BP106T · B.PHARM THEORY

BP106T Pharmaceutical Inorganic and Analytical Chemistry

Unit V — Expectorants, Emetics, Haematinics, Poison and Antidote

Pills & Python Notes

From-zero teaching standard: every technical term is defined before use.

Syllabus coverage: Unit V (6 hours).

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CHAPTER 16: EXPECTORANTS AND EMETICS

Unit V · ~2 hours

16.1 Introduction

A cough that brings up thick, sticky mucus is miserable — and a medicine that helps the body *throw up* a swallowed poison can save a life. Both jobs are done by inorganic drugs in this chapter. **Expectorants** help clear mucus from the airways; **emetics** induce vomiting. Four syllabus drugs — potassium iodide, ammonium chloride (expectorants), copper sulphate, sodium potassium tartrate (emetics) — each get the full monograph treatment: formula, preparation, properties, assay principle, and uses.

Learning objectives — after studying this chapter, you should be able to:

- define expectorant and emetic in scientific and simple terms;
- explain how expectorants work (the gastric-reflex mechanism) in simple words;
- give the formula, preparation principle, properties, assay principle, and uses of potassium iodide and ammonium chloride;
- give the formula, preparation principle, properties, assay principle, and uses of copper sulphate and sodium potassium tartrate;
- distinguish expectorants from emetics and from antitussives.

16.2 Definition

Expectorant — scientific: a drug that promotes the expulsion of sputum (mucus/phlegm) from the respiratory tract, usually by increasing bronchial secretions and making mucus thinner and easier to cough out. **Expectorant — simple:** a medicine that loosens the sticky phlegm in your chest so coughing can push it out.

Sputum = the mucus coughed up from the lungs and airways. **Mucus** = the slimy protective secretion lining the airways.

Emetic — scientific: a drug that induces vomiting by irritating the stomach lining (local action) or by stimulating the vomiting centre in the brain. **Emetic — simple:** a medicine that makes you vomit — used to empty the stomach, classically after swallowing certain poisons.

Antitussive (for contrast): a drug that *suppresses* the cough reflex itself (e.g., codeine) — the opposite strategy to an expectorant.

16.3 Key Terminology

Term	Meaning
Sputum/phlegm	Mucus expelled from the respiratory tract by coughing
Bronchial secretion	Fluid produced by glands lining the bronchi (air tubes)
Gastric reflex mechanism	Stomach irritation sends nerve signals that reflexly increase bronchial secretions — how many expectorants work
Vomiting centre	The area in the brainstem (medulla) that coordinates vomiting
Demulcent	A soothing agent that coats irritated surfaces (relevant in poisoning first aid, Chapter 18)

16.4 Detailed Explanation

16.4.1 How expectorants work

Most inorganic expectorants (KI, NH_4Cl) work by the **gastric reflex route**: they mildly irritate the stomach lining → nerve impulses travel to the brain → a reflex signal increases secretion from the **bronchial glands** → more, thinner fluid in the airways → the thick mucus is diluted and coughed out more easily. They do not "dissolve" phlegm directly; they help the body wash it out.

16.4.2 Monograph 1 — Potassium Iodide (KI)

Item	Details
Formula	KI
Preparation (principle)	Prepared by neutralising hydriodic acid (or an iodine-containing solution) with potassium hydroxide or potassium carbonate, then evaporating and crystallising. In essence: an acid–base neutralisation yielding the potassium salt, purified by crystallisation.
Properties	Colourless, cubic crystals or white powder; very soluble in water; saline-bitter taste; solutions slowly turn yellow on standing (liberation of traces of iodine on exposure to air and light — store in well-closed, light-resistant containers).
Assay (principle)	**Redox (iodometric) titration.** The iodide is oxidised to iodine under acidic conditions, and the liberated iodine is titrated against standard sodium thiosulphate using starch as indicator. The volume of thiosulphate consumed is proportional to the KI content.
Uses	Expectorant in cough mixtures (increases bronchial secretion via the gastric reflex); also used in thyroid-related preparations and as a reagent.

Exam Pearl: KI solutions turning yellow on storage = slow liberation of iodine. This is why the assay is iodometric — it measures the iodide that can release iodine.

16.4.3 Monograph 2 — Ammonium Chloride (NH_4Cl)

Item	Details
Formula	NH_4Cl (also called sal ammoniac)
Preparation (principle)	Direct neutralisation: ammonia gas (or ammonium hydroxide) + hydrochloric acid → $NH_4Cl + H_2O$. Industrially it is also obtained as a by-product of the ammonia–soda (Solvay) process. Purified by sublimation or crystallisation.
Properties	Colourless crystals or white powder; cooling, saline taste; freely soluble in water; on heating it sublimes (solid → vapour directly); aqueous solution is slightly acidic (ammonium ion hydrolyses: $NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$).
Assay (principle)	**Formaldehyde (formol) titration.** Formaldehyde reacts with the ammonium ion, liberating an equivalent amount of acid; this liberated acid is titrated with standard sodium hydroxide. The NaOH volume gives the NH_4Cl content.
Uses	Expectorant in cough mixtures (gastric-reflex stimulation of bronchial secretion); also used as a urinary/systemic acidifier in some formulations.

Exam Pearl: The formol titration is the signature assay of ammonium salts — formaldehyde "locks up" NH_4^+ and frees H^+, which you then titrate. If an exam asks "assay of ammonium chloride", answer: *formaldehyde method*.

16.4.4 Monograph 3 — Copper Sulphate ($CuSO_4 \cdot 5H_2O$)

Item	Details
Formula	$CuSO_4 \cdot 5H_2O$ (pentahydrate; "blue vitriol" / "neela thotha")
Preparation (principle)	Copper metal (or copper oxide) dissolved in hot concentrated sulphuric acid, then crystallised: $Cu + 2H_2SO_4 \rightarrow CuSO_4 + SO_2\uparrow + 2H_2O$. The blue pentahydrate crystals separate on cooling.
Properties	Deep blue triclinic crystals; effloresces slightly in dry air (loses water); soluble in water giving an acidic blue solution; strong metallic, astringent taste; **poisonous in larger amounts** (copper poisoning — links to Chapter 18).
Assay (principle)	**Iodometric titration.** In acidic solution, Cu^{2+} oxidises added potassium iodide, liberating iodine ($2Cu^{2+} + 4I^- \rightarrow 2CuI\downarrow + I_2$); the liberated iodine is titrated with standard sodium thiosulphate (starch indicator). Thiosulphate volume ∝ copper content.
Uses	Emetic (gastric irritation induces vomiting — historically used to empty the stomach in certain poisonings); astringent; also used as a fungicide in agriculture. Because of toxicity, its emetic use is limited and supervised.

