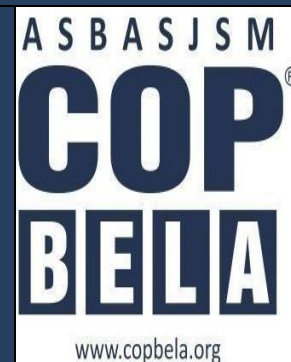


Amar Shaheed Baba Ajit Singh Jujhar Singh Memorial

COLLEGE OF PHARMACY

(An Autonomous College)

Bela (Ropar) Punjab



Program	B. Pharmacy
Semester	1 st
Subject /Course	Pharmaceutical Inorganic and Analytical Chemistry
Subject/Course ID	Pharmaceutical Inorganic and Analytical Chemistry/BP106T
Module No.	05
Module Title	Miscellaneous Compounds: Expectorants, Emetics, Haematinics, Poison and antidote
Course coordinator	Ms. Pooja Devi
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LO	Particular
1.	Explain the mechanism of action, properties, and therapeutic uses of expectorants, emetics, haematinics, and antidotes.
2.	Differentiate the pharmaceutical characteristics and clinical applications of Potassium iodide, Ammonium chloride, Copper sulphate, Sodium potassium tartrate, Ferrous sulphate, Ferrous gluconate, and Sodium thiosulphate.
3.	Apply the knowledge of miscellaneous compounds for the appropriate selection and safe use in the management of respiratory disorders, anaemia, poisoning, and related conditions.
4.	Evaluate the role of antidotes in poisoning and justify the selection of suitable inorganic compounds based on their mechanism of action, efficacy, and safety.

Module Content Table

Sr. no.	Topic
1.	Expectorants: Potassium iodide, Ammonium chloride*.
2.	Emetics: Copper sulphate*, Sodium potassium tartrate.
3.	Haematinics: Ferrous sulphate*, Ferrous gluconate
4.	Poison and Antidote: Definition, classification of antidotes, Sodium thiosulphate

MISCELLANEOUS AGENTS

Miscellaneous compounds are a group of important inorganic pharmaceutical substances that do not belong to the major categories such as gastrointestinal agents, electrolytes, or radiopharmaceuticals, but play a significant role in the prevention and treatment of various medical conditions. These compounds are widely used as expectorants, emetics, haematinics, and antidotes because of their specific pharmacological actions.

Expectorants such as Potassium iodide and Ammonium chloride help loosen and expel mucus from the respiratory tract. Emetics, including Copper sulphate and Sodium potassium tartrate, induce vomiting in selected cases of poisoning, although their use has become limited due to safety concerns. Haematinics like Ferrous sulphate and Ferrous gluconate are essential for the prevention and treatment of iron deficiency anaemia by promoting haemoglobin synthesis. Sodium thiosulphate serves as an important antidote in the management of cyanide poisoning by converting toxic cyanide into a less toxic compound that can be excreted from the body.

EXPECTORANTS

Expectorants are the drugs that help in removing sputum from the respiratory tract. These drugs either increase the fluidity or reduce the viscosity of sputum or increase the volume of fluids that are to be expelled out from the respiratory tract by coughing.

Cough is a productive reflex help to expel irritant matter from the respiratory tract to clean the air way.

Infections that cause coughing can be due to chemical irritants, allergies, retained body secretions and presence of foreign bodies that stimulates the nerve endings in the respiratory tract.

Coughing can be of two types:

1. **Productive Cough:** It is a type of cough that produces sputum or exudates producing cough and is often associated with asthma and bronchitis.
2. **Unproductive Cough:** Otherwise called as dry cough or irritative cough, which may be caused by colds or by inhalation of irritating dust and gases and produces no sputum or any other discharges.

The latin word '**Expectorate**' means 'to drive from the chest'. Expectorants are drugs used to help in the removal i.e. expulsion of secretions or exudate from the trachea, bronchii or lungs. Hence, they are used in the treatment of cough.

Expectorants act upon the respiratory tract in two ways:

- By decreasing the viscosity of the bronchial secretion and facilitating their elimination local irritants are expelled and ineffectual coughing is alleviated.
- By increasing the amount of respiratory tract fluid, a demulcent action is exerted on dry mucosal lining, thus relieving the unproductive cough.

Classification of expectorants

Based on mechanism of action expectorant are classified into two categories:

1. **Sedative type of expectorants**
2. **Stimulant type of expectorants**

1. Sedative type of expectorants

These are stomach irritants. They produce their effect through stimulation of gastric reflexes. Example: Ipecac, Ammonium chloride, Potassium iodide.

2. Stimulant type of expectorants

These are the expectorants which bring about stimulation of secretory cells of the respiratory tract directly or indirectly. Since these drugs stimulate secretion, more fluid gets produced in the respiratory tract and sputum is diluted. Example: Eucalyptus, lemon.

AMMONIUM CHLORIDE

Molecular Formula: NH_4Cl

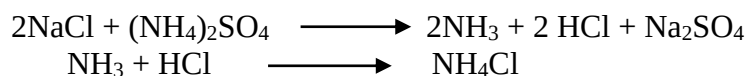
Molecular weight: 53.49g/mol

Synonyms: Ammonium muriate, sal ammoniac or anchlor

According to IP Standards: It is having not less than 99.5% NH_4Cl

Preparation:

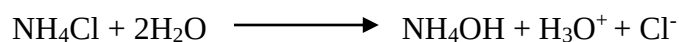
1. Commercially, it is prepared by neutralizing ammonia with HCl. The solution is evaporated till crude, crystalline mass of ammonium chloride is obtained.
2. It is also prepared by treating ammoniacal gas with lime and the liberated NH_3 is passed into HCl solution. The crude ammonium chloride obtained occurs as tough, crystalline masses. The crude salt of ammonium chloride is purified either by crystallization or by sublimation.
3. Ammonium chloride is also produced by heating ammonium sulphate with sodium chloride.



Properties:

- It is a white fine or coarse crystalline powder.

- It is odorless.
- It is having cool saline test.
- It is slight hygroscopic in nature.
- It is soluble in water, alcohol and glycerine.
- 0.8% w/v of ammonium chloride is isotonic with serum.
- Freshly prepared aqueous solutions are neutral to litmus but become acidic on standing because of hydrolysis.



