in natural deaths (consent from relatives)
- Virtopsy is conducted by using imaging techniques, like CT & MRI Scan.
- Individual organs are removed one by one in: Virchow's technique
- Organs removed enmasse-Lettule's technique; Organs removed en bloc-Ghon's technique; Organs dissected in situ-Rokitansky Technique (preferred in highly Infectious diseases)
- Spinal canal is not opened in routine autopsy. If preferred, Posterior dissection is the best method.
- Exhumation (176 (3) CrPC) can be done only after a written order by 1st class magistrate.
- Time limit for exhumation in India: No time limit
- Kevorkian sign is fragmentation or segmentation of the blood column in the Retinal vessels.
- Tache noire refers to discoloration of sclera due to drying & dust deposition (3–6 hours after death)
- In determination of postmortem interval, Potassium level from vitreous is the best one.
- Body core temperature is ideally measured in sub hepatic surface and commonly measured in rectum.
- Post mortem hypostatis: Suggillation, vibices, cadaveric lividity
- Post mortem staining is not seen in: Pressure point; Drowning in a fast flowing river
- Fixation of postmortem staining occurs in 8–12 hours
- Rule of 12, Shapiro's rule & Nysten's rule is related to: Rigor mortis.
- Rigor mortis first involves myocardium (internally) & eyelids (externally)
- Primary relaxation phase is not seen in cadaveric spasm
- Cadaveric spasm is seen only in a group of voluntary muscles
- First visible sign of putrefaction is: Greenish discoloration of skin over right iliac fossa
- Chief agent for bacterial putrefaction is *Clostridium welchi*
- Enzyme which has maximum role in putrefaction : Lecithinase
- Marbling is due to the staining of vessels by sulfhemoglobin
- First internal organ to putrefy is Larynx/trachea
- Correct sequence of putrefaction : Spleen – brain – heart – uterus
- Last organ to putrefy is bone.
- Honeycomb liver & Foamy liver are seen in putrefaction.
- Casper's dictum is related with: Rate of decomposition in different media. Fastest in air and slowest in soil.
- Adipocere common in warm moist climate, mummification common in dry hot climate.
- Dehydration/Shriveling of cadaver is called *mummification*
- Hydrolysis and hydrogenation of fats into fatty acids is adipocere.
- Mummified body is odorless and adipocere is inflammable and having rancid butter smell.
- Embalming a body within 6 hours - satisfactory result.
- Embalming produces a chemical stiffening similar to rigor mortis.
- Discontinuous injection and drainage is the best technique of injection of fluid.
- Ethanol is not a constituent of embalming fluid.
- If embalming is done prior to autopsy in poisoning cases, that amounts to destruction of the evidences (poisons) and liable to be punished under section 201 IPC.
- Color after embalming in Jaundice cases is Green.
- Maggots should be preserved in boiling absolute alcohol or hot 10% formalin
- Postmortem blisters contain gas.

IMAGE-BASED QUESTIONS

1. Which of the following is true regarding the change? **(Recent Question 2021)**

a. Seen in 24 hours
b. Due to Sulfhemoglobin
c. Due to non-bacterial cause
d. Due to asepsis

2. Mark correct option with regard to the condition and time of appearance? **(AIIMS Nov 2019)**

a. Algor mortis 2–4 hours
b. Rigor mortis 8–12 hours
c. Marbling 36–72 hours
d. Postmortem staining 6-8 hours