Exam Pearl: Copper sulphate assay = iodometry, the same family as the KI assay — both end with "liberated iodine titrated against thiosulphate." Learn one pattern, apply twice.

16.4.5 Monograph 4 — Sodium Potassium Tartrate (Rochelle Salt)

Item	Details
Formula	$KNaC_4H_4O_6 \cdot 4H_2O$ (potassium sodium tartrate tetrahydrate)
Preparation (principle)	Prepared by neutralising potassium hydrogen tartrate ("cream of tartar") with sodium carbonate solution, then crystallising: the carbonate neutralises the acidic tartrate, giving the mixed sodium–potassium salt.
Properties	Colourless, transparent crystals; mild saline taste; very soluble in water; effloresces in dry air; aqueous solution is slightly alkaline.
Assay (principle)	**Acid–base titration.** The tartrate is a salt of a weak organic acid; it is assayed by titration with a standard acid (or by the pharmacopoeial non-aqueous/complexometric procedure) — at principle level: neutralisation titration with a suitable indicator, volume of titrant ∝ tartrate content.
Uses	Listed in the syllabus under **emetics** — in adequate doses it irritates the stomach and causes vomiting; it is also widely used as a mild **saline purgative** (draws water into the bowel) and as a stabiliser/complexing agent (Fehling's solution) in analytical chemistry.

Exam Pearl: Rochelle salt wears three hats — emetic (syllabus), saline purgative, and the complexing agent in Fehling's solution. If asked "which tartrate is in Fehling's?", it is this one.

16.4.6 Expectorants vs emetics — comparison

Feature	Expectorants (KI, NH_4Cl)	Emetics ($CuSO_4$, Rochelle salt)
Target	Airways (bronchial glands)	Stomach → vomiting centre
Purpose	Clear mucus by coughing	Empty the stomach
Mechanism	Gastric-reflex ↑ bronchial secretion	Gastric irritation → vomiting
Typical formulation	Cough syrups/mixtures	Single emergency use, supervised

16.5 Easy Analogy

An expectorant is like **pouring water on dried mud on a floor** — the mud (phlegm) loosens and can be swept (coughed) out. An emetic is like the **fire alarm that triggers the sprinklers** — an emergency response that empties the building (stomach) fast.

16.6 Diagram — Gastric Reflex Pathway of Expectorants

> KI / NH_4Cl swallowed
> ↓
> Mild irritation of stomach lining
> ↓
> Sensory nerve signals → brainstem
> ↓
> Reflex signal → bronchial glands
> ↓
> ↑ Thin bronchial secretion dilutes thick mucus
> ↓
> Easier coughing → sputum expelled

> **AI Image Prompt:** "Simple pharmacy textbook flowchart diagram on white background showing the expectorant reflex pathway: stomach icon with mild irritation waves, nerve signal arrows to a brainstem icon, return arrow to lung/bronchi icon with droplets, then an arrow to expelled sputum, clean flat medical illustration style, labelled steps 1 to 5."

16.7 Flowchart — Choosing the Assay

> Which drug?
> ├─ KI → Iodometric: oxidise I^- to I_2, titrate with $Na_2S_2O_3$ (starch)
> ├─ NH_4Cl → Formol titration: add formaldehyde, titrate freed H^+ with NaOH
> ├─ $CuSO_4$ → Iodometric: Cu^{2+} liberates I_2 from KI, titrate with $Na_2S_2O_3$
> └─ Rochelle salt → Acid–base neutralisation titration

16.8 Examples

- **KI in cough mixtures** — the classic inorganic expectorant still found in traditional cough preparations.
- **NH_4Cl expectorant mixtures** — combined with other ingredients in pharmacy-compounded cough syrups.
- **$CuSO_4$ as emetic** — textbook example of a metallic-salt emetic; also the blue crystals used in school labs.
- **Rochelle salt in Fehling's solution** — the same salt you meet in qualitative organic analysis keeps cupric ions in solution.

16.9 Pharmacy Relevance

A pharmacist dispensing cough preparations should know **why** an expectorant is chosen (productive, mucus-laden cough) versus an antitussive (dry, irritating cough) — the wrong choice worsens the patient's condition. For emetics, the pharmacist must know they are **emergency, supervised** drugs, never for routine use, and never for corrosive poisonings (see Chapter 18).

16.10 Important Points to Remember

1. **Remember:** Expectorant = helps expel sputum; Emetic = induces vomiting.
2. **Exam Pearl:** KI and NH_4Cl work by the **gastric reflex** — stomach irritation → reflex ↑ bronchial secretion.
3. **Exam Pearl:** KI assay = iodometric (thiosulphate, starch). NH_4Cl assay = **formaldehyde (formol) titration** with NaOH.
4. **Exam Pearl:** $CuSO_4$ assay = iodometric (Cu^{2+} liberates I_2 from KI → titrate with thiosulphate).
5. Rochelle salt = $KNaC_4H_4O_6{\cdot}4H_2O$ — emetic, saline purgative, and Fehling's complexing agent.
6. $CuSO_4$ is poisonous in larger doses — emetic use is supervised.
7. Do not confuse expectorant (clears mucus) with antitussive (suppresses cough).

16.11 Common Confusions & Common Mistakes

Do not confuse: Expectorant ≠ antitussive (one promotes coughing out mucus; the other suppresses cough) · **Emetic ≠ purgative** (vomiting vs bowel evacuation — though Rochelle salt can do both, the syllabus classes it as an emetic) · **Formol titration ≠ iodometry** (formaldehyde method is for NH_4^+; iodometry is for I^-/Cu^{2+}). **Mistakes:** writing the KI assay as acid–base (it is redox); forgetting starch indicator in iodometric titrations; giving the formula of Rochelle salt without the $4H_2O$.