Assay Procedure:

Weigh accurately about 0.1 gm of sample, dissolved in 20 ml of water and 5 ml of formaldehyde. Allow the reaction to take place for 2 minutes and titrate slowly with 0.1N NaOH solution using phenolphthalein as an indicator. Appearance of pink is the endpoint.

Principle:

Ammonium chloride is assayed based on acid base titration in which specified weight of the substance is dissolved in water and treated with formaldehyde solution liberating equivalent amount of HCl. This HCl is determined by titrating with standard NaOH by using phenolphthalein as an indicator.

Uses:

1. It acts in maintaining acid base equilibrium of body fluids. Deamination of amino acid produces ammonia which is excreted in kidney and in the process sodium ions are retained.
2. The diuretic effect is because of utilization of ammonium cation in conversion into urea and in the process H^+ and Cl^- are formed. The H^+ ions react with bicarbonate and carbon dioxide and water are produced.
3. Ammonium chloride acts as mild expectorant by causing local irritation which produces increasing secretion of respiratory tract and makes the mucus less viscous.

Storage: Stored in tightly closed containers.

POTASSIUM IODIDE

Molecular Formula: KI

Molecular weight: 166 g/mol

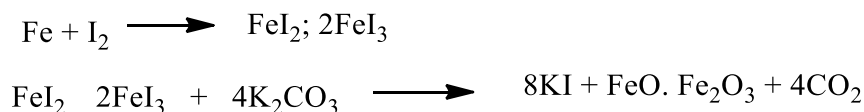
Synonyms: Kalii iodidum, Pot. Iod.

According to IP Standards: It is having not less than 99% of potassium iodide.

Preparation:

There are two different processes for the preparation of potassium iodide which have been the same for the preparation of potassium bromide and also for sodium iodide.

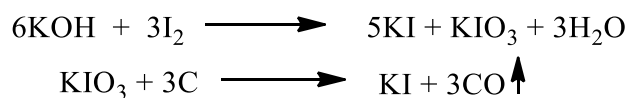
1. It is obtained by the action of iodine on moist iron fillings to form ferro-ferric iodide which then gets decomposed with potassium carbonate.



Ferroso-ferric oxide is filtered out. The filtrate is concentrated to get potassium iodide. The salt may be purified by recrystallization.

2. It is also prepared by treating a hot aqueous solution of KOH with iodine in excess to form a mixture of potassium iodide and potassium iodate.

The solution is concentrated and then treated with excess of charcoal powder followed by evaporating the mixture to dryness followed by ignition. The charcoal reduces the iodate to iodine, utilizing thus the total iodine to get the potassium iodide. Then it is filtered and potassium iodide is obtained by crystallization.

**Properties:**

- It occurs as colorless, transparent or opaque crystals or a white granular powder.
- It is odorless, having saline and bitter taste.
- The salt is deliquescent in moist air.
- It is soluble in water, glycerine, alcohol and acetone.

Uses:

1. It is used internally for supplying iodine for treatment of thyroid deficiency.
2. It is used as expectorant in cough mixture and also as a diuretic.
3. It has a mild antifungal activity.

EMETICS

Emetics are the drugs that remove fluid from respiratory tract that is expelled through the oral cavity. Emetics find its value in the treatment of poisoning cases. These acts either by local irritation of gastric mucosa (example: ammonium bicarbonate) or directly on the chemoreceptor trigger zone in the floor of fourth ventricle in medulla.

Sometimes these are added to cough preparations in low doses to stimulate flow of respiratory tract secretions.

In case of poisoning, some poisons remain in stomach for sometime before entering intestine where they get absorbed. Before this, emetics are given to patients for physically expelling the toxic substances and to reduce the harmful effects and may be able to save a patient's life.

Definition

Emetics are chemical agents that produce vomiting by stimulating the vomiting centre directly or by irritating the gastric mucosa, thereby helping to expel harmful substances from the stomach.

Classification of Emetics

Emetics are broadly classified into two types based on their mechanism of action:

1. Centrally Acting Emetics

These drugs stimulate the **chemoreceptor trigger zone (CTZ)** present in the medulla oblongata, which in turn activates the vomiting centre. **Example:** Apomorphine (rarely used today)

2. Peripherally Acting (Reflex) Emetics

These drugs irritate the gastric mucosa, producing nerve impulses that stimulate the vomiting centre through the vagus nerve. **Examples:** Copper sulphate, Sodium potassium tartrate (Tartar emetic)

Mechanism of Action

Copper Sulphate

Copper sulphate acts as a **local gastric irritant**. It irritates the mucous membrane of the stomach, which stimulates sensory nerve endings. These impulses travel through the vagus nerve to the vomiting centre in the medulla oblongata, resulting in vomiting. Copper sulphate also has mild astringent and antiseptic properties.

Sodium Potassium Tartrate (Tartar Emetic)

Sodium potassium tartrate produces vomiting by irritating the gastric mucosa. It also has a weak central action on the chemoreceptor trigger zone. Because of its toxic effects on the heart and liver, it is no longer recommended as an emetic.

Ideal Properties of an Emetic

An ideal emetic should:

- Produce vomiting rapidly.
- Empty the stomach effectively.
- Be safe and non-toxic.
- Not produce prolonged nausea.
- Not cause damage to the stomach or oesophagus.
- Be easy to administer.
- Have a predictable action.

COPPER SULPHATE

Molecular Formula: $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$

Molecular Weight: 249.7 g/mol

Synonym: Blue vitriol

According to IP Standards: It is containing not less than 98.5% in not more than 101% of copper sulphate.

Preparation:

It is obtained by roasting copper containing sulphide ore in presence of air or by heating copper in a furnace with Sulphur. The mixture of copper sulphate and the copper oxide formed in the above processes is treated with dilute Sulphuric acid. The resulting solution is filtered, concentrated and allowed to crystallized and are separated out.

It is also obtained by treating a granulated copper in the presence of air with Sulphuric acid. The oxygen of air assists the reaction.



The solution is filtered, and evaporated to crystallization when crystals of copper sulphate separate out.