3. The green color is due to:

a. Reduced hemoglobin
b. Sulfhemoglobin
c. Oxyhemoglobin
d. Methemoglobin

4. Identify the phenomenon. **(INI-CET July 2020)**

a. Filigree burns
b. Marbling
c. Hypostasis
d. Poisoning

5. During autopsy, bloating of face, tongue with blisters noted. Identify the phenomenon. **(Recent Question 2020)**

a. Electrocution
b. Filigree burns
c. Scalds
d. Decomposition

6. Identify the image. **(AIIMS May 2019 & Nov 2018)**

a. Tattooing
b. Suggilation
c. Putrefaction
d. Decomposition

7. Which of the following is the true statement from the image given below? **(FMGE Dec 2021)**

a. A case of homicide
b. A case of suicide
c. Rigor mortis
d. Cadaveric spasm

8. Identify the nature of this finding

a. Antemortem
b. Postmortem
c. Both
d. Artificially induced

9. The time since death for this color change is:

a. 2–6 hrs
b. 12–18 hrs
c. 36–48 hrs
d. >48 hrs

10. In a dead body recovered from an open field, the below finding is seen. What could be the time since death?

a. 24–36 hrs
b. 3–5 days
c. 5–10 days
d. More than 2 weeks

11. The medicolegal importance of the below finding noted in the eye is:

a. To determine time since death
b. To determine cause of death
c. To determine antemortem poisoning
d. To determine position of the body

12. The chief gas that is formed during decomposition is:

a. H_2S
b. Methane
c. Ammonia
d. Ethane

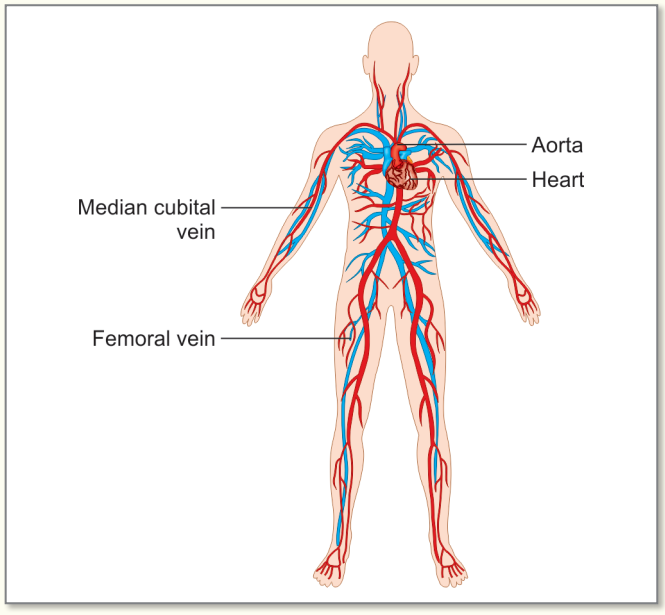
13. Which of the following is true statement(s) about exhumation?

a. Police can order for exhumation
b. Executive magistrate can order for exhumation
c. Postmortem cannot be done on exhumed body
d. Cr PC 176(4) is related to enquiry of exhumed body
e. CrPC 174 is related to enquiry of exhumed body

14. An image is given below. Identify the odor caused by it.
(FMGE Dec 2021)

a. Ammoniacal
b. Odorless
c. Foul
d. Rancid

15. Which is the ideal site to collect blood sample for toxicological analysis during autopsy?



a. Stomach
b. Femoral vein
c. Aorta
d. Heart
e. Cubital vein

ANSWERS WITH EXPLANATIONS TO IMAGE-BASED QUESTIONS

1. Ans. b. Due to sulfemogobin

2. Ans: c. marbling 36-72 hours

3. Ans. b. sulfhemoglobin

4. Ans b. Marbling

Review of Forensic Medicine and toxicology by Gautum biswas, 5th edition, Page no 163

The images show marbling – Greenish marbled appearance on the skin (Time since death - 36-72 hours)
The green color is due to the pigment sulfhemoglobin.

5. Ans. d. Decomposition

Ref: Essentials of Forensic Medicine & toxicology, KS Narayana Reddy, 33rd Edition, page 165

The image shows peeling of skin, greenish discoloration, blisters suggestive of decomposition

Electrocution	Crocodile skin appearance Joule burns
Lightning stroke	Filigree burns
Scalds	Burn from liquid above 60° C or steam
Putrefaction	• Change in tissue color (greenish black) • Evolution of gases • Liquefaction of tissues

6. Ans. b. Suggillation

Review of Forensic Medicine and toxicology by Gautam biswas, 5th edition, Page no 156

The picture showing the hypostasis over the back with contact pallor
Synonyms of livor mortis:
- Lividity
- Hypostasis
- Cadaveric lividity
- **Suggillation**[Q]
- Cogitation

7. Ans. b. A case of suicide

8. Ans. a. Antemortem

- The pictures showing the hand grasping the grass is cadaveric spasm.
- Cadaveric spasm is spasm of group of voluntary muscles, which were in intense contraction before death.