16.12 Memory Tricks

- "**K**I **K**oughs it out" — KI = expectorant (K for potassium, K for "kough"/cough).
- "**F**ormol for **F**ormula NH_4^+" — ammonium assay uses **f**ormaldehyde.
- "**C**opper **C**auses **C**hucking (vomiting)" — $CuSO_4$ = emetic.

16.13 Exam-Oriented Summary

Expectorants (KI, NH_4Cl) clear sputum via the gastric-reflex increase in bronchial secretion. KI: formula KI, iodometric assay. NH_4Cl: sal ammoniac, neutralisation preparation, formol titration assay. Emetics induce vomiting: $CuSO_4{\cdot}5H_2O$ (blue vitriol, Cu + hot H_2SO_4 preparation, iodometric assay, toxic in excess) and Rochelle salt $KNaC_4H_4O_6{\cdot}4H_2O$ (from cream of tartar + Na_2CO_3, acid–base assay; also saline purgative and Fehling's component).

One-Minute Revision: Expectorant = expels sputum (gastric reflex). KI: iodometric assay. NH_4Cl: formol titration. Emetic = induces vomiting. $CuSO_4{\cdot}5H_2O$: iodometric assay, toxic. Rochelle salt: $KNaC_4H_4O_6{\cdot}4H_2O$ — emetic + purgative + Fehling's.

16.14 Questions

Very Short Answer: 1. Define expectorant (scientific + simple). 2. Define emetic. 3. Give the formula of Rochelle salt. 4. What is the gastric reflex mechanism? 5. Distinguish expectorant from antitussive.

Short Answer: 1. Explain the gastric-reflex mechanism of expectorant action with a flow diagram. 2. Describe the preparation and assay principle of ammonium chloride. 3. Why is copper sulphate's emetic use supervised? 4. List the three roles of sodium potassium tartrate.

Long Answer: 1. Give the formula, preparation, properties, assay principle, and uses of (a) potassium iodide and (b) copper sulphate. 2. Write monographs (formula, preparation, properties, assay, uses) of ammonium chloride and sodium potassium tartrate.

MCQs

1. The assay of ammonium chloride is based on: (a) iodometry (b) formaldehyde (formol) titration (c) complexometry (d) gravimetry — **Ans: (b)**. Formaldehyde liberates H^+ from NH_4^+, titrated with NaOH.
2. Potassium iodide is assayed by: (a) acid–base titration (b) iodometric titration with thiosulphate (c) argentometry (d) non-aqueous titration — **Ans: (b)**.
3. In the assay of copper sulphate, iodine is liberated by the reaction of Cu^{2+} with: (a) NaOH (b) KI (c) starch (d) formaldehyde — **Ans: (b)**. Cu^{2+} oxidises I^- to I_2.
4. Rochelle salt is: (a) $NaKC_4H_4O_6{\cdot}4H_2O$ (b) $KNaC_4H_4O_6{\cdot}4H_2O$ (c) $Na_2C_4H_4O_6$ (d) $K_2C_4H_4O_6$ — **Ans: (b)**. Potassium sodium tartrate tetrahydrate.
5. Which statement is correct? (a) Expectorants suppress the cough reflex (b) Emetics are used routinely for indigestion (c) KI increases bronchial secretion via gastric reflex (d) Antitussives help expel sputum — **Ans: (c)**. (a) and (d) describe antitussives backwards; (b) emetics are emergency, supervised drugs.

Viva: Why do KI solutions turn yellow on storage? What happens when ammonium chloride is heated?
Application-based: A patient with a dry, irritating cough is given an expectorant cough syrup. Is this appropriate? *(Ans: No — expectorants suit productive, mucus-laden coughs; a dry cough calls for an antitussive/demulcent. The expectorant adds secretion without mucus to clear.)* A student proposes assaying KI by acid–base titration. What is wrong? *(Ans: KI is the salt of a strong acid and strong base — no neutralisation reaction to titrate; its assay is redox/iodometric.)*

CHAPTER 17: HAEMATINICS

Unit V · ~2 hours

17.1 Introduction

Feeling tired all the time, looking pale, getting breathless on stairs — these are the classic signs of **anaemia**, and one of its commonest causes is iron deficiency. **Haematinics** are the drugs that correct this: iron-containing medicines that help the body make more haemoglobin. This chapter covers two syllabus haematinics — ferrous sulphate and ferrous gluconate — and the crucial reason pharmacists must know **ferrous (Fe^{2+}) from ferric (Fe^{3+})**.

Learning objectives — after studying this chapter, you should be able to:

- define haematinic, anaemia, and haemoglobin in simple words;
- explain why iron is needed for haemoglobin formation;
- explain why ferrous (Fe^{2+}) iron is preferred over ferric (Fe^{3+});
- give the formula, preparation, properties, assay principle, and uses of ferrous sulphate and ferrous gluconate;
- counsel a patient on iron therapy (what to expect, what to avoid).

17.2 Definition

Haematinic — scientific: a drug that increases the formation of haemoglobin and red blood cells, used in the treatment of anaemia. **Haematinic — simple:** an iron medicine that helps your blood make more of its red oxygen-carrying pigment.

Anaemia — scientific: a condition in which the haemoglobin concentration (or red-cell count) falls below normal, reducing the blood's oxygen-carrying capacity. **Anaemia — simple:** "thin blood" — too little haemoglobin, so the body gets too little oxygen; causes tiredness and paleness.

Haemoglobin — scientific: the iron-containing protein in red blood cells that binds and transports oxygen. **Haemoglobin — simple:** the red pigment in blood that picks up oxygen in the lungs and delivers it to the body. Each haemoglobin molecule carries **four iron atoms** at the heart of four haem groups.