Properties:

- It is deep blue, tricyclic crystals of pentahydrate or as blue crystalline granules or powder.
- It efflorescence slowly in dry air and crystals is covered with a white anhydrous salt.
- It is soluble in water, very soluble in boiling water, soluble in glycerol and almost insoluble in alcohol.
- The salt has been stable to heat upto 60°C. At higher temperature it decomposes into SO₂, oxygen and black cupric oxide.

**Assay Procedure:**

An accurately weighed sample is first of all dissolved in water with the aid of small amount of dilute Sulphuric acid. About 1 gram equivalent weight is put into the iodine flask and treated with an excess of potassium iodide, 5 ml of acetic acid is added and the contents are shaken well. The liberated iodine is made to titrate with 0.1N sodium thiosulphate until the dark iodine colour changes to yellow. Now 1 ml starch is added and titration is continued until blue colour is appeared. Towards the end point of titration 2 gm of potassium thiocyanate is added the contents are stirred and the titration is continued until the blue colour gets disappears.

Each ml of 0.1 Na₂S₂O₃ is equivalent to 0.02497 grams of copper sulphate.

Principle:

The principle is based upon the oxidation reduction reaction. Where the copper sulphate is dissolved in water to this slight excess of potassium iodide is added followed by acetic acid. It yields cupric iodide. Cupric iodide is unstable and it decomposes to yield cuprous iodide with the liberation of free iodine. The liberated iodine is titrated with standard sodium thiosulphate solution by using starch as an indicator. Titration is continued until faint blue colour persists. 2 grams of Potassium thiocyanate is then added in titration is continued until blue colour disappears.

Uses:

- At a dose of 300 mg in 30 ml it is used as emetic.
- Used as a chemical antidote in phosphorus poisoning.
- Externally used as an astringent and fungicide.
- Used as an ingredient of Benedict's and Fehling's reagent.

SODIUM POTASSIUM TARTARATE

Synonym: Rochelle salt

Chemical Formula: $C_4H_4NaKO_6$

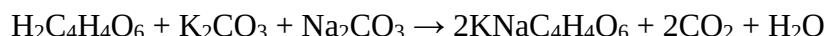
Molecular Weight: 282.2 g/mol

Properties: It is a colorless or white colorless crystalline powder with a cooling saline taste. It is soluble in water and insoluble in alcohol.

The crystals melt at about 75, when ignited the crystalline powder becomes red and leaves a residue of sodium and potassium carbonate.

Preparation of Sodium Potassium Tartrate (Rochelle Salt):

Sodium potassium tartrate (Rochelle salt) is prepared by neutralizing tartaric acid with potassium carbonate and sodium carbonate (or sodium bicarbonate). During the reaction, carbon dioxide is evolved, and after complete neutralization the solution is concentrated and crystallized to obtain sodium potassium tartrate tetrahydrate.



(Using sodium bicarbonate instead of sodium carbonate is also possible.)

Uses:

It is used as a cathartic, as the tartrate anion has very poor intestinal permeability. It is also used in the food industry as a stabilizer in cheese and meat product.

Storage:

It should be store in airtight containers.

HAEMATINICS

Haematinics: Haematinics are the agents used for formation of blood to treat various types of anemias. These include: Iron, Vitamin B₁₂ and Folic Acid.

Anemia occurs when the balance between production and reduction of red blood cells is decreased or Decreased capacity of RBCs to carry oxygen to tissues.

Anemia occurs when the balance between production and destruction of RBCs is disturbed by:

- a) Blood loss (acute or chronic)
- b) Impaired red cell formation due to :
Deficiency of essential factors, i.e. iron, Vitamin B₁₂ and Folic Acid.
Bone marrow depression (hypoplastic anemia), erythropoietin deficiency.
- c) Increased destruction of RBCs (hemolytic anemia)
Iron deficiency occurs due to: Malnutrition, Loss

Types of Anemia:

Classification	Type of Anaemia	Cause	Examples
Morphological (Based on size and colour of RBCs)	Microcytic Hypochromic Anaemia	RBCs are small and contain less haemoglobin.	Iron deficiency anaemia, Thalassaemia
	Normocytic Normochromic Anaemia	RBCs are normal in size and colour, but their number is reduced.	Aplastic anaemia
	Macrocytic Anaemia	RBCs are larger than normal due to defective DNA synthesis.	Megaloblastic anaemia
Etiological (Based on Cause)	Blood Loss (Hemorrhagic) Anaemia	Excessive loss of blood (acute or chronic).	Trauma, Surgery
	Anaemia due to Decreased RBC Production	Bone marrow fails to produce adequate RBCs.	Iron deficiency anaemia, Megaloblastic anaemia, Aplastic anaemia
	Haemolytic Anaemia	RBCs are destroyed faster than they are produced.	Sickle cell anaemia, Thalassemia

- 1. Microcytic anaemia:** The size of red blood cell is smaller than normal size.
- 2. Macrocytic anaemia:** The size of red blood cell is larger than normal.
- 3. Microcytic hypochromic anaemia:** The size of the red blood cells (RBC) is found smaller than the normal size and the haemoglobin amount is less than the normal value.
- 4. Aplastic anaemia:** It is a condition in which there is inadequate red blood cells formation as a result of degeneration of the bone marrow. RBCs present are of the normal size.
- 5. Haemolytic anaemia:** It is a condition in which there is increased destruction of red blood cells. The red cell present is of normal size and contains normal quantity of haemoglobin.
- 6. Iron deficiency anaemia:** It is due to inadequate of iron or loss of iron by haemorrhage. In this condition, the red blood cells are small in size and contain less than the normal quantity of haemoglobin (hypochromic).
- 7. Megaloblastic anaemia:** It the condition in which erythrocytes (Red blood cells) fail to mature because of deficiency of vitamin B12 or folic acid.
- 8. Sickle cell anaemia:** In this condition, mutant hemoglobin molecule undergo polymerization under low oxygen tension, the shape of RBC changes from biconcave disc to elongated sickle like shape.
- 9. Pernicious anaemia:** It occurs in old people for lack of intrinsic factor essential for absorption of vitamin B12. The maturation of RBC

Haematopoiesis: The production of circulating erythrocytes, leukocytes and platelets from undifferentiated stem cells, is called haematopoiesis.
It requires: Iron-for Hb formation, Vitamin B₁₂, Folic Acid, Hematopoietic growth factors, Proteins that regulate the proliferation and differentiation of hematopoietic cells.

