

Non-Metallic Fertilants:

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- i) Phosphorus
- ii) Mechanical Fertilants
- iii) Iodine
- iv) Chlorine

Phosphorus:

Allotropes: 4

- i) **White:** with impurities \Rightarrow yellow ($P_4 \rightarrow$ tetramer)
- ii) **Red:** formed by heating white phosphorus to $250^\circ C$ in vacuum
- iii) **Violet:** formed by dissolving white phosphorus in molten lead
- iv) **Black:** formed by heating white phosphorus at 12,000 atm.

gaseous phosphorus = P_4

Features	White Phosphorus	Red phosphorus
Colour	White (yellow when impure)	Reddish brown
Appearance	Translucent, waxy paste	Amorphous, solid mass
Smell & taste	Garlic-like	Odorless & tasteless
Luminosity	Luminesces in the dark (poisoning results in luminescent vomit & stools)	Non-luminous
Exposure to air	Pyrophoric (self-igniting); ignites spontaneously at $34^\circ C$ (must be kept under water)	Does not ignite spontaneously
Use	Rat baits, fireworks, fertilizers	On the sides of modern match boxes (along with powdered glass)
Toxicity	Highly toxic	Non-toxic

Mechanism of Action:

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- i) Uncoupling of oxidative phosphorylation in hepatocytes
- ii) Decreases ATP levels in hepatocytes
- iii) Decreases transformation of triglycerides into β -lipoproteins \rightarrow rapid rise in hepatic triglycerides \rightarrow Massive hepatic steatosis (hallmark of white phosphorus toxicity)

- iv) Hepatic necrosis in zone 1 (around portal tracts where oxygenation is good)
[ccl₄ & acetaminophen produce zone 3 necrosis \Rightarrow around central veins where oxygenation is poor]

Symptoms & Signs:

- A) Local application: highly toxic to skin (\because P is an oxidizing agent)
 - \rightarrow thermal & chemical burns (2nd & 3rd degree Dupuytren burns)
 - \rightarrow yellowish discolouration of skin & mucus membrane

(P has to be neutralized immediately since P continues to oxidize & injure tissues)

B) Ingestion:

- i) Acute fulminant poisoning: when victim takes more than 1g
 - \rightarrow vomiting, diarrhea
 - \rightarrow peripheral vascular collapse
 - \rightarrow death within 12 hours

- ii) Subacute poisoning: when victim takes fatal or near fatal dose

* First Stage (2 days):

- \rightarrow severe burning pain in the mouth & abdominal pain
- \rightarrow vomiting, diarrhea
- \rightarrow garlicy odour
- \rightarrow luminous vomit & stools
- \rightarrow fumes emanate from the stools (\because P in stools combines with atmospheric oxygen to form phosphorus pentoxide)
 \Rightarrow Smoking / Smoky Stool Syndrome.

* Second stage [4 days]: Patient is symptom free (but should not be discharged)
[similar to lucid interval]

* Third stage [2 days]:

→ Hepatic toxicity develops:

- musty odour of breath (*foetus hepaticus*)
- flapping tremor of hands (*astereoxis*)
- hepatomegaly, jaundice, bleeding tendency, pruritis
- finally, hepatic encephalopathy & death

→ Prolongation of QTc interval, ST-T wave abnormalities

→ If death does not occur in 8 days, patient goes on to recover.

iii) Chronic Poisoning: seen in workers working with white phosphorus.

* Signs & symptoms: unusual mandibular osteonecrosis ⇒ **Phossy Jaw / Lucifer's jaw / glass jaw.**

* Preventive measures: Mandibular necrosis starts with toothache
∴ employ regular dental checkups.

Fatal Dose: 1 mg/kg

Fatal Period: ½ day - 8 days (no fatalities reported after 8 days)

Management:

i) Protection of healthcare personnel: wear gloves & other protecting equipment

ii) Supportive care:

→ continuous cardiac monitoring

→ fluid resuscitation

→ vitamin K by IV drip (to treat hypoprothrombinemia)

→ PT, PTT, hepatic enzymes, serum electrolytes, serum phosphate, serum calcium should be measured.

→ Whole blood / fresh frozen plasma (to correct coagulation defects)

→ evaluation of renal function & renal output.

→ Ophthalmic irrigation (if P has entered the eye)

iii) Skin decontamination: continuous irrigation with water or saline

→ application of silver nitrate on skin (prevents ignition by depositing a thin film of silver over phosphorus particles)

→ application of $CuSO_4$

- helps in identifying occult phosphorus particles by causing a characteristic black colour change

- neutralizes P (by formation of cupric phosphide)

→ identification of phosphorus particles by Wood's lamp (blue fluorescence)

iv) GIT decontamination:

→ Gastric lavage with 1:5000 $KMnO_4$.