17.3 Key Terminology

Term	Meaning
Ferrous (Fe^{2+})	Iron in the +2 oxidation state — the form absorbed by the gut
Ferric (Fe^{3+})	Iron in the +3 oxidation state — must be reduced to Fe^{2+} before absorption
Oxidation state	The charge an atom carries in a compound (Fe^{2+} vs Fe^{3+})
Redox titration	A titration based on oxidation–reduction (electron transfer)
Elemental iron	The actual mass of iron in a salt — what matters therapeutically (different salts contain different % iron)

17.4 Detailed Explanation

17.4.1 Why iron, and why ferrous?

The body cannot make haemoglobin without iron — iron sits at the centre of the haem group that binds oxygen. Dietary or blood-loss deficiency → less haem → less haemoglobin → **iron-deficiency anaemia**. Iron medicines (haematinics) refill the body's iron stores so haemoglobin production restarts.

Ferrous vs ferric — the key point: the intestine absorbs iron mainly as **Fe^{2+} (ferrous)**. Ferric (Fe^{3+}) iron must first be reduced to ferrous in the gut before absorption, so ferrous salts are **better absorbed and therefore preferred** in therapy. This is why both syllabus haematinics are ferrous salts — and why their assays are redox titrations that measure Fe^{2+}.

17.4.2 Monograph 1 — Ferrous Sulphate ($FeSO_4 \cdot 7H_2O$)

Item	Details
Formula	$FeSO_4 \cdot 7H_2O$ (heptahydrate; "green vitriol" / "hara kashish")
Preparation (principle)	Iron metal dissolved in dilute sulphuric acid: $Fe + H_2SO_4 \rightarrow FeSO_4 + H_2\uparrow$. The pale-green heptahydrate crystallises on evaporation. (Excess iron ensures no ferric salt forms.)
Properties	Pale bluish-green crystals; astringent, metallic taste; freely soluble in water; **oxidises in moist air** — the surface turns brownish as Fe^{2+} becomes Fe^{3+} (basic ferric sulphate coating); aqueous solution is acidic. Must be stored in well-closed containers.
Assay (principle)	**Redox titration.** Fe^{2+} is oxidised to Fe^{3+} by a standard oxidising agent (pharmacopoeial procedures use ceric sulphate or potassium permanganate). The volume of oxidant consumed is directly proportional to the ferrous iron content. Because only Fe^{2+} reacts, the assay truly measures the therapeutically useful form.
Uses	The most widely used oral haematinic for **iron-deficiency anaemia**; also used in the preparation of other iron salts.

Exam Pearl: Ferrous sulphate turning brown on storage = oxidation of Fe^{2+} to Fe^{3+}. The redox assay is elegant because it measures *only* the ferrous form — exactly what therapy needs.

17.4.3 Monograph 2 — Ferrous Gluconate

Item	Details
Formula	Commonly written as $C_{12}H_{22}FeO_{14} \cdot 2H_2O$ (ferrous dihydrate salt of gluconic acid)
Preparation (principle)	Prepared by reacting a ferrous salt (or freshly prepared ferrous carbonate) with **gluconic acid**, then crystallising. In essence: the organic acid gluconic acid neutralised with a ferrous base gives the ferrous salt.
Properties	Yellowish-grey or pale greenish-yellow powder; slight caramel-like odour; soluble in water; **less irritating to the stomach** than ferrous sulphate (the gluconate is an organic-acid salt, gentler on the gastric lining); also oxidises slowly on exposure to air.
Assay (principle)	**Redox titration** — same principle as ferrous sulphate: Fe^{2+} oxidised to Fe^{3+} by a standard oxidant (ceric sulphate), volume of titrant ∝ ferrous content.
Uses	Oral haematinic for iron-deficiency anaemia, **preferred when ferrous sulphate causes too much gastric irritation** (nausea, cramps) — the same iron, kinder delivery.

17.4.4 Comparison — the two haematinics

Feature	Ferrous sulphate	Ferrous gluconate
Formula	$FeSO_4 \cdot 7H_2O$	$C_{12}H_{22}FeO_{14} \cdot 2H_2O$
Colour	Pale bluish-green crystals	Yellowish-grey powder
Gastric irritation	More	Less (better tolerated)
Assay	Redox ($Fe^{2+} \rightarrow Fe^{3+}$)	Redox ($Fe^{2+} \rightarrow Fe^{3+}$)
Use	First-choice oral haematinic	Alternative when sulphate not tolerated

17.5 Easy Analogy

Haemoglobin is a **delivery truck**, and iron is its **engine** — no engine, no deliveries (oxygen). Ferrous iron is the engine **already fitted**; ferric iron is an engine **still in its packing crate** that the body must unpack (reduce) first. Haematinics deliver ready-fitted engines.

17.6 Diagram — From Iron Tablet to Haemoglobin

Ferrous salt tablet swallowed (Fe^{2+})
↓
Dissolves in stomach acid
↓
Fe^{2+} absorbed in upper intestine
(Fe^{2+} would need reduction first — slower, poorer)
↓
Transported in blood → bone marrow
↓
Built into haem groups → new haemoglobin
↓
Red cells carry more oxygen → tiredness and paleness improve

AI Image Prompt: "Simple pharmacy textbook flow diagram on white background: tablet icon dissolving in a stomach outline, arrow to an intestine section labelled 'Fe2+ absorbed', arrow to a blood drop travelling to a bone marrow icon, arrow to red blood cells carrying oxygen bubbles, clean flat medical illustration, numbered steps 1 to 5."

17.7 Flowchart — Counselling a Patient on Iron Therapy

Dispense iron tablets → counsel:
├─ Take on an empty stomach for best absorption
│ (but WITH food if it causes nausea/cramps)
├─ Do NOT take with antacids, calcium, tea or coffee
│ (they reduce iron absorption — separate by a couple of hours)
├─ Stools will turn BLACK — harmless, expected, warn in advance
├─ Keep OUT of reach of children — iron overdose is dangerous
└─ Continue for the full prescribed course
(stores refill slowly; stopping early = relapse)

17.8 Examples

- **Ferrous sulphate tablets** — the standard iron tablet in anaemia treatment and in national anaemia-control programmes.
- **Ferrous gluconate capsules/syrups** — prescribed when patients complain of stomach upset with the sulphate.
- **Black stools on iron therapy** — the classic counselling point every pharmacist must give unprompted.

