B. Pharmacy 1st Semester - Pharmaceutical Inorganic Chemistry

UNIT – 4: Miscellaneous Compounds 💊

Topics Covered in This Unit 📋

- **Expectorants** 🫁
- **Emetics** 🤢
- **Haematinics** 🩸
- **Poison and Antidotes** ⚠️
- **Astringents** 🧴

EXPECTORANTS 🫁

Expectorants are therapeutic agents that facilitate the removal of sputum from the respiratory tract through two primary mechanisms: increasing the fluidity of sputum by reducing its viscosity, or increasing the volume of fluids that need to be expelled from the respiratory tract through coughing. These medications play a crucial role in treating respiratory conditions where excessive or thick mucus impairs normal breathing and lung function.

Classification of Expectorants 📊

Type	Mechanism	Examples
Sedative Expectorants	Stomach irritant expectorants that produce effects through gastric reflex stimulation	Ipecac, Senega
Stimulant Expectorants	Direct or indirect stimulation of respiratory tract secretory cells	Eucalyptus, Lemon, Anise

Sedative expectorants function as stomach irritants that achieve their therapeutic effect by stimulating gastric reflexes. These compounds typically consist of bitter drugs that trigger reflexive responses in the digestive system, which subsequently influence respiratory secretions.

Stimulant expectorants work by directly or indirectly stimulating the secretory cells within the respiratory tract. Since these medications enhance secretion production, they increase fluid generation in the respiratory system, effectively diluting thick sputum and making it easier to expel through coughing.

POTASSIUM IODIDE 🧪

Molecular Formula: KI
Molecular Weight: 166.01
Synonyms: Kalium iodidum, Pot. Iod.

Preparation

Potassium iodide is synthesized through multiple chemical processes. The primary method involves treating iron filings with iodine in an aqueous environment to produce iodide, which is subsequently reacted with potassium carbonate. An alternative preparation method involves the

reaction of hydrochloric acid with potassium bicarbonate, resulting in potassium iodide formation.

Properties

Potassium iodide presents as odourless, transparent or opaque crystals that appear as a white granular powder. The compound exhibits slightly hygroscopic characteristics, meaning it readily absorbs moisture from the surrounding atmosphere.

Chemical Properties: Iodine demonstrates remarkable solubility in aqueous potassium iodide solutions, forming a distinctive dark brown solution containing potassium tri-iodide. This reaction is fundamental to many analytical applications and serves as a characteristic identification test.

Uses

- **Primary therapeutic application:** Essential ingredient in expectorant mixtures for respiratory conditions
- **Endocrine applications:** Prophylaxis and treatment of simple goitre conditions
- **Veterinary medicine:** Functions as an antifungal agent in animal healthcare
- **Nutritional supplementation:** Potassium iodide solutions serve as iodine supplements for deficiency prevention

AMMONIUM CHLORIDE 🧂

Molecular Formula: NH_4Cl

Molecular Weight: 53.49

Synonyms: Ammonium Muriate, Sal ammoniac, Amchlor, Ammon.

Preparation

Ammonium chloride is produced as a byproduct of the Solvay Process, which simultaneously generates ammonium chloride and sodium carbonate. This industrial method is specifically designed to minimize ammonia release during manufacturing operations. The compound can also be prepared by combining ammonia with either hydrogen chloride gas or hydrochloric acid in controlled conditions.

Properties

Ammonium chloride appears as a white crystalline salt with exceptional water solubility. Solutions of this compound exhibit mildly acidic properties and demonstrate somewhat hygroscopic behavior. The substance is completely odourless and possesses a characteristic cooling saline taste.

Chemical Reactions:

- **Base reaction:** $NH_4Cl + NaOH \rightarrow NH_3 + NaCl + H_2O$
- **Carbonate reaction:** $2NH_4Cl + Na_2CO_3 \rightarrow 2NaCl + CO_2 + H_2O + 2NH_3$

Uses

- **Agricultural applications:** Serves as a nitrogen source in fertilizers, particularly in chloro ammonium phosphate formulations
- **Respiratory medicine:** Functions as an expectorant in cough medications through irritative action on bronchial mucosa

- **Medical applications:** Used as a systemic acidifying agent for treating severe metabolic alkalosis
- **Food industry:** Functions as a flavoring agent in various products
- **Industrial applications:** Essential in textile and leather industries for dyeing, tanning, and textile printing processes
- **Cosmetic applications:** Used in hair shampoos as a thickening agent

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EMETICS 🤢

Emetics are pharmacological agents that induce forced regurgitation (emesis), causing the contents of the stomach to be expelled through the oral cavity. These medications constitute an invaluable component of treatment protocols in poisoning cases, where rapid gastric evacuation can prevent further absorption of toxic substances. The mechanism involves stimulating the vomiting reflex through various pathways, including direct gastric irritation or central nervous system stimulation.