9. Ans. b. 12–18 hours

- The photograph shows the greenish discoloration of right iliac fossa; which is the earliest color change of decomposition.
- It is seen in 12-18 hours in summer and 1-2 days in winter.

10. Ans. b. 3–5 days

- Peeling of skin is a sign of decomposition.
- Skin slippage is noted on 2–3 days,
- Degloving and destocking type of peeling – 3-5 days.

11. Ans. a. To determine time since death

- The picture shows tache noir in eye.
- Tache noire is the triangle-shaped discoloration noted in sclera.
- Deposition of dust, producing yellow, brown color triangle.
- Time since death can be determined from tache noire – (3–4 hours)

12. Ans. a. H_2S

Gas formation in putrefaction
- Hydrogen sulfide (chief gas), CO_2, ammonia, methane, mercaptans.

13. Ans. b. Executive magistrate can order for exhumation; d. Cr PC 176(4) is related to enquiry of exhumed body

Exhumation:
- It is the *legal digging out* [Q]of an already buried body from the grave.

Authorization:
- Written order from the *First Class Magistrate*[Q]*/District Magistrate/Executive Magistrate under 176 Cr P* [Q]
- Police cannot order exhumation.

Time limit: In India, there is **no time limit**[Q] for ordering of the exhumation

14. Ans: b. Odorless

The image shows mummified body.
The mummified body is odorless.
Mummification is due to drying and dehydration of tissues.

15. Ans. b. Femoral vein

To avoid contamination from the gastric contents, blood is always collected from the peripheral vessels preferable femoral vein.

NEXT/CLINICAL CASE-BASED QUESTIONS

1 CBQ

A 45-year-old who had allegedly committed suicide by hanging in the hostel premises has been brought for autopsy. He was diagnosed to have HIV infection. The doctor conducts the medicolegal autopsy. Which of the following method of organ removal is preferred?

a. Organs are removed en masse
b. Organs are removed as block
c. Organs are removed one by one
d. In situ dissection combined with en bloc removal

2 CBQ

A 23-year-old woman has had a stillbirth. During the 24th week of pregnancy, she had experienced bleeding from the vagina associated with crampy abdominal pain. On examination, the obstetrician was unable to detect any fetal heart sounds. After delivery, the fetus was sent for autopsy to determine the cause of death. Which cavity is to be opened by the doctor first during the autopsy?

a. Head
b. Chest
c. Abdomen
d. Back

3 CBQ

In the investigation of the death of the 30-year-old actress, the forensic team was enquired about the possible time frame of the murder. The forensic team has an approximate time of death which they determine from various observations. All of the following can also be studied by the team to narrow the time frame of death, except?

a. Cadaveric spasm
b. Algor mortis
c. Rigor mortis
d. Livor mortis

4 CBQ

An 18-year-old man with H/o RTA/head injury, has been admitted in an hospital without relatives. Patient suffered coma due to brain stem death. Victim's relatives willing for organ donation. In brain stem death, no human organ shall be removed, unless such death is certified, by a board of medical experts consisting of all the following, except:

a. The Registered medical practitioner, in charge of the hospital in which brain-stem death has occurred.
b. Neurosurgeon nominated from the Panel of Names approved by the appropriate authority
c. An independent Medical Specialist nominated from the panel of Names not approved by the appropriate authority
d. Surgeon
e. None of the above.

5 CBQ

In a case of 30-year-old man, who was brought in for an autopsy, it appeared to be in rigor mortis. The doctor noticed the stiffening is present all over the body. This phenomenon of rigidity follows all of the following rules; except:

a. Shapiro
b. Nysten
c. Morrison
d. Rule of 12

6 CBQ

An unknown male body was recovered from a well in advanced decomposed state. During autopsy, vitreous humor is preserved. To determine time since death, Potassium, glucose, sodium and urea are analysed.