Distribution of Iron in Body

Iron is an essential body constituent. Total body iron in an adult is 2.5-5 g. It is more in men than in women. It is distributed into:

Haemoglobin: 66%

Iron stores as ferritin and hemosiderin: 25%

Myoglobin (in muscles): 3%

Parenchymal iron (in enzymes): 6%

Haemoglobin is a protoporphyrin, each molecule having 4 iron containing heme residues. It has 0.33% iron, thus loss of 100 ml of blood means loss of 50 mg elemental iron. To raise the Hb level of blood by 1g/dl about 200 mg of iron is needed. Iron is stored only in ferric form, in combination with a large protein apoferritin.

Daily Requirement of Iron

To make good average daily loss, iron requirements are:

Adult male: 0.5-1 mg (13 µg/kg)

Adult female: 1-2 mg (21 µg/kg)

Infants: 60µg/kg

Children: 25 µg/kg

Pregnancy: 3-5 µg/kg

Dietary Sources of Iron

Rich: Liver, egg yolk, oyster, dry beans, dry fruits, wheat germ, yeast

Medium: Meat, chicken, fish, spinach, banana, apple

Poor: Milk and its products, root vegetables.

Factors Facilitating Iron Absorption

Acid: Acid enhances dissolution and reduction of ferric iron.

Reducing Substances: Ascorbic acid reduces ferric iron and forms absorbable complexes.

Meat: Meat also facilitates iron absorption by increasing HCl secretion.

Pregnancy/Menstruation: Due to increased iron requirement

Iron Deficiency Anaemia

Iron deficiency anaemia manifests as hypochromic, microcytic anaemia in which:

- i) Erythrocyte mean cells volume is low
- ii) Mean cell Hb concentration is low

Causes:

A. People with increased iron requirements

- i) Infants
- ii) Children during rapid growth
- iii) Pregnant and lactating women
- iv) Patients of chronic kidney disease

B. Inadequate iron absorption seen in

- i) Gastrectomy (A gastrectomy is a medical procedure where all or part of the stomach is surgically removed)
- ii) Generalized malabsorption
- iii) Females, menstrual bleeding or during postmenopausal
- iv) Males and most common site is GIT.

C. Adults due to blood loss.

Treatment of Iron Deficiency

Oral preparations can be used. Oral preparation is present in the form of salts like: **Ferrous gluconate, Ferrous Sulphate.**

Parenteral Therapy: Iron Dextran, Sodium ferric gluconate complex, Iron Sucrose.

Adverse effect of oral iron preparation: Individuals differ in susceptibility like epigastric pain, heartburn, nausea, vomiting, staining of teeth, metallic taste, blotting, colic and constipations more common (believed to be due to astringent action of iron).

Formula for calculating total dose of iron in grams

Dose of iron in grams = $0.25 \times (\text{normal Hb} - \text{Patients Hb})$

Iron requirement (mg) = $4.4 \times \text{body weight (kg)} \times \text{Hb deficit (g/dl)}$

[Hb = Haemoglobin]

FERROUS SULPHATE

Molecular Formula: $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$

Molecular weight: 278.02 g/mol

Synonym: Green vitriol, Iron vitriol, Copperas

Properties:

Appearance: White crystals (anhydrous), white yellow crystals (monohydrate), blue green crystals (heptahydrate)

Crystal structure: Orthorhombic (anhydrous), monoclinic (heptahydrate)

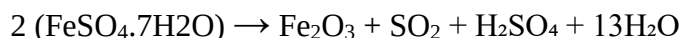
Odor: Odorless

Taste: Astringents and metallic taste

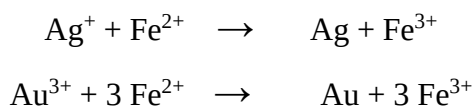
Density: 3.65 g/cm^3 (anhydrous)

Solubility: Soluble in boiling water but insoluble in alcohol.

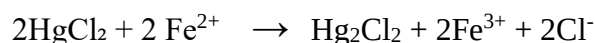
1. Ferrous sulphate when heated, decomposes to yield ferric oxide, sulphur dioxide and sulphuric acid.



2. Ferrous sulphate reduces the salts of silver and gold to their corresponding metals. With some alkali sulphates, it forms double salts.



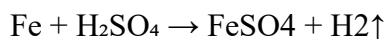
3. In presence of light, ferrous sulphate reduces mercuric chloride to mercurous chloride.



Preparation:

It is having not less than 98.0 per cent not more than 103.3 N of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$.

Ferrous sulphate is obtained by dissolving iron in excess of dilute Sulphuric acid. After the effervescence ceases, the liquid is filtered, concentrated and cooled. The green crystals formed are separated by filtration at room temperature. In all these operations undue exposure to air is prevented because ferrous sulphate is oxidised readily on exposure to moist air and the crystals get coated with brownish yellow ferric sulphate.



Assay: Weigh accurately 1 gm of ferrous sulphate (FeSO_4) and dissolve in 20 ml of diluted sulphuric acid. Titrate the contents of the flask with 0.1 N potassium permanganate (KMnO_4) until a permanent pink colour is obtained.

Uses: Ferrous sulphate finds a use as a hematinic that is for promoting formation of hemoglobin in anaemias caused due to iron deficiency. Excessive use or consumed mistakenly by children may cause gastrointestinal irritation, shock, etc. Orally, it is administered in the form of tablets or capsules. Many oral preparations, including liquids are marketed. In order to stabilise the ferrous form, certain reducing agents such as hypo phosphorus acid and dextrose are included in such formulations. Ferrous sulphate solutions may bring about discoloration of teeth in contact.

Also finds a use in dyeing fabrics and in tanning leather.

Storage: It should be stored in a tightly closed container.

