ANTIMICROBIAL AGENTS

- These are the substance which help in reducing and preventing infection due to microbes.
- It can be classified in Specific terminology describes exact mode or mechanism of action
- **Antiseptic**

These are substances that are **able to kill or prevent** the growth of microorganisms. These preparations which are to be applied to living tissues.

- **Disinfectants**

These are substances that prevent infection by the **destruction of pathogenic micro organisms.** These are widely used for non living things (home and hospital etc).

- **Germicides**

These are substances which **kill microorganisms**. More specific terminology like **bactericide, fungicide, virucide** etc.

- **Bacteriostatic**

These are substances which primary function by **inhibiting the growth of bacteria.** Thus bacteriostatic drugs or agents **do not kill but arrest the growth** of bacteria.

- **Sanitizers**

Disinfectants that are used to **maintain general public health** standards are termed as sanitizers. Sanitation is mainly concerned with cleaning or washing away the organic matter (saliva, mucous etc)

- **Sterilization**

It is the chemical or mechanical process by which an object is completely **free from living microbes**

- **Astringents**

These are drugs which **precipitates proteins** and form a protective coating when applied to a **damaged skin** of mucous membrane.

MECHANISM OF ANTIBACTERIAL ACTIVITY

The mechanism of action of inorganic antimicrobials can be divided into three types

- Oxidation
- Halogenations
- Protein precipitation

Oxidation

- Certain **anions** and **non metals** eg. Peroxides, permanganates, halo oxygens and halogens (chlorine and iodine) oxidize the reducing groups present in the **microbial protein.**
- The **protein after oxidation** is not fit for routine **metabolic activity** and thus the microbe is killed.
- At higher concentration the drug will also affect the **host protein** (protein from human body).

Halogenations

- The hypochlorite anion **(OCl^-)** present in the antiseptic drug **halogenates peptide linkage of the protein** molecule.
- The halogenation changes the **shape and specific function of the protein.**

R-CONH- + OCl- --------→ R-CO-N-Cl

Protein precipitation

- Certain metallic ions having **strong electrostatic fields** precipitateprotein by forming **metal protein complex**.
- At sufficient concentration, the metal ion will also react with host as well as microbial protein.

Classification antimicrobial agents

- The inorganic antimicrobials are classified as

- **Oxidative antimicrobial**
- Hydrogen peroxide, Potassium permanganate, Bleaching powder
- **Iodine and its compounds**
- Iodine solution, Iodine tincture, Povidone iodine
- **Protein precipitants**
- Boric acid, Borax etc

Potassium permanganate $KMnO_4$

Preparation

1. **From Manganese dioxide**

- MnO_2 is fused with excess of KOH in the presence of a free supply of air or in the presence of an oxidising agent such as potassium chlorate.

  $6KOH + 3MnO_2 + KClO_3 \rightarrow 3K_2MnO_4 + KCl + 3H_2O$

- The green residue consisting of potassium manganate is extracted with water. From this $KMnO_4$ is made by any one of the following 3 methods

1. **By passing carbon dioxide**

- Manganate are converted into $KMnO_4$ while one of the third is precipitated as manganese dioxide.

$3K_2MnO_4 + 2CO_2 \rightarrow 2KMnO_4 + MnO_2 + 2K_2CO_3$

2**. By passing chlorine gas**

- All the manganate may be converted into $KMnO_4$ by passing chlorine gas.

$2K_2MnO_4 + 2Cl_2 \rightarrow 2KMnO_4 + 2KCl$

3. By electrolyzing a warm solution of manganate

- The solution obtained by any one of the above methods is filtered and concentrated until $KMnO_4$ separates as crystals.