Assertion: PMI is best done by K level
Reasoning: K has got linear increase with increase in PMI

a. Both assertion and reasoning are correct
b. Both assertion and reasoning are incorrect
c. Assertion is correct but reasoning is incorrect
d. Reasoning is correct but assertion is incorrect

7 CBQ

A victim of RTA, has been brought for autopsy. Bluish discoloration seen in the dependent parts. It becomes pale on applying pressure. In incision test, blood gets washed away with water.

Assertion: PM interval is <12 hours
Reasoning: Blue color indicates the PMI <12 hours

a. Both assertion and reasoning are correct
b. Both assertion and reasoning are incorrect
c. Assertion is correct but reasoning is incorrect
d. Reasoning is correct but assertion is incorrect

8 CBQ

A girl was missing for a period of about two years. The accused persons admitted of committing the crime of sexual assault, strangulating and then burying the victim to evade detection at a later date. The accused identified the burial site. In this case, the exhumation is authorized under section:

a. 176 (2) CrPC
b. 176 (1A) CrPC
c. 176 (3) CrPC
d. 176 (5) CrPC

9 CBQ

A female was missing for a period of about two weeks. The husband (accused) admitted of committing the crime of murder by giving poison in food and then burying the victim to evade detection at a later date. Exhumation was ordered by the magistrate. All of the following samples are preserved during exhumation except:

a. Bones
b. Teeth
c. 100 gm of soil from above, below and in actual contact with the body
d. Liver

10 CBQ

A dead body with suspected poisoning is having hypostasis of red brown in color.

Statement 1: It is suggestive of poisoning due to cyanides
Statement 2: Red brown color hypostasis is due to oxyhemoglobin

a. Both statements are true
b. Both statements are false
c. Statement 1 is true but statement 2 is false
d. Statement 1 is false but statement 2 is true

ANSWERS TO NEXT/CLINICAL CASE-BASED QUESTIONS

1. Ans. d. In situ dissection combined with en bloc removal

2. Ans. c. Abdomen

3. Ans. a. Cadaveric spasm

4. Ans. c. An independent Medical Specialist nominated from the panel of Names not approved by the appropriate authority

5. Ans. c. Morrison

6. Ans. a. Both assertion and reasoning are correct

7. Ans. c. Assertion is correct but reasoning is incorrect.

8. Ans. c. 176 (3) Cr P C

176 Cr P C
1A. Where, any person dies or disappears, or rape is alleged to have been committed on any woman, while such person or woman is in the custody of the police or in any other custody, an inquiry shall be held by the Judicial Magistrate or the Metropolitan Magistrate.
2. The Magistrate shall record the evidence taken by him.
3. The magistrate can order for exhumation of a body, to discover the cause of death.

9. Ans. c. 100 gram of soil from above, below and in actual contact with the body.

The following viscera and materials are sent for chemical analysis:
- About 500 gm of soil from above, below and in actual contact with the body.
- Hairs from head and pubic region.
- Nails, teeth and bones.
- Viscera such as liver, stomach and intestines

10. Ans. b. Both statements are false.

MULTIPLE CHOICE QUESTIONS

1. Match the timeline of the following events after death: **(INI-CET July 2021)**

a.	Relaxation of sphincter	I.	5-10 days
b.	Marbling	II.	1-2 weeks
c.	Adipocere	III.	1-3 days
d.	Liquefaction	IV.	Within 24 hours

1. A II, B I, C IV, D 1
2. A III, B II, C I, D IV
3. A IV, B III , C II , D 1
4. A I , B IV , C III , D II

2. In a case of RTA, the dead body showed spasm of group of muscles immediately after death. In which of the following condition, primary relaxation is not seen? **(FMGE Dec 2020)**

a. Heat stiffening b. Cold stiffening
c. Cadaveric spasm d. Rigor mortis

3. Cherry red-colored PM lividity is associated with poisoning by **(FMGE June 2021)**

a. Hydrogen sulfide b. Hydrocyanic acid
c. Carbon monoxide d. Nitrites

4. Rigor mortis first seen in **(Recent Question 2019)**

a. Eyelids b. Heart
c. Limbs d. Neck

5. Which option is correct? **(AIIMS Nov 2019)**

a. Rockitansky – in situ b. Virchow – en masse
c. Ghon's – en bloc d. Letulle – one by one
a. a and c are correct b. a, b, c are correct
c. b and d correct d. a, b, c, d are correct