FERROUS GLUCONATE**Molecular formulae:** $C_{12}H_{22}FeO_{14} \cdot 2H_2O$ **Molecular weight:** 482.2**Properties:**

1. **Appearance:** Yellowish-grey to pale greenish-yellow crystalline powder or granules.
2. **Odour:** Odourless or almost odourless.
3. **Taste:** Slightly sweet with a metallic taste.
4. **Solubility:** Freely soluble in water and practically insoluble in alcohol.
5. **Reaction:** Its aqueous solution is **slightly acidic**.

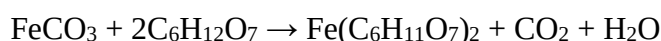
Chemical Properties

8. Contains **ferrous iron (Fe^{2+})**, which is readily absorbed from the gastrointestinal tract.
9. On exposure to **air and moisture**, ferrous ions are gradually oxidized to ferric (Fe^{3+}) ions, causing discoloration and reduced therapeutic activity.
10. Forms stable complexes with gluconic acid, improving its stability and tolerability compared to some other iron salts.

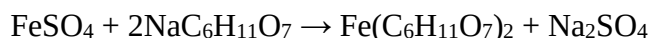
Preparation:

1. Ferrous gluconate is prepared by the reaction of gluconic acid (or sodium gluconate) with a ferrous salt, such as ferrous sulphate, under controlled conditions. The ferrous ion (Fe^{2+}) combines with gluconate ions to form ferrous gluconate. The solution is then concentrated, crystallized, filtered, and dried to obtain the final product.

Using **gluconic acid**:



2. Also prepared by double decomposition reaction between ferrous sulphate and sodium gluconate. Ferrous ions (Fe^{2+}) react with gluconate ions to form ferrous gluconate, while sodium sulphate remains in the mother liquor. The product is then crystallized, filtered, washed, and dried.



Assay: (By using complexometric titration) About 1.5 g of ferrous gluconate is dissolved in 75 ml of water and 15 ml of dilute sulphuric acid in a 300 ml of conical flask which is fitted with Bunsen's valve. To this 0.25 g of zinc dust is added and this is allowed to stand for 20 minutes at room temperature or until the solution becomes colourless. The solution is filtered through a sintered crucible. The crucible and contents are first washed with 10 ml of dilute sulphuric acid

and then with 10 ml of water. The combined filtrate and washings are immediately titrated with 0.1 M ceric ammonium sulphate $\text{Ce}(\text{NH}_4)_2\text{SO}_4$, using ferroin sulphate solution as an indicator.

Each ml of N/10 ceric ammonium sulphate = 0.04461 g of ferrous gluconate.

Storage: It is stored in well-closed containers which are protected from light.

Uses: Similar to any other ferrous salt, it finds use as a hematinic. It is regarded to cause less side effects than other ferrous salts including ferrous sulphate. It is generally given in the form of tablets or as elixirs. It is used for the preparation of ferrous gluconate tablets.

POISON AND ANTIDOTE

Poison may be defined as any substance that when introduced into or absorbed by a living organism causes illness or death. Poisoning occurs in many ways:

- i) by accidentally
- ii) by use of recreational substances (such as cannabis, opiates etc.)
- iii) by intentional behavior
- iv) by occupational exposure

So, as to counteract the effects of a poison, antidotes are used.

Antidotes may be defined as those substances which react specifically with an ingested poison or toxic substance or an overdose of a potent drug. They act either by neutralising the poison or its toxic effect or pharmaceutically (antagonistic action) or chemically by converting them to non-toxic or less toxic forms (e.g., chelates, acids, insoluble derivatives).

It is possible to classify antidotes on the basis of their mechanism of action as follows:

(1) Physiological antidotes: They act by producing the effect opposite to that of poison, or to counteract the effect of poison physiologically. For example, **Naloxone** (opioid poisoning), Atropine (organophosphorus poisoning), Vitamin K (warfarin overdose).

(2) Chemical antidotes: They act usually by combining with the poison and thus changes its nature and poison cannot act any more. For example, **Sodium thiosulphate** (cyanide poisoning), Potassium permanganate (some poisonings).

(3) Mechanical antidotes: They usually act by preventing the absorption of poisons in the body or expelling out the poison by emesis or elimination through urine. For example, **activated charcoal**, Milk, Egg albumin

The Poisoning of the body can be ascribed to various reasons. The most common poisoning occurs because of heavy metals as the environment is getting richer in heavy metals, or metallic contamination of food and water. Many times, the metals get leached from eating utensils and cookware's can give rise to inadvertent poisoning. The poisoning can also occur because of the insecticides or pesticides. poisoning can occur because of excessive use of drugs (drug over doses).

HEAVY METALS AND THEIR ANTAGONISTS

The common heavy metals responsible for poisoning are the salts of arsenic, lead, mercury, iron and cadmium. Heavy metal poisoning occurs because of overdose intake or because of their incomplete metabolism in the body. Depending upon the content and type of heavy metal the

toxic effects can be seen in the patients. The most widely method adopted is to use such heavy metal antagonist which will be able to form specific chelate or complex with the heavy metals.

The initial treatment in heavy metal poisoning is to administer activated charcoal for adsorbing heavy metal or poison. It is followed by administering compounds which are able to produce emesis. This eliminates any poison left in stomach being absorbed in circulation. Some inorganic compounds precipitate heavy metals and prevent their absorption.

1. Activated Charcoal

Preparation: Commercially, it is obtained as a residue during destructive distillation of various organic matters or from burning of organic materials in a special manner. The coarse material is crushed and powdered.

Properties: It is a fine black, odourless, tasteless powder having smooth touch and free from gritty particles. It is almost insoluble in usual solvents. The fine powder provides more surface area for adsorbent properties.

Action and Uses: It is a general type of adsorbent which finds use in poisoning. It not only adsorbs heavy metals. but also adsorbs drugs such as hypnotics, sedatives, alkaloids etc. and also gases like carbon monoxide, carbon dioxide, nitrous oxide etc. It is normally employed in the ratio of 5:1 or 10: 1 (charcoal to poison). It is administered in the form of tablets. It also finds use in diarrhea to adsorb toxins.

2. Light Kaolin

Chemical formula: $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$

It is a native hydrated aluminium silicate which is freed from most of its impurities by elutriation and dried. It does not contain any dispersing agent.