17.9 Pharmacy Relevance

Iron therapy fails more often from **poor counselling than poor drugs**: patients stop because of nausea or panic at black stools. The pharmacist's five counselling lines (empty stomach, separate antacids/tea, black stools normal, keep from children, finish the course) directly decide treatment success. Also note the **poison link**: accidental iron overdose in children is a genuine poisoning emergency — keep iron products out of reach (Chapter 18 thinking).

17.10 Important Points to Remember

1. **Remember:** Haematinic = drug that builds haemoglobin/RBCs; used in anaemia.
2. **Exam Pearl:** Gut absorbs iron as **Fe^{2+} (ferrous)** — ferric must be reduced first, so ferrous salts are preferred.
3. **Exam Pearl:** Both haematinics are assayed by **redox titration** ($Fe^{2+} \rightarrow Fe^{3+}$ with a standard oxidant) — the assay measures exactly the absorbable form.
4. Ferrous sulphate = $FeSO_4 \cdot 7H_2O$, green vitriol, Fe + dil. H_2SO_4 preparation, browns in moist air.
5. Ferrous gluconate = $C_{12}H_{22}FeO_{14} \cdot 2H_2O$ — **less gastric irritation** than the sulphate.
6. Black stools on iron therapy are **harmless and expected** — always warn the patient.
7. Keep iron away from children — overdose is dangerous.

17.11 Common Confusions & Common Mistakes

Do not confuse: Ferrous (Fe^{2+}) ≠ ferric (Fe^{3+}) — therapy uses ferrous; ferric needs reduction before absorption · **Haematinic ≠ haematemesis** (one builds blood; the other is vomiting blood — a favourite examiner trap) · **Green vitriol ($FeSO_4$) ≠ blue vitriol ($CuSO_4$)** — same "vitriol" nickname, different metals, different chapters. **Mistakes:** writing the ferrous sulphate assay as acid–base (it is redox); forgetting the $7H_2O$ in the formula; saying black stools indicate bleeding (on iron therapy, they are expected and harmless).

17.12 Memory Tricks

- "**F**errous is **F**irst choice, **F**ast absorbed" — Fe^{2+} beats Fe^{3+}.
- "**G**luconate is **G**entle" — less gastric irritation than sulphate.
- "**B**lack stools = **B**enign" on iron therapy.

17.13 Exam-Oriented Summary

Haematinics treat anaemia by supplying iron for haemoglobin. Iron is absorbed as Fe^{2+}, so ferrous salts are preferred. Ferrous sulphate ($FeSO_4 \cdot 7H_2O$, green vitriol; Fe + dil. H_2SO_4; browns in air; redox assay) is the first-choice oral haematinic. Ferrous gluconate ($C_{12}H_{22}FeO_{14} \cdot 2H_2O$; gentler on the stomach; redox assay) is the alternative when sulphate irritates. Counsel: empty stomach, separate antacids/tea, black stools normal, keep from children, finish the course.

One-Minute Revision: Haematinic = builds haemoglobin. Absorbed form = Fe^{2+}. $FeSO_4 \cdot 7H_2O$ (green vitriol) — redox assay. Ferrous gluconate — gentler. Counsel: empty stomach, no antacid/tea together, black stools OK, away from children.

17.14 Questions

Very Short Answer: 1. Define haematinic (scientific + simple). 2. Define anaemia. 3. Why is ferrous iron preferred over ferric? 4. Give the formula of ferrous sulphate. 5. Why do stools turn black on iron therapy, and is it dangerous?

Short Answer: 1. Explain why the assay of haematinics is a redox titration. 2. Compare ferrous sulphate and ferrous gluconate. 3. Why does ferrous sulphate turn brownish on storage? 4. List five counselling points for a patient starting iron tablets.

Long Answer: 1. Define haematinic. Give the formula, preparation, properties, assay principle, and uses of ferrous sulphate and ferrous gluconate, and explain the ferrous vs ferric distinction. 2. Discuss the pharmacist's counselling role in iron therapy.

MCQs

1. Iron is absorbed from the gut mainly as: (a) Fe^{3+} (b) Fe^{2+} (c) elemental Fe^0 (d) FeO — **Ans: (b)**. Ferrous is the absorbable form; ferric must be reduced first.
2. The assay of ferrous sulphate is based on: (a) acid–base titration (b) redox titration ($Fe^{2+} \rightarrow Fe^{3+}$) (c) argentometry (d) complexometry — **Ans: (b)**.
3. Ferrous sulphate turns brownish on storage because: (a) it loses water (b) Fe^{2+} oxidises to Fe^{3+} in moist air (c) it absorbs CO_2 (d) of bacterial growth — **Ans: (b)**.
4. Ferrous gluconate is preferred over ferrous sulphate when: (a) the patient needs less iron (b) the sulphate causes gastric irritation (c) a ferric salt is required (d) injections are needed — **Ans: (b)**. Same iron, gentler salt.
5. A patient on iron tablets reports black stools. The pharmacist should: (a) stop the iron at once (b) reassure that it is expected and harmless (c) order a blood transfusion (d) switch to a ferric salt — **Ans: (b)**. Warn in advance; it is unabsorbed iron, not bleeding.

Viva: What is green vitriol? Why must ferrous sulphate be stored in well-closed containers? **Application-based:** A mother keeps iron syrup on a low kitchen shelf where her toddler can reach it. What is the risk and your advice? *(Ans: Accidental iron poisoning in children can be life-threatening — store all iron products locked/away from children; this is a poisoning emergency needing immediate medical care, Chapter 18.)* A student writes "ferric sulphate is the better haematinic because Fe^{3+} has more charge." Correct the error. *(Ans: Absorption needs Fe^{2+}; ferric must be reduced first, so ferrous salts are better absorbed and preferred.)*

CHAPTER 18: POISON AND ANTIDOTE

Unit V · ~2 hours

18.1 Introduction

Every pharmacist may one day face a frightened person holding an empty bottle: "my child swallowed this — what do I do?" **Poisons and antidotes** is the chapter that prepares you. A poison is any substance that harms the body; an **antidote** is an agent that counteracts it. You will learn the three families of antidotes — chemical, physiological, and mechanical — and study **sodium thiosulphate**, the syllabus antidote used in cyanide poisoning.