6. During cranial autopsy, facial incision is started at:

a. At occiput b. Behind the ear lobe
c. In front of the ear lobe d. At vertex

7. A patient died due to jaundice. What will be the color of corpse after embalming?

a. Grey b. Green
c. Yellow d. Brown

8. While performing embalming, difficulty encountered due to arterial system problem. How should the embalming fluid be introduced to overcome this problem?

a. Low pressure high flow b. Low pressure low flow
c. High pressure high flow d. High pressure low flow

9. Heat rigor occurs due to:

a. Coagulation of proteins
b. Heat hyperpyrexia
c. >65°C Burn
d. Heat stroke
e. Heat cramp

10. Which of the following is not used as a preservative in chemical analysis?

a. Glycerin b. Formalin
c. Rectified spirit d. Salt solution

11. Forensic entomology: **(Recent Question 2016)**

a. Study of insects b. Study of poisons
c. Study of death d. Study of snakes

12. Which of the following is NOT correct about postmortem changes?

a. Post- mortem lividity fixes at 6-8 hours
b. Rigor mortis occurs when ATPs decrease up to 85% of normal
c. Rigor mortis is delayed in cholera and strychnine poisoning
d. Cadaveric spasm is instantaneous at the time of death
e. Postmortem caloricity occurs after 5-6 hours of death

13. True about pugilistic attitude is?

a. Indicates only antemortem burn
b. Indicates only postmortem burn
c. Cannot differentiate between antemortem and postmortem burn
d. Occurs due to intense heat
e. Indicate defense by victim during antemortem death

14. All of the following is true about Kevorkian sign, except:

a. Persists even after 3 years of death
b. Appears within minutes of death
c. Visualized using ophthalmoscope
d. Cattle tracking sign

15. Tache noire: **(Recent Question 2016)**

a. Deposition of dust in sclera
b. Decrease in body temperature after death
c. Muscle stiffening after death
d. Staining after death

16. Postmortem caloricity is not seen in: **(Recent Question 2015)**

a. Strychnine poisoning
b. Typhoid
c. Organophosphorus poisoning
d. Septicemia

17. Which is the first organ to putrefy? **(Recent Question 2018)**

a. Brain b. Heart
c. Prostate d. Kidney

18. What is the smell of mummified body? **(Recent Question 2018)**

a. Odorless b. Putrid
c. Pungent d. Offensive

19. Adipocere occurs in: **(Recent Question 2016)**

a. Arsenic poison
b. Body lying in water
c. Body inside car locked doors
d. Inside shallow soil

20. Suitable environmental conditions for mummification: **(Recent Question 2016)**

a. Lying in water b. Inside shallow soil
c. Dry and hot air d. Under earth

21. Postmortem examination stomach incision done after: **(Recent Question 2018)**

a. Double ligation b. Single ligation
c. Cut open d. Triple ligation

ANSWERS WITH EXPLANATIONS

1. Ans. 3. (A IV , B III , C II , D 1)

[Ref: Essentials of Forensic medicine, Dr KS Narayana Reddy, 33th Edition, P: 137, 161]

- Primary flaccidity (relaxation of sphincters) - <24 hours
- Cadaveric spasm- immediately after death
- Marbling – 36- 72 hours
- Adipocere – 3 d – 3m
- Mummification – 3m- 12 m
- Liquefaction of tissues- 5-10 days
- Livor mortis – 30 minutes (onset) & 6-12 hours (max appearance)

2. Ans. c. Cadevric spasm

Review of Forensic Medicine and toxicology by Gautum Biswas, 5th edition, Page no 160

- The dead body showing spasm of group of muscles immediately after death, without primary relaxation.
- This is indicative of cadaveric spasm.