Preparation: It is prepared from natural clay by powdering and separating particles by electrical sedimentation. It must be purified from gritty particles and other impurities.

Properties: It is light, white powder free from gritty particles. It is odourless, almost tasteless, unctuous to the touch.

Storage: It is stored in well-closed containers.

Dose: 15-75 g

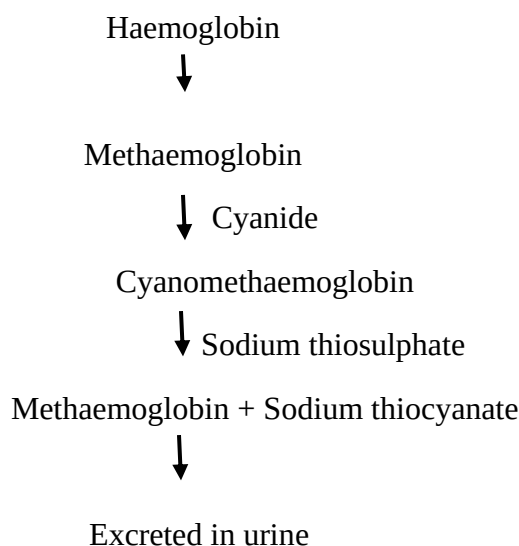
Action and uses: Kaolin is mainly used as adsorbent in treatment of food and alkaloidal poisoning as it adsorbs toxins. Besides adsorbent, it also finds use externally in preparation of kaolin poultice. For internal use it is the light kaolin which is commonly employed.

CYANIDE POISONING

Cyanide poisoning normally takes place accidentally or when cyanide poison is taken intentionally to commit suicide. In cyanide poisoning cyanide ion combines with ferric ion of cytochrome oxidase, an enzyme which is responsible for electron transfer reactions. This causes stoppage of cellular respiration and metabolic reaction. Cyanide poisoning is usually fatal, if it is not treated immediately and instantaneously.

For cyanide poisoning two inorganic antidotes such as sodium nitrite and sodium thiosulphate are used. Both are used in conjunction with each other.

First of all, an intravenous infusion of sodium nitrite injection is given. This is then followed by sodium thiosulphate infusion intravenously. The sodium nitrite is able to convert haemoglobin to methaemoglobin, which binds cyanide ions. Thus, cyanide poisoning of cytochrome oxidase gets prevented, which is the main toxic action of cyanides. However, the cyanide-methaemoglobin complex slowly gets dissociated. The sodium thiosulphate converts this immediately to non-toxic thiocyanate, which gets excreted by the kidney. Another compound dicobalt edetate is even more specific and directly reacts with cyanide ions to yield a stable non-toxic cobaltcyanooedetate complex. Both dicobalt edetate and sodium nitrite are toxic.



SODIUM THIOSULPHATE

Molecular formulae: $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$

Molecular weight: 248

Synonym: Sodium hyposulphate

Properties:

Appearance: Colourless, transparent, monoclinic crystals or crystalline powder.

Odour: Odourless.

Taste: Saline and slightly bitter.

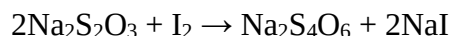
Solubility: Freely soluble in water and practically insoluble in alcohol.

Chemical Properties

1. On heating, sodium thiosulphate loses its water of crystallization and decomposes at higher temperatures.
2. It reacts with dilute acids to produce sulphur dioxide, sulphur, and water.



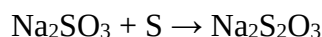
3. It is a reducing agent and reacts readily with oxidizing agents.
4. It reacts with iodine, reducing it to iodide, and is therefore widely used in iodometric titrations.



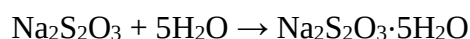
5. Forms stable complexes with certain metal ions, contributing to its detoxifying action.

Preparation:

Sodium thiosulphate is prepared by boiling an aqueous solution of sodium sulphite with sulphur. During the reaction, sulphur combines with sodium sulphite to form sodium thiosulphate. The solution is then filtered, concentrated, and crystallized to obtain sodium thiosulphate pentahydrate crystals.



On crystallization:



Assay: It is assayed by titration with standard iodine solution with starch as indicator. About its 0.8 g accurately weighed is made to dissolve in about 30 ml of water in a conical flask. This is titrated with 0.1 N (standard) iodine solution added from a burette. Towards the end-point, 3 ml of starch solution is added as indicator. The approach of end-point can be recognised, by the yellow colour of iodine, which gets discharged by shaking for a few seconds. Each ml of 0.1 N iodine is equivalent to 0.02482 g of sodium thiosulphate.

Uses: Sodium thiosulphate has been included in Pharmacopoeia as an antidote for cyanide poisoning. For this purpose a 10% w/v solution is used intravenously although a 2.98% w/v solution is isotonic with serum. The solution can be sterilised by autoclaving and is relatively non-toxic. Solutions may slowly deteriorate and become cloudy because of precipitation of

sulphur. Such injections have to be rejected. It reacts with the cyanide ion to form relatively harmless thiocyanate.

Sodium thiosulphate is also a very important reducing agent (as hypo in photographic processing) and is used as a standard titrant in iodimetry analysis.

Storage: It should be stored in tightly closed containers.