Learning objectives — after studying this chapter, you should be able to:

- define poison and antidote in scientific and simple terms;
- classify antidotes into chemical, physiological/pharmacological, and mechanical types with examples;
- explain each class with its mechanism in simple words;
- give the formula, preparation, properties, assay principle, and uses of sodium thiosulphate;
- explain the role of sodium thiosulphate in cyanide poisoning at textbook level;
- state the general first-aid principles in poisoning (and what NOT to do).

18.2 Definition

Poison — scientific: any substance which, when introduced into the body in a relatively small amount, causes injury, illness, or death by its chemical action. **Poison — simple:** anything that harms or kills the body even in small amounts because of what it *does chemically* — not because it is sharp or hot.

Antidote — scientific: an agent that counteracts the harmful effects of a poison, by chemical neutralisation, opposing physiological action, or preventing absorption. **Antidote — simple:** the "opposite medicine" — something that cancels out, blocks, or washes out a poison's harm.

Toxicology = the science of poisons: their nature, effects, detection, and treatment.

18.3 Key Terminology

Term	Meaning
Universal antidote (historical)	An old textbook mixture (activated charcoal + magnesium oxide + tannic acid) once proposed for unknown poisons — of historical interest; modern practice uses specific measures
Chelating agent	A chemical that grips metal ions like a claw and carries them out (e.g., for lead/mercury poisoning — principle only)
Demulcent	A soothing substance (milk, egg white, starch) that coats irritated stomach lining
Adsorbent	A substance that traps poison molecules on its surface (activated charcoal) — note *ad*sorb (surface), not *ab*sorb

18.4 Detailed Explanation

18.4.1 Classification of antidotes

Antidotes are classified by **how** they fight the poison:

1. Chemical antidotes — react *chemically* with the poison to form a harmless (or less harmful) compound.

- *Simple idea:* "lock the poison into a safe chemical cage."
- *Examples:* **sodium thiosulphate** in cyanide poisoning (helps convert cyanide to much less toxic thiocyanate, excreted in urine); weak acids/alkalis neutralising each other; chelating agents gripping metal poisons.

2. Physiological (pharmacological) antidotes — act on the body in the *opposite direction* to the poison, without touching the poison chemically.

- *Simple idea:* "push the body's seesaw back the other way."
- *Examples:* drugs that stimulate breathing against a poison that depresses it; agents that reverse the poison's effect at the same receptor (the classic textbook pair: a stimulant vs a depressant acting on the same system).

3. Mechanical antidotes — *physically* prevent the poison from being absorbed or remove it.

- *Simple idea:* "stop the poison reaching the blood, or wash it out."
- *Examples:* **activated charcoal** (adsorbs poison in the gut), **demulcents** (milk, egg white coat the stomach), stomach wash (gastric lavage) performed by trained staff, and **emetics** (Chapter 16!) used under supervision to empty the stomach.

Class	How it works	Key example
Chemical	Reacts with poison → harmless product	Sodium thiosulphate (cyanide → thiocyanate)
Physiological	Opposes the poison's action on the body	Stimulant vs depressant-type reversal
Mechanical	Blocks absorption / removes poison	Activated charcoal, demulcents, stomach wash

Exam Pearl: The exam favourite is matching each antidote to its class: sodium thiosulphate = **chemical**, activated charcoal = **mechanical**. Learn the *mechanism logic*, not just lists.

18.4.2 Monograph — Sodium Thiosulphate ($Na_2S_2O_3 \cdot 5H_2O$)

Item	Details
Formula	$Na_2S_2O_3 \cdot 5H_2O$ (pentahydrate; "hypo" — the photographer's hypo)
Preparation (principle)	Boiling sodium sulphite solution with elemental sulphur: $Na_2SO_3 + S \rightarrow Na_2S_2O_3$. The thiosulphate crystallises as the pentahydrate on cooling.
Properties	Colourless, transparent crystals; soluble in water; **reduces iodine** (this is why it is the titrant in all the iodometric assays of Chapters 16–17 — KI, $CuSO_4$); on treatment with dilute acid it gives sulphur dioxide and a milky precipitate of sulphur.
Assay (principle)	**Iodometric (redox) titration.** Sodium thiosulphate is titrated directly against a standard iodine solution using starch as indicator: $I_2 + 2Na_2S_2O_3 \rightarrow Na_2S_4O_6 + 2NaI$. The blue starch–iodine colour disappears at the end point. Volume of iodine ∝ thiosulphate content.
Uses	**Antidote in cyanide poisoning** — it supplies sulphur so the body's enzyme systems can convert deadly cyanide (CN^-) into thiocyanate (SCN^-), which is far less toxic and excreted in urine. Also used in photography (fixing agent) and as an analytical reagent.

How it works in cyanide poisoning (textbook level): cyanide kills by blocking the cells' oxygen use. The body has an enzyme (rhodanese) that can detoxify cyanide *if* it has enough sulphur donor — sodium thiosulphate provides that sulphur, converting $CN^- \rightarrow SCN^-$ (thiocyanate), which the kidneys excrete. It is given as part of hospital-based cyanide-poisoning management — never a home remedy.

> **Exam Pearl:** Notice the beautiful loop in this unit: sodium thiosulphate is the *titrant* in the assays of KI and $CuSO_4$ (Chapters 16) — and the *antidote* in Chapter 18. One chemical, two starring roles.