→ Activated charcoal

→ Whole bowel irrigation with polyethylene glycol (decreases the absorption of phosphorus)

v) Other measures:

→ N-acetylcysteine (primarily an antidote for paracetamol)

→ Ubiquinone, cysteine, sulfate \Rightarrow decrease liver damage

→ Exchange transfusion

→ Liver transplantation.

PM Appearance:

→ Bleeding points in skin (bleeding diathesis)

→ Stomach contents \Rightarrow garlicy odour

→ luminous material in stomach & intestine (blue fluorescence in Wood's lamp)

→ erosions & haemorrhages in esophagus & stomach.

- Heart: subendothelial petechial haemorrhages
- Liver: fatty, enlarged, yellow.
- Petechial haemorrhages in all internal organs
- Individuals who survive for a week or so, show \Rightarrow acute yellow atrophy

Viscera Analysis:

- Stomach & intestines: tied at both ends; viscera must be opened under nitrogen just before analysis.
- Other viscera: preserve in saturated saline.
- Collect feces from rectum.

MLI:

- Long retention in organs after death: can be detected even in exhumed bodies
- Homicide: luminescence & strong garlicy odour \therefore very rarely used
- Suicide: deliberate ingestion of rat paste
- Accident: inadvertent ingestion of rat paste.

Iodine: (normal iodide content of blood = 2-5 mg/dL)

- bluish-black, soft & scaly crystals with a metallic lustre & unpleasant taste.
- gives off violet vapour at all temperatures with a characteristic odour.

Mechanism of Action:

- protoplasmic poison fixing protein & causing necrosis
- vapours irritate respiratory passages

Signs & Symptoms:

- Inhalation: glottic & pulmonary edema
- Ingestion of solid: it acts as an acid corrosive poison
 - burning pain from mouth to stomach
 - intense thirst
 - salivation
 - purging
 - cramps
 - fainting
 - vomiting
 - giddiness
 - convulsive movements of limbs
- lips & angles of mouth are stained brown
- vomitite & excreta \Rightarrow dark-yellow/blue, contain blood & have peculiar odour of iodine
- urine is scanty/suppressed, red-brown colour, contains albumin
- metabolic acidosis, nephritis & renal failure
- pulse is slow & weak
- skin is cold & clammy

Fatal Dose: 2-4 g (30-60 mL of tincture)

Fatal Period: 24 hours

Treatment:

- evacuate stomach with emetics or wash it out with warm water containing soluble starch & albumin.
- 1-5% solution of Sodium thiosulphate converts harmful tincture iodine to harmless iodide
- Sodium chloride (NaCl) will promote excretion of iodide ($\because \text{Cl}^-$ competes with I^- at level of tubules)
- Give alkalis, arrow root & barley water & treat symptomatically
- Activated charcoal binds iodine.
- Skin lesions can be treated with 20% alcohol.

PM Appearance:

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- Mucosa of stomach & intestine: Inflamed, excoriated
- Heart, liver, Kidney: fatty degeneration
- Brain: oedema

Chronic Poisoning: Sodium

- pain over frontal sinus
- running nose
- conjunctivitis
- bronchial catarrh
- parotid swelling
- wasting of breasts, testes
- salivation
- nausea, vomiting, purging
- emaciation
- lymphadenopathy
- acne / erythematous patches on the skin

Chlorine:

- greenish-yellow gas with unpleasant irritating odour
- oxidizing agent ∴ causes destruction of organic tissues
- found in laboratories, bleaching powder factories

Signs & Symptoms:

- Inhalation causes irritant & suffocative effect

Acute poisoning:

- intense irritation of eyes & throat
- violent coughing
- spasm of glottis
- extreme dyspnoea
- nausea, vomiting
- death due to cardiac failure following inflammatory oedema of lungs & pulmonary congestion

Chronic inhalation:

- anemia
- cachexia
- dental caries
- progressive wasting

Fatal dose: Exposure to 1 in 1000 parts may prove fatal within 5 minutes

Fatal period: within 2 days

Treatment:

- remove from poisonous atmosphere
- treat shock, circulatory collapse, pulmonary oedema

PM appearance: (mainly asphyxial signs)

- inflammation of respiratory tract
- Pulmonary oedema
- Rupture of alveolar walls
- Haemorrhage & thrombosis in lung beds
- Increased viscosity of blood

Mechanical Irritants:

- i) Powdered glass
- ii) Diamond powder
- iii) Needles, nails

Powdered glass:

Symptoms:

- sharp burning pain in throat, stomach & intestine
- nausea, vomiting
- constipation > diarrhoea
- death from shock (if stomach is perforated)

Treatment:

- bulky food
- emetics
- purgatives

PM appearance:

- erosion from mouth to upper part of small intestine
- mucosa of stomach is covered with sticky mucus
- glass particles may be found in stomach & intestine
- Mucosa of GIT is congested & inflamed.

MLI:

- rarely used for suicide or homicide
- occasionally used as cattle poison.