$2K_2MnO_4 + 2H_2O \rightarrow KMnO_4 + 2KOH + H_2$

Properties – It acts as a powerful oxidizing agent

$$2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$$

It reacts with HCl, it produce Chlorine

$$2KMnO_4 + 16HCl \rightarrow 2KCl + MnCl_2 + H_2O + 5Cl_2$$

Storage -Stored in a well closed container

Uses

- Anti infective ie) disinfectant
- 1 in 4000 solution can be used to mouth wash and gargle
- Urethritis
- Antidote in case of poisoning
- Vertinary antiseptic
- Crystals are used as first aid treatment for snake bite
- 0.02% stomach wash in the treatment of morphine, opium poisoning

Assay- It is assayed by Redox titration method.

Caution

- It is a powerful oxidizing agent great care should be observed in handling the substance it produces explosions when it contact with readily oxidising substance like glycerin.

Boric acid H_3BO_3

Syn: Ortho boric acid

Preparation

1. **Laboratory method**

Borax is mixed with con. H_2SO_4 and allowed to cool. The crystals of boric acid formed is washed with water until free from sulphate and dried

$$Na_2B_4O_7 + H_2SO_4 + 5H_2O \rightarrow 4H_3BO_4 + 2Na_2SO_4$$

2. Industrial method

- Colemanite ($Ca_2B_6O_{11}\,5H_2O$) is dissolved in boiling water and SO_2 is passed through the solution.

$Ca_2B_6O_{11} + 4SO_2 + 11H_2O \rightarrow 2Ca(HSO_3)+ 6H_3BO_3$

- Among the products calcium bisulphite goes into solution and the less soluble boric acid crystallize on cooling.

Storage- Stored in a well closed container

Uses

- Germicide. Local anti-infective, Eye and mouth wash
- Dusting powder, Mild antiseptic
- Preparation of bioglycerin-used as a suppository base

Hydrogen peroxide (H_2O_2)

Syn: Oxygenated water

Preparation

1. **From Barium peroxide**

It is obtained by adding barium peroxide in ice cold water to a calculated quantity of ice cold dil H_2SO_4. The insoluble $BaSO_4$ is filtered off.

$BaO_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O_2$

2. Electrolytic method

It is obtained by electrolysis of ice cold 50% H_2SO_4. Persulpuric acid is formed which on distillation under reduced pressure gives H_2O_2.

$H_2SO_4 \rightarrow H_2S_2O_8 + H_2$

$H_2S_2O_8 + 2H_2O \rightarrow 2H_2S_2O_4 + H_2O_2$

3. Sodium peroxide/Barium peroxide

It is obtained by adding sodium peroxide in ice cold water to a calculated quantity of ice cold dil H_2SO_4 or decomposing barium peroxide with phosphoric acid.

$$3BaO_2 + 2H_3PO_4 \rightarrow Ba(PO_4)_2 + H_2O_2$$

$$Na_2O_2 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O_2$$

Storage

- Stored or preserved in a light resistant container with stopper made of glass or plastic resistant to H_2O_2
- It is kept in a dark and cool place

Properties

- It is a colourless, odourless liquid with acidic taste.
- The solution decomposes with oxidation or alkali.

$$H_2O_2 \rightarrow 2H_2O + O_2$$

Uses

- Strong oxidizing agent
- Used for bleaching the hair
- Cleaning cuts and wounds
- Effective antidote for phosphorous and cyanide poisoning
- Antiseptic, germicide and deodorant
- Cleaning ears and removing the surgical dressing
- 1-5% uses as mouth wash to clean root canals and septic sockets

Assay

PRINCIPLE:

- It is assayed by Redox titration method.
- It act as an oxidising agent it liberates nascent oxygen readily.
- Titrated in an acidic medium against potassium permanganate.
- $KMnO_4$ act as a self indicator
- End point is appearance of pale pink colour.

$$2KMnO_4 + 3H_2SO_4 \rightarrow 2MnSO_4 + K_2SO_4 + 3H_2O + 5[O]$$

$$H_2O_2 + [O] \rightarrow H_2O + O_2$$

$$2KMnO_4 + 3H_2SO_4 + H_2O_2 \rightarrow 2MnSO_4 + K_2SO_4 + 8H_2O + 5O_2$$

ASSAY OF HYDROGEN PEROXIDE:

Procedure

- Pipette out 1ml of hydrogen peroxide and dilute to 100ml with water.
- To 10ml of above solution transfer into a conical flask and add 40ml of dilute sulphuric acid and
- Titrate with 0.1N $KMnO_4$ and continuing the titration until a pale pink colour appears.
- Each ml of 0.1N $KMnO_4$ is equivalent to 0.001701g of hydrogen peroxide.