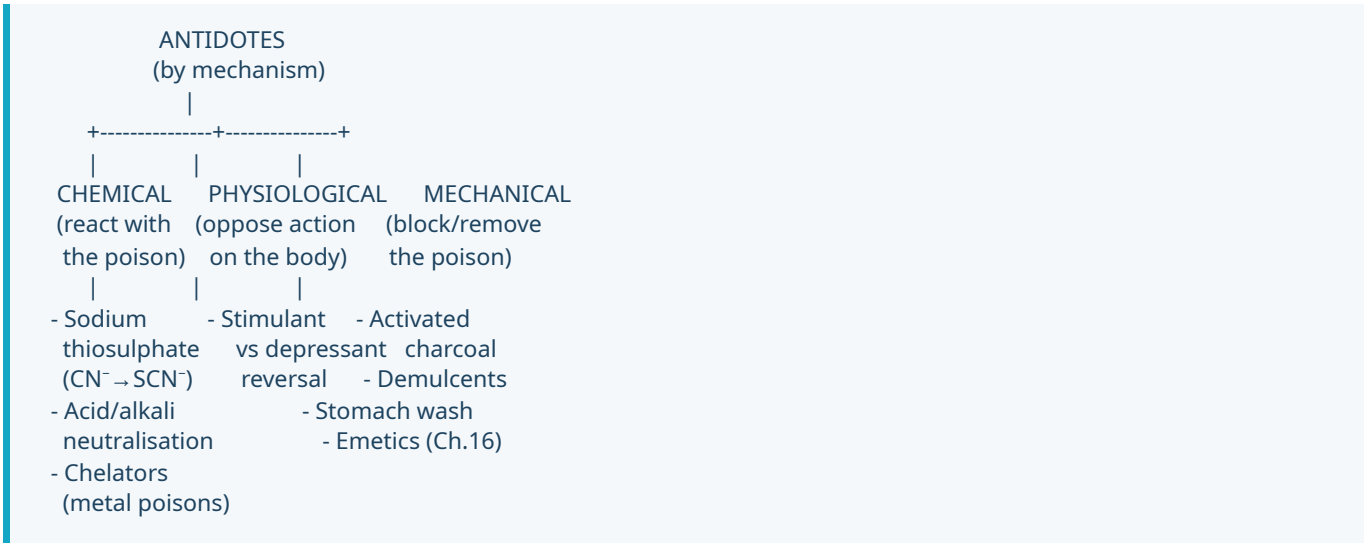
18.4.3 General first-aid principles in poisoning (and what NOT to do)

1. **Remove the person from the poison** (fresh air, wash skin, remove contaminated clothing).
2. **Keep the poison's container/label** — it tells the doctor exactly what was taken.
3. **Call for medical help immediately** — doctor, hospital, or poison control; act fast, do not "wait and watch."
4. **Do NOT induce vomiting** for corrosive substances (acids, alkalis), petroleum products, or in an unconscious/drowsy person — vomiting can cause more damage or choking.
5. **Do NOT give home "remedies" blindly** — wrong treatment wastes the critical early minutes.
6. **Keep the person calm and still**; if trained, give demulcents (milk/egg white) only when appropriate and advised.

18.5 Easy Analogy

A chemical antidote is a **fire extinguisher** (reacts with the fire itself). A physiological antidote is **opening the windows after the extinguisher** (restores the room, doesn't touch the fire). A mechanical antidote is **closing the fire door** (stops the fire spreading to other rooms — stops poison reaching the blood).

18.6 Diagram — Antidote Classification



> **AI Image Prompt:** "Pharmacy textbook classification tree diagram on white background: top box 'ANTIDOTES', three branches labelled Chemical (test-tube reaction icon), Physiological (seesaw/balance icon), Mechanical (shield/barrier icon), each with 2-3 example boxes beneath, clean flat educational style, clear labels."

18.7 Flowchart — First Response to a Suspected Poisoning

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Suspected poisoning
      ↓
Is the person conscious and breathing?
  ├─ NO → call emergency, start basic life support if trained
  └─ YES ↓
Remove from source (fresh air / wash skin / remove clothing)
      ↓
KEEP the container/label — note what, how much, when
      ↓
Call doctor / hospital / poison control IMMEDIATELY
      ↓
Do NOT induce vomiting if: corrosive, petroleum product,
  unconscious/drowsy, or convulsing
      ↓
Follow medical advice; give demulcents only if advised
```

18.8 Examples

- **Sodium thiosulphate + cyanide** — the syllabus chemical antidote: $CN^- \rightarrow SCN^-$, excreted.
- **Activated charcoal** — the classic mechanical antidote; adsorbs many poisons in the gut (surface trapping, not absorption).
- **Milk/egg white** — demulcents that coat the stomach lining (mechanical + soothing).
- **Acid vs alkali neutralisation** — the simplest chemical antidote logic (weak neutralises weak; never use strong corrosives to "treat" each other).

18.9 Pharmacy Relevance

The pharmacist is often the **first health professional** a panicked family reaches. Knowing the three antidote classes, the sodium thiosulphate story, and the first-aid do's and don'ts turns panic into correct action: secure the label, call for help, and avoid the classic error of inducing vomiting for corrosives. Pharmacists also counsel on **prevention** — safe storage of medicines, pesticides, and iron syrups (Chapter 17's link).

18.10 Important Points to Remember

1. **Remember:** Poison = harmful in small amounts by chemical action; Antidote = agent that counteracts it.
2. **Exam Pearl:** Three classes — **chemical** (reacts with poison), **physiological** (opposes its action), **mechanical** (blocks/removes it).
3. **Exam Pearl:** Sodium thiosulphate = **chemical antidote** for cyanide poisoning ($CN^- \rightarrow SCN^-$, excreted in urine); formula $Na_2S_2O_3 \cdot 5H_2O$ ("hypo").
4. **Exam Pearl:** Activated charcoal = **mechanical** antidote (adsorption — surface trapping).
5. Thiosulphate preparation: Na_2SO_3 + S (boiled) → $Na_2S_2O_3$; its assay is iodometric (vs standard iodine, starch indicator).
6. The same thiosulphate titrates iodine in the assays of KI and $CuSO_4$ (Chapters 16) — one chemical, two roles.
7. **Never induce vomiting** for corrosives, petroleum products, or unconscious patients.

18.11 Common Confusions & Common Mistakes

Do not confuse: Adsorb ≠ absorb (charcoal *ad*sorbs — surface trapping; a sponge *ab*sorbs) · **Chemical ≠ physiological antidote** (one reacts with the poison; the other opposes its body effects) · **Antidote ≠ emetic** (an emetic only empties the stomach; an antidote counteracts the poison — though emetics can be *used* as mechanical measures). **Mistakes:** calling sodium thiosulphate a "physiological" antidote (it is chemical — it reacts with cyanide via the body's sulphur pathway); writing the thiosulphate–iodine equation unbalanced ($I_2 + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2I^-$); recommending vomiting for acid ingestion.

18.12 Memory Tricks

- "**C**hemical = **C**ombines (with the poison); **P**hysiological = **P**ushes back; **M**echanical = **M**akes a barrier."
- "**Hypo** helps in **hy**-cyanide" — sodium thiosulphate ("hypo") for cyanide.
- "**Ad**sorb = **Ad**heres to surface" — charcoal traps poison on its surface.

18.13 Exam-Oriented Summary

Poison harms in small amounts by chemical action; an antidote counteracts it. Three classes: chemical (reacts with poison — sodium thiosulphate: $CN^- \rightarrow SCN^-$), physiological (opposes the poison's body action), mechanical (blocks/removes — activated charcoal by adsorption, demulcents, stomach wash). Sodium thiosulphate: $Na_2S_2O_3 \cdot 5H_2O$ ("hypo"), from Na_2SO_3 + S, iodometric assay vs standard iodine (starch), antidote in cyanide poisoning. First aid: remove from source, keep the label, call for help immediately, never induce vomiting for corrosives/petroleum/unconscious patients.

One-Minute Revision: Antidote classes: chemical / physiological / mechanical. Thiosulphate ($Na_2S_2O_3 \cdot 5H_2O$) = chemical antidote, $CN^- \rightarrow SCN^-$. Charcoal = mechanical (adsorption). First aid: remove, keep label, call help, no vomiting for corrosives.

18.14 Questions

Very Short Answer: 1. Define poison and antidote (scientific + simple). 2. Name the three classes of antidotes with one example each. 3. Give the formula of sodium thiosulphate. 4. What is the difference between adsorb and absorb? 5. Why should vomiting not be induced after acid ingestion?

Short Answer: 1. Classify antidotes with mechanism and one example for each class. 2. Describe the preparation and assay principle of sodium thiosulphate. 3. Explain the role of sodium thiosulphate in cyanide poisoning. 4. List the general first-aid principles in poisoning.

Long Answer: 1. Define poison and antidote. Classify antidotes with examples, and give the formula, preparation, properties, assay principle, and uses of sodium thiosulphate. 2. A child has swallowed an unknown household chemical. Describe step-by-step what a pharmacist should advise the family to do (and not do).

MCQs

1. Sodium thiosulphate acts as a: (a) physiological antidote (b) mechanical antidote (c) chemical antidote (d) universal antidote — **Ans: (c)**. It chemically converts cyanide to thiocyanate.
2. In cyanide poisoning, sodium thiosulphate helps convert cyanide to: (a) cyanate (b) thiocyanate (c) carbonate (d) sulphate — **Ans: (b)**. SCN^- is far less toxic and excreted in urine.
3. Activated charcoal is a ___ antidote and works by ___: (a) chemical, neutralisation (b) mechanical, adsorption (c) physiological, receptor blockade (d) chemical, chelation — **Ans: (b)**.
4. The assay of sodium thiosulphate uses: (a) standard iodine with starch indicator (b) standard NaOH (c) formaldehyde (d) EDTA — **Ans: (a)**. $I_2 + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2I^-$; blue colour disappears at the end point.
5. Vomiting should NOT be induced when the poison is: (a) a non-corrosive tablet taken 5 minutes ago (b) a corrosive acid (c) spoiled food (d) an iron tablet in a child — **Ans: (b)**. Vomiting a corrosive re-burns the food pipe; also avoid in unconscious patients and petroleum ingestion.

Viva: Why is sodium thiosulphate called "hypo"? What is the historical "universal antidote"? **Application-based:** A farmer rushes in saying his coworker drank pesticide. List your first four actions in order. *(Ans: 1. Ensure the coworker is out of further exposure and breathing; 2. Keep the pesticide container/label; 3. Call/send for emergency medical help immediately; 4. Do NOT induce vomiting or give home remedies — follow medical advice.)* A student labels activated charcoal a "chemical antidote because it reacts with poison." Correct them. *(Ans: Charcoal does not react chemically; it traps poison molecules on its surface — adsorption — so it is a mechanical antidote.)*

UNIT V INFOGRAPHIC CONCEPT — "THE IODINE THREAD"

Layout: a single horizontal thread (a blue iodine-coloured ribbon) running left to right across the page, tying the whole unit together:

- 🫁 **EXPECTORANTS** (Ch 16): KI + NH_4Cl — gastric reflex → bronchial secretion → sputum out
- 🤢 **EMETICS** (Ch 16): $CuSO_4$ + Rochelle salt — gastric irritation → vomiting
- 🩸 **HAEMATINICS** (Ch 17): $FeSO_4$ + ferrous gluconate — Fe^{2+} absorbed → haemoglobin rebuilt
- ☠️ **POISON & ANTIDOTE** (Ch 18): $Na_2S_2O_3$ — chemical antidote, CN^- → SCN^-

> **The thread's secret:** the blue ribbon is *iodine* — sodium thiosulphate (the antidote) is the titrant in the iodometric assays of KI and $CuSO_4$. One chemical ties expectorants, emetics, and antidotes together. **Bottom banner:** "Fe^{2+} absorbed, Fe^{3+} reduced first · Assays: iodometry for KI/$CuSO_4$/thiosulphate, formol for NH_4Cl, redox for iron · First aid: remove, keep the label, call for help."

UNIT V REFERENCES (combined)

- Schroff, M. L. *Pharmaceutical Chemistry-I (Inorganic)* — standard Indian text for inorganic monographs, assays, and antidotes.
- Bentley and Driver. *Bentley's Textbook of Pharmaceutics* — general pharmaceutical reference.
- *Indian Pharmacopoeia* — official monographs, assay procedures, and quality standards (procedural principles cited; no monograph numbers or limit values invented).