Rigor mortis – ATP depletion[Q]
Cadaveric spasm – unknown mechanism[Q]
Heat stiffening – Muscle protein coagulation[Q]
Cold stiffening – Solidification of fat[Q]

3. Ans. C. Carbon monoxide

[Ref: Reddy 30th/e p. 144]

- Cause of Death (Poisonings) can be determined by the color of PM staining.

Normal	:	Blue purplish
Carbon monoxide	:	Cherry red
Cyanide	:	Bright Red/Brick red[Q]
Hypothermia/Refrigeration	:	Pink
Nitrate/Potassium chlorate	:	Chocolate Brown
Septic abortion	:	Bronze
Hydrogen sulfide	:	Bluish Green
Aniline	:	Brown/deep blue

4. Ans. b. Heart

[Ref: Essentials of Forensic medicine, Dr KS narayana Reddy, 33th Edition, P: 161]

Nysten's rule:

- It first appears _in involuntary muscles; the myocardium becomes rigid in an hour.

Then it develops in eyelids, neck and lower jaw and passes upwards to the muscles of the face, and downwards to the muscles of the chest, upper limbs, abdomen and lower limbs and lastly in the fingers and toes

5. Ans. a. a and c are correct

[Ref: Reddy 30th/e p. 96–98] Refer theory discussion

Techniques of organ removal

- **Virchow:** Organ by organ (most common)
- **Lettule's:** En masse (Quicker; Anatomical relationships can be studied)
- **Ghon's:** En bloc
- **Rokitansky:** In situ dissection (preferred for infectious diseases)

6. Ans. b. Behind the ear lobe

[Ref: KSN Reddy, Essentials of Forensic Medicine & Toxicology, 33rd Ed., P. 116]

Scalp incision: A coronal incision is made in the scalp, which starts from the mastoid process just behind one ear.
It is carried over the vertex of the scalp to the back of the opposite ear (intermastoidal incision).
The scalp is reflected forward and backward.

7. Ans. b. Green

8. Ans. d. High pressure, Low flow

[Ref: earlier discussion]

In embalming of jaundice cases, the formaldehyde-based solutions convers the bilirubin in the body into biliverdin and the color changes into green.

9. Ans. a. Coagulation of proteins c. >65°C (refer earlier discussion)

10. Ans. b. Formalin

High Yield Data

[Ref: Parikh 6th/e p. 2.62; Sumit Seth's 2nd/e p. 158]

Preservatives used

Saturated solution of common salt	Rectified spirit	Rectified spirit contraindicated in	Sodium flouride is used in	Preservative not required in	Virological study
• **Most-commonly**[Q] used preservative • Easily available & cheap • All poisons except **corrosive acids**[Q]	• **Best-preservative**	• Alcohol[Q] • Kerosene[Q] • Chloral hydrate • Phosphorus • Formaldehyde & Formic acid[Q] • Paraldehyde & Acetic acid	• Blood • Vitreous • Poisonings like • *Alcohol* • *Cocaine*[Q] • *Co*[Q] • *Cyanide*[Q]	• *Hair* • *Bone*[Q] • *hair*[Q] • If the viscera analyzed in 24 hours • Refrigeration <4* C	• *50% sterile glycerine*

Note:

- **Vitreous humor is the preferred specimen**[Q] for confirmation of alcohol ingestion during autopsy.
- *Very useful in decomposing body.*
- Blood should *never* be collected from the pleural or the abdominal cavities to *avoid gastric contamination.*
- **Formalin is not used**[Q] **as preservative for chemical analysis because extraction of poison becomes difficult.**

Routine viscera preserved during autopsy

- Stomach and its contents
- Upper part of small intestine 30 cm length
- Liver (right lobe is preferred) 500 g
- Kidney (half of each kidney)
- Blood 10 mL & Urine 100 mL

Viscera preservation:

- Suspected poisoning deaths
- To rule of drug intoxication[Q]
- Cause of death could not be found after autopsy
- Advanced decomposition[Q]
- Any case, if requested by the magistrate