COPPER SULPHATE 🔵

Molecular Formula: $CuSO_4 \cdot 5H_2O$
Molecular Weight: 159.6
Synonym: Blue vitriol

Preparation

Copper sulphate is prepared through several chemical processes involving the dissolution of various copper compounds in dilute sulfuric acid:

- **$CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$** (Cupric oxide reaction)

- **$Cu(OH)_2 + H_2SO_4 \rightarrow CuSO_4 + 2H_2O$** (Cupric hydroxide reaction)
- **$CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2$** (Cupric carbonate reaction)

Properties

The hydrated form of copper sulphate exhibits a distinctive blue coloration, while the anhydrous salt appears colorless. The compound demonstrates excellent water solubility but remains completely insoluble in alcohol. This solubility profile is crucial for its various applications and bioavailability.

Uses

- **Agricultural applications:** Functions as both a germicide and insecticide for crop protection
- **Fungicide applications:** Combined with lime to create Bordeaux mixture for fungal disease control
- **Industrial applications:** Essential in electroplating processes, calico printing, and electrical battery manufacturing

SODIUM AND POTASSIUM TARTRATE

Molecular Formula: $C_4H_4NaKO_6$
Molecular Weight: 210.158
Synonyms: Rochelle salt

Properties

Sodium and potassium tartrate occurs as colorless crystals with a distinctive saline taste. The compound demonstrates good solubility in hot water but remains insoluble in alcohol. These solubility characteristics determine its pharmaceutical applications and administration methods.

Uses

- **Gastrointestinal applications:** Functions as a laxative for constipation relief
- **Industrial applications:** Historically used in mirror silvering processes

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HAEMATINICS

Haematinics are essential substances required for blood formation and are primarily used in the treatment of various types of anemia. These therapeutic agents increase both the number of red blood cells and hemoglobin levels to normal values when they fall below physiological ranges. The importance of haematinics extends beyond simple supplementation, as they address fundamental deficiencies that can lead to serious health complications.

Pathophysiology of Anemia

Anemia develops when the delicate balance between red blood cell production and destruction becomes disrupted through several mechanisms:

Primary causes include:

- **Blood loss:** Acute or chronic hemorrhage leading to decreased red cell mass
- **Impaired red cell formation due to:**
  - Deficiency of essential factors: Iron, folic acid, vitamin B_{12}
  - Bone marrow depression and erythropoietin deficiency

- **Increased red blood cell destruction:** Hemolytic anemia conditions

Treatment Approaches for Anemia 💊

Anemia Type	Hemoglobin Level	Treatment Protocol
Severe Anemia	≤7 gm%	Blood transfusion required
Microcytic/Hypochromic	Variable	Iron supplementation + iron-rich diet
Macrocytic	Variable	Liver extract, Vitamin B_{12}, Folic acid
Pernicious	Variable	Vitamin B_{12} specifically required

General Treatment Principles:

1. In severe anemia with hemoglobin levels of 7 gm percent or below, immediate blood transfusion is necessary regardless of underlying cause
2. Microcytic and hypochromic anemia specifically require iron administration alongside iron-rich dietary modifications
3. Macrocytic anemia treatment involves liver extract, vitamin B_{12}, and folic acid, used individually or in combination
4. Pernicious anemia specifically requires vitamin B_{12} for effective treatment
5. All anemia cases benefit from concurrent symptomatic treatment with appropriate dietary supplements

FERROUS SULPHATE 🟢

Molecular Formula: $FeSO_4 \cdot 7H_2O$

Molecular Weight: 278

Synonyms: Green vitriol

Preparation

Ferrous sulphate is synthesized through the reaction of iron with dilute sulfuric acid, where iron dissolves to form ferrous sulphate while liberating hydrogen gas:

$$\mathbf{Fe + H_2SO_4 \rightarrow FeSO_4 + H_2}$$

Properties

Ferrous sulphate appears as transparent, pale bluish-green crystalline powder. The compound is completely odourless but possesses a characteristic metallic taste. It demonstrates excellent solubility in boiling water and good solubility in water, while being practically insoluble in alcohol.