Points to Remember:

- ✓ **Expectorants** increase the secretion of respiratory tract fluids, making mucus less viscous and easier to expel by coughing.
- ✓ **Potassium iodide** acts as a saline expectorant by increasing bronchial secretions, whereas **ammonium chloride** acts both as an expectorant and a systemic acidifier.
- ✓ **Emetics** induce vomiting and were traditionally used in the management of certain poisoning cases; however, their use is now limited because safer treatment options are available.
- ✓ **Copper sulphate** and **sodium potassium tartrate (tartar emetic)** are examples of inorganic emetics, but they are rarely used today due to their toxic effects.
- ✓ **Haematinics** are substances that increase haemoglobin levels and promote the formation of red blood cells in the treatment of iron deficiency anaemia.
- ✓ **Ferrous sulphate** is the most commonly prescribed oral iron preparation because it contains a higher percentage of elemental iron than many other iron salts.
- ✓ **Ferrous gluconate** contains less elemental iron than ferrous sulphate but is generally better tolerated and produces fewer gastrointestinal side effects.
- ✓ **Anaemia** may result from blood loss, decreased red blood cell production, or increased destruction of red blood cells; iron deficiency anaemia is the most common nutritional anaemia.
- ✓ An **antidote** is a substance that prevents, neutralizes, or reduces the toxic effects of a poison. Antidotes are classified as **physical, chemical, physiological, and chelating agents**.
- ✓ **Sodium thiosulphate** is a **chemical antidote** used in the treatment of **cyanide poisoning**. It acts as a sulphur donor and converts toxic cyanide into the less toxic **thiocyanate** in the presence of the enzyme **rhodanese**.
- ✓ Sodium thiosulphate is also an important **reducing agent** and is widely used in **iodometric titrations** in pharmaceutical analysis.
- ✓ Iron preparations should be stored in **well-closed containers** to protect them from moisture and oxidation, while sodium thiosulphate should be protected from **heat, moisture, and acids**.
- ✓ Knowledge of the **mechanism of action, preparation, assay, uses, storage, and pharmaceutical importance** of these compounds is essential for their safe and rational use in pharmaceutical practice.

Remember the four groups in this module:

- **Expectorants** → Remove mucus
- **Emetics** → Induce vomiting
- **Haematinics** → Increase haemoglobin
- **Antidotes** → Neutralize poison

Case-Based Learning (CBL)

Case: Iron Deficiency Anaemia

A 26-year-old female visits the hospital with complaints of fatigue, weakness, dizziness, and pale skin. She has a history of heavy menstrual bleeding for the past six months. Laboratory investigations reveal a haemoglobin level of 8.5 g/dL, confirming iron deficiency anaemia. The physician prescribes Ferrous sulphate tablets along with dietary advice.

Questions

1. What is the most probable diagnosis in this patient?
2. Why is Ferrous sulphate preferred for the treatment of this condition?
3. What counselling points should be given to the patient to improve the effectiveness of iron therapy?

Problem-Based Learning (PBL)

Problem: Management of Cyanide Poisoning

A laboratory worker accidentally inhales hydrogen cyanide gas while handling industrial chemicals. He develops difficulty in breathing, dizziness, confusion, and loss of consciousness. The emergency physician decides to administer Sodium thiosulphate as part of the treatment.

Questions

1. What type of poisoning is the patient suffering from?
2. Which antidote should be administered immediately and why?
3. Explain the mechanism of action of Sodium thiosulphate in cyanide poisoning.
4. What supportive measures should be provided to the patient along with antidote therapy?

Multiple Choice Questions**Expectorants (Potassium Iodide, Ammonium Chloride)**

1. Expectorants are drugs that:

- A. Suppress cough
- B. Relieve pain
- C. Promote expulsion of mucus from the respiratory tract
- D. Reduce fever

Answer: C

2. Which of the following is an inorganic expectorant?

- A. Potassium iodide
- B. Aspirin
- C. Paracetamol
- D. Ibuprofen

Answer: A

3. Potassium iodide acts mainly by:

- A. Depressing cough center
- B. Increasing bronchial secretions
- C. Causing bronchodilation
- D. Acting as an antihistamine

Answer: B

4. The chemical formula of potassium iodide is:

- A. KCl
- B. KI
- C. KBr
- D. NaI

Answer: B

5. Ammonium chloride has the chemical formula:

- A. NH_4Cl
- B. NaCl
- C. NH_4OH
- D. KCl

Answer: A

6. Ammonium chloride is used as:

- A. Sedative
- B. Expectorant
- C. Antacid
- D. Anticoagulant

Answer: B

7. Potassium iodide should be stored in:

- A. Open containers
- B. Airtight containers protected from light
- C. Wet containers
- D. Transparent bottles exposed to sunlight

Answer: B

8. Which ion is responsible for the expectorant action of potassium iodide?

- A. Sodium ion
- B. Chloride ion
- C. Iodide ion
- D. Calcium ion

Answer: C

9. Excess use of potassium iodide may produce:

- A. Diabetes
- B. Iodism
- C. Hypertension
- D. Anemia

Answer: B

10. Ammonium chloride belongs to which pharmacological class?

- A. Antacid
- B. Expectorant
- C. Analgesic
- D. Antiemetic

Answer: B

Emetics (Copper Sulphate, Sodium Potassium Tartrate)

11. Emetics are drugs used to:

- A. Stop vomiting
- B. Induce vomiting
- C. Reduce fever
- D. Relieve cough

Answer: B

12. Copper sulphate has the chemical formula:

- A. $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
- B. CuCl_2
- C. CuO
- D. CuCO_3

Answer: A

13. Copper sulphate acts as an emetic by:

- A. Stimulating the stomach lining
- B. Lowering blood pressure
- C. Increasing heart rate
- D. Neutralizing acid

Answer: A

14. Sodium potassium tartrate is commonly known as:

- | | |
|-------------------|---------------|
| A. Glauber's salt | C. Epsom salt |
| B. Rochelle salt | D. Borax |

Answer: B

15. Excessive use of copper sulphate may cause:

- | | |
|--------------------|-----------------|
| A. Kidney toxicity | C. Diabetes |
| B. Hair loss | D. Hypertension |

Answer: A

16. Which of the following is not an emetic?

- | | |
|------------------------------|----------------------|
| A. Copper sulphate | C. Potassium iodide |
| B. Sodium potassium tartrate | D. None of the above |

Answer: C

17. Emetics should generally not be used in poisoning by:

- | | |
|--------------------|-----------------------------|
| A. Food poisoning | C. Non-corrosive substances |
| B. Corrosive acids | D. Mild drug overdose |

Answer: B

18. Sodium potassium tartrate contains which two metal ions?

- | | |
|-------------------------|----------------------------|
| A. Sodium and calcium | C. Potassium and magnesium |
| B. Sodium and potassium | D. Sodium and iron |

Answer: B

19. Copper sulphate crystals are generally:

- | | |
|----------|-----------|
| A. White | C. Green |
| B. Blue | D. Yellow |

Answer: B

20. Copper sulphate is rarely used today because of:

- | | |
|--------------|-------------------------|
| A. High cost | C. Lack of availability |
| B. Toxicity | D. Poor taste only |