Special Organs has to be Sent for Specific Poisons

Viscera preserved	Poisonings
Heart	*Strychnine, digitalis*[Q]
Brain	Organophosphorus, opiates Carbon monoxide, cyanide, Barbiturates. Rabies (for Negri bodies)
Spinal cord	*Gelsemium, Strychnine*[Q]
CSF	*Alcohol*[Q]
Vitreous	Alcohol (particularly in decomposed bodies[Q])
Lungs	Gaseous poisons
Skin	*Injected poisons & firearm injuries*[Q]
Fatty tissues	*Pesticides*[Q]
Bile	Opiods[Q], benzodiazepine, Cocaine[Q] & heavy metals
Spleen culture	*Septicemia cases*[Q]

11. Ans. a. Study of insects

[Ref: Reddy 30th/e p. 121]

Thanatology[Q]	Death & its aspects
Taphonomy	Decomposition of human remains
Anthropometry	Study of the measurements and proportions of the human body
Dactylography[Q]	***Finger prints***
Cheiloscopy[Q]	***Lip prints***
Poroscopy[Q]	***Sweat pores***[Q] ***in between fingerprint ridges***
Rugoscopy[Q]	***Palatal rugae***[Q] ***of hard palate***[Q]
Odontology[Q]	Dentition pattern & bite marks
Podography[Q]	Foot prints
Calligraphy	Hand writing
Medical etiquette	Level of courtesy between medical colleagues
Medical ethics	Moral principles guiding the doctors
Ecotoxicology	**Poisons in relation to environment**
Toxicology	Poisons and its effects
Toxinology	Toxins and its effects
Herpetology	Reptiles
Ophiology[Q]	**Snakes**
Entomology[Q]	Insects

12. Ans. c. Rigor mortis is delayed in cholera and strychnine poisoning; d. Cadaveric spasm is instantaneous at the time of death

13. Ans. c. Cannot differentiate between antemortem & postmortem burn; d. Occurs due to intense heat

14. Ans. a. Persists even after 3 years

[Ref: Review of Forensic Medicine and toxicology by Gautam Biswas, Page no138]

Kevorkian sign/Cattle trucking[q] sign:

- It is the earliest change in eye[Q] after death.
- It appears with in few seconds to minutes after death and persists for an hour.

15. Ans. a. Deposition of dust in sclera

[Ref: Parikh 6th/e p. 3.10]

Tache noire Sclerotica:

- If the eyelids are open, *deposition of dust in sclera*[Q] produces *two yellow triangles*[Q], which change to brown & black
- Time since death: 3–4 hours[Q]

16. Ans. c. Organophosphorus poisoning

[Ref: Reddy 30th/e p. 139, 140; SK Singhal 4th/e p. 92]

- The most logical answer could be organophosphorus poisoning.
- PM Caloricity is seen in conditions where heat is produced inside the body (endogenous heat production).

Mechanisms of postmortem caloricity

- Disturbed heat regulation in the body – heat stroke, pontine hemorrhage
- Increased bacterial activity in the body - septicemia
- Increased heat production by muscle contraction – tetanus, strychnine poisoning

Postmortem caloricity is not seen in burns[Q] (**burns is exogenous heat**; not endogenous heat)

17. Ans. a. Brain

- Larynx is the *earliest organ*[Q] to putrefy.
- *Nulliparous uterus*[Q] *is the last organ*[Q] to putrefy, gravid uterus and the uterus soon after delivery putrefies rapidly
- In males, Prostate[Q] is the last organ to putrefy

Larynx & trachea → Stomach, intestines & Spleen → Liver (foamy liver) lings → Brain → Heart → Kidneys, bladder → Prostate, uterus → Skin, muscle, tendon → Bones

18. Ans. a. Odorless

19. Ans. b. Body lying in water

20. Ans. c. Dry & hot air

[Ref: KSN Reddy, Essentials of Forensic Medicine & Toxicology, 33rd Ed., P. 172]

- **Mummification is dehydration or drying of body[Q].**
- Absence of moisture[Q], hot air[Q], dry sandy soil[Q], arsenic, antimony[Q] favor mummification.
- **Warm, moist climate, Clostridium (lecithinase) & Intrinsic lipase favor adipocere**

21. Ans. a. double ligation