Chemical Behavior: When treated with ceric ammonium sulphate in acidic conditions, ferrous sulphate reduces ceric iron according to the reaction:

$$\mathbf{2Fe^{++} + Ce^{+++} \rightarrow 2Fe^{+++} + Ce^{++}}$$

Uses

- **Primary medical application:** Essential haematinic for treating iron deficiency anemia
- **Industrial applications:** Used in fabric dyeing processes and leather tanning operations

FERROUS GLUCONATE 🟡

Molecular Formula: $C_{12}H_{22}FeO_{14}·2H_2O$
Molecular Weight: 482.17

Properties

Ferrous gluconate occurs as a yellowish-grey fine powder with a distinctive burnt sugar-like odour. The compound is soluble in water but insoluble in alcohol, which influences its pharmaceutical formulation and bioavailability.

Uses

- **Therapeutic application:** Serves as an iron source for treating various types of anemia, often preferred over ferrous sulphate due to better gastrointestinal tolerance

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POISON AND ANTIDOTES ⚠️

POISON ☠️

A **poison** is defined as any substance that, when introduced into or absorbed by a living organism, destroys life or injures health. This broad definition encompasses a wide range of chemical, biological, and physical agents that can cause harm through various mechanisms including cellular damage, metabolic disruption, or physiological dysfunction.

ANTIDOTES 🛡️

Antidotes are therapeutic agents that counteract the effects of poisons through specific mechanisms. Understanding the different types of antidotes is crucial for effective poisoning management.

Classification of Antidotes 📋

Antidote Type	Mechanism	Example	Poison Treated
Chemical Antidotes	Changes poison's chemical nature	Sodium thiosulphate	Cyanide poisoning
Mechanical Antidotes	Prevents poison absorption	Activated charcoal	Multiple poisons
Physiological Antidotes	Counteracts poison effects	Sodium nitrite	Cyanide poisoning

Chemical antidotes function by altering the chemical structure of the poison, converting it into a non-toxic or less toxic form. This transformation typically occurs through chemical reactions that neutralize the harmful properties of the original compound.

Mechanical antidotes work by physically preventing the absorption of poisons into the systemic circulation. These agents create barriers or bind to toxins, preventing their uptake across biological membranes.

Physiological antidotes counteract poisoning effects by producing opposing physiological responses or by competing for the same biological targets as the poison.

SODIUM THIOSULPHATE 🧪

Molecular Formula: $Na_2S_2O_3 \cdot 5H_2O$
Molecular Weight: 248.2
Synonym: Sodium hyposulphate

Preparation

Sodium thiosulphate can be prepared through multiple synthetic routes:

Primary method: $Na_2SO_3 + S \rightarrow Na_2S_2O_3$ (Boiling sodium sulphite with sulphur)

Alternative method: $2Na_2S + Na_2CO_3 + 4SO_2 \rightarrow 3Na_2S_2O_3 + CO_2$ (Mixing sulphide liquors with sodium carbonate while passing SO_2 gas)

Properties

Sodium thiosulphate occurs as large, colorless crystals that are completely odourless and possess an alkaline taste. The compound demonstrates excellent water solubility but remains insoluble in alcohol.

Chemical Behavior: When acidified with hydrochloric acid, sodium thiosulphate decomposes according to:

- $\mathbf{Na_2S_2O_3 + 2HCl \rightarrow H_2S_2O_3 + 2NaCl}$
- $\mathbf{H_2S_2O_3 \rightarrow S\downarrow + H_2O + SO_2}$ (Decomposition producing sulfur, water, and sulfur dioxide)

Uses

- **Primary antidote application:** Essential treatment for cyanide poisoning
- **Dermatological applications:** Treatment of parasitic skin diseases

SODIUM NITRITE 🔴

Molecular Formula: $NaNO_2$

Molecular Weight: 69.00

Synonym: Nitrous acid, Sodium salt

Preparation

Sodium nitrite can be prepared through thermal decomposition processes:

Primary method: $2NaNO_3 \rightarrow 2NaNO_2 + O_2$ (Strong heating of sodium nitrate)

Alternative method: $NaNO_3 + Pb \rightarrow NaNO_2 + PbO$ (Heating nitrate with metallic lead)

Properties

Sodium nitrite appears as odourless, colorless to slightly yellow crystals with a saline taste. The compound is highly water-soluble but only sparingly soluble in alcohol.

Chemical Reactions:

- **Acid decomposition:** $2NaNO_2 + H_2SO_4 \rightarrow Na_2SO_4 + 2HNO_2$
- **Redox reactions:** $2HNO_2 + 2KI + H_2SO_4 \rightarrow I_2 + 2NO\uparrow + 2H_2O + K_2SO_4$

Uses

- **Antidote application:** Used in cyanide poisoning treatment in conjunction with sodium thiosulphate, forming a comprehensive antidotal approach

ACTIVATED CHARCOAL ⚫

Activated charcoal is a dark grey residue consisting primarily of carbon and residual ash, obtained by removing water and other volatile constituents from animal and vegetable materials through controlled pyrolysis.

Preparation

Activated charcoal is prepared by burning wood in the absence of air, creating controlled combustion conditions. The resulting residue consists of nearly pure carbon with an extensively developed pore structure that provides exceptional adsorptive capacity.

Properties

Activated charcoal appears as a fine black powder that is completely odourless and tasteless. The material is free from gritty matter and remains insoluble in water and other organic solvents. Its effectiveness stems from its enormous surface area and pore structure.

Uses

- **Emergency antidote:** Widely used as a universal antidote in numerous poisoning cases
- **Protective agent:** Functions as both a protective and adsorbent material for toxin removal

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ASTRINGENTS 🩹

Astringents are compounds that cause protein precipitation and form protective layers on tissue surfaces, thereby stopping bleeding through

blood vessel constriction. These agents demonstrate local styptic (bleeding-stopping) and antiseptic properties, making them valuable in both medical and cosmetic applications.

Mechanism of Action ⚙️

The protein precipitation effect of astringents results from the presence of metallic ions with large charges that create strong electrostatic fields. These metal ions form stable complexes with various polar groups present on proteins and enzymes. This complexation of important functional groups at protein active sites causes dramatic changes in protein properties, leading to precipitation and tissue contraction.

Clinical Applications and Effects 🏥

Wound healing applications: When applied to wounds in small quantities, astringents stimulate new tissue growth and promote healing. However, higher concentrations can produce tissue irritation and should be avoided.

Additional therapeutic uses include:

- **Gastrointestinal disorders:** Effective treatment for diarrhea conditions
- **Deodorant properties:** Natural odor-controlling capabilities
- **Antiperspirant effects:** Reduction of sweating and skin texture modification
- **Healing promotion:** Acceleration of natural healing processes

ZINC SULPHATE 🤍

Molecular Formula: $ZnSO_4 \cdot 7H_2O$
Molecular Weight: 287.54 gm

Preparation

Zinc sulphate is prepared through multiple synthetic pathways:

Primary method: $ZnO + H_2SO_4 \rightarrow ZnSO_4 + H_2O$ (Action of dilute sulphuric acid on zinc oxide)

Alternative method: $ZnS + 2O_2 \rightarrow ZnSO_4$ (Heating zinc sulphide in air)

Properties

Zinc sulphate appears as colorless, odourless crystals with a characteristic metallic taste. The compound effloresces in dry air, losing water of crystallization. It demonstrates excellent solubility in water and glycerine but remains insoluble in alcohol.

Uses

- **Primary application:** Functions as an effective astringent agent
- **Emetic properties:** When used internally, acts as an emetic agent for poison treatment
- **Biochemical activity:** Demonstrates significant protein precipitation activity

POTASH ALUM 💎

Molecular Formula: $KAl(SO_4)_2 \cdot 12H_2O$
Molecular Weight: 474.33 g
Synonyms: Aluminium potassium sulphate

Preparation

Potash alum is prepared by adding a concentrated solution of potassium sulphate to a hot solution containing equimolar proportions of aluminium sulphate. This process requires careful temperature control and stoichiometric precision to ensure proper crystal formation.

Properties

Potash alum occurs as large, colorless crystals that are completely odourless and possess a sweet astringent taste. The compound demonstrates excellent water solubility but remains insoluble in alcohol, which determines its pharmaceutical applications and formulation options.

Uses

- **Primary applications:** Functions as both an astringent and antiseptic agent
- **Biochemical properties:** Demonstrates significant protein precipitation capabilities
- **Pharmaceutical applications:** Used as a pharmaceutical aid in various formulations

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Summary 📚

This comprehensive unit covers five major categories of miscellaneous pharmaceutical compounds, each serving distinct therapeutic purposes. From expectorants that facilitate respiratory clearance to astringents that promote tissue healing, these compounds represent fundamental tools in

pharmaceutical practice. Understanding their preparation methods, chemical properties, and therapeutic applications is essential for pharmaceutical professionals working in clinical, industrial, and research settings.