Chlorinated lime Ca (OCl)Cl

Syn : Bleaching Powder

Preparation

- **Slaked lime** is spread in a box-like container and subjected to the action of **chlorine gas** which is introduced at the top of the chamber and flows through the contents.
- The temperature maintained **below 25°C** so that formation of **calcium chlorate** is brought down.
- When the absorption of chlorine is complete, which may take about **12 to 24 hours**, powdered chlorinated lime is sent into the chamber so that any excess chlorine may be absorbed.

$$Ca(OH)_2 + Cl_2 \rightarrow Ca(OCl)Cl + H_2O$$

Assay

- It is assayed by iodometric method. An aqueous suspension of the substance is first treated with excess of potassium iodide and acetic acid. Acetic acid, like other acids, liberates chlorine from chlorinated lime as below.

$$Ca(OCl)Cl + 2CH_3COOH \rightarrow (CH_3COO)_2Ca + HOCl + HCl$$

$$HOCl + HCl \rightarrow Cl_2 + H_2O$$

- The liberated chlorine displaces an equivalent amount of iodine from potassium iodide

$$2KI + Cl_2 \rightarrow KCl + I_2$$

- This iodine is titrated against 0.1N sodium thiosulphate using starch mucilage as indicator.

$$2\ Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2NaI$$

Properties

- It is a white or granular powder having a odour of chlorine consisting of "calcium chlorohypochlorite", which is intermediate between calcium chloride and calcium hypochlorite, $Ca(OCl)_2$.
- When exposed to air, it absorb moisture and decomposed.
- With water, it shows bleaching and oxidizing properties

$$Ca(OCl)Cl + CO_2 + H_2O \rightarrow CaCO_3 + HOCl + HCl$$

$$HOCl + HCl \rightarrow Cl_2 + H_2O$$

Uses

- It is used in latrines and other places because chlorine is produced as given above and **sterilizes the places.**
- It is used mainly for its **disinfecting properties** and as a bleaching agent.

Storage

- It has varying amounts of calcium hydroxide and moisture. Although it becomes moist on exposure to air, it is not deliquescent.
- When It is exposed to the air, it **slowly decomposes**. And for this reason chlorinated lime should be stored only in **tightly stoppered bottles.**

Iodine (I_2)

Preparation

- Iodine is manufactured by extracting kelp (Seaweed's ash) with water.

- The solution is concentrated when the sulphate and chloride of sodium and potassium gets crystallized out and the liquid containing soluble sodium and potassium iodide is added with sulphuric acid, the sulphur is liberated and settle down.
- The mother liquid is decanted and to this add MnO_2 and the iodine distils over.

$2NaI+3H_2SO_4+ MnO_2 \rightarrow MnSO_4 + 2NaHSO_4 + I_2 + 2H_2O$

- **Iodine is also found in the brine oil wells**

Properties

- Iodine is heavy, bluish-black, rhombic prism.
- It has peculiar odour and sublimation property.
- It is insoluble in water and soluble in alcohol, chloroform and ether.
- It reacts with some non-metals and many metals.

  $2P + 3I_2 \rightarrow 2PI_3$

  $Fe + I_2 \rightarrow FeI_2$

- Aqueous solution of Iodine oxidizes the reducing agents

  $H_3AsO_3 + I_2 + H_2O \rightarrow 2HI + H_3AsO_4$