Answer: B

Haematinics (Ferrous Sulphate, Ferrous Gluconate)

21. Haematinics are used for the treatment of:

- | | |
|-----------------|---------------------------|
| A. Hypertension | C. Iron deficiency anemia |
| B. Diabetes | D. Asthma |

Answer: C

22. Ferrous sulphate supplies which essential mineral?

- | | |
|------------|--------------|
| A. Calcium | C. Zinc |
| B. Iron | D. Magnesium |

Answer: B

23. The chemical formula of ferrous sulphate is:

- | | |
|--|-------------------------------|
| A. $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ | C. Fe_2O_3 |
| B. FeCl_3 | D. $\text{Fe}(\text{NO}_3)_2$ |

Answer: A

24. Ferrous gluconate is preferred because it:

- | | |
|--------------------------------------|-----------------------|
| A. Contains no iron | C. Is more expensive |
| B. Causes fewer gastric side effects | D. Is poorly absorbed |

Answer: B

25. Ferrous sulphate is best absorbed in:

- | | |
|--------------------|------------------------|
| A. Alkaline medium | C. Neutral medium |
| B. Acidic medium | D. Basic solution only |

Answer: B

26. Which vitamin enhances iron absorption?

- | | |
|--------------|----------------|
| A. Vitamin D | C. Vitamin K |
| B. Vitamin C | D. Vitamin B12 |

Answer: B

27. A common side effect of oral iron therapy is:

- | | |
|-----------------|-----------------|
| A. Hair loss | C. Vision loss |
| B. Black stools | D. Hearing loss |

Answer: B

28. Ferrous gluconate belongs to the class of:

- | | |
|---------------|----------------|
| A. Antacid | C. Diuretic |
| B. Haematinic | D. Expectorant |

Answer: B

29. Iron deficiency leads to decreased synthesis of:

- | | |
|---------------|----------------|
| A. Hemoglobin | C. Albumin |
| B. Insulin | D. Cholesterol |

Answer: A

30. Ferrous salts are generally stored in:

- | | |
|------------------------|----------------------|
| A. Moist conditions | C. Open containers |
| B. Airtight containers | D. Plastic bags only |

Answer: B

Poison and Antidote

31. A poison is a substance that:

- | | |
|---|-----------------------|
| A. Improves digestion | C. Promotes appetite |
| B. Produces harmful effects on the body | D. Increases immunity |

Answer: B

32. An antidote is a substance that:

- | | |
|--|-----------------------|
| A. Increases toxicity | C. Causes poisoning |
| B. Neutralizes or counteracts a poison | D. Prevents infection |

Answer: B

33. Which of the following is a chemical antidote?

- | | |
|------------------------|----------|
| A. Activated charcoal | C. Milk |
| B. Sodium thiosulphate | D. Water |

Answer: B

34. Sodium thiosulphate is mainly used as an antidote for:

- | | |
|----------------------|----------------------|
| A. Cyanide poisoning | C. Alcohol poisoning |
| B. Iron poisoning | D. Mercury poisoning |

Answer: A

35. The chemical formula of sodium thiosulphate is:

- | | |
|--|---------------------|
| A. Na_2SO_4 | C. NaHSO_4 |
| B. $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ | D. NaCl |

Answer: B

36. Mechanical antidotes act by:

- | | |
|-----------------------------------|---------------------------------|
| A. Neutralizing poison chemically | C. Producing antibodies |
| B. Preventing poison absorption | D. Increasing poison absorption |

Answer: B

37. Physiological antidotes act by:

- | | |
|---|------------------------|
| A. Adsorbing poison | C. Neutralizing acids |
| B. Producing opposite pharmacological effects | D. Destroying bacteria |

Answer: B

38. Activated charcoal is classified as a:

- | | |
|------------------------|---------------------------|
| A. Chemical antidote | C. Physiological antidote |
| B. Mechanical antidote | D. Chelating agent |

Answer: B

39. Sodium thiosulphate detoxifies cyanide by converting it into:

- | | |
|--------------------|----------------------|
| A. Sulphur dioxide | C. Sulphide |
| B. Thiocyanate | D. Cyanogen chloride |

Answer: B

40. The primary aim of antidote therapy is to:

- | | |
|--|---|
| A. Increase toxicity | C. Cause vomiting in every poisoning case |
| B. Prevent or reduce harmful effects of poison | D. Increase drug absorption |

Answer: B

Short Answer Type Questions

1. Define expectorants. Write the mechanism of action and uses of Potassium iodide.
2. Describe the preparation and pharmaceutical uses of Ammonium chloride.
3. Define emetics. Classify emetics with suitable examples.
4. Write a note on the preparation and properties of Copper sulphate.
5. Explain the preparation of Sodium potassium tartrate with a balanced chemical equation.
6. Define haematinics. Differentiate between Ferrous sulphate and Ferrous gluconate.
7. Discuss the pharmaceutical uses and storage of Ferrous sulphate.
8. Write the preparation and properties of Ferrous gluconate.
9. Define anaemia and classify it based on morphology.
10. Classify antidotes with suitable examples.
11. Explain the mechanism of action of Sodium thiosulphate as an antidote in cyanide poisoning.
12. Write the assay principle and pharmaceutical uses of Sodium thiosulphate.

Long Answer Questions

1. Discuss expectorants in detail. Explain the preparation, properties, mechanism of action, uses, storage, and pharmaceutical importance of ammonium chloride.
2. Discuss haematinics in detail. Explain the preparation, properties, mechanism of action, uses, storage, and pharmaceutical importance of ferrous sulphate
3. Define poison and antidote. Explain the classification of antidotes with suitable examples and discuss the mechanism of action.
4. Analyze the therapeutic importance of expectorants, emetics, haematinics, and antidotes with suitable pharmaceutical examples.
5. Explain the role of haematinics in the management of iron deficiency anaemia and justify the selection of different iron preparations in pharmaceutical practice.
6. Discuss the preparation, properties, mechanism of action, uses, adverse effects, and storage of copper sulphate and sodium potassium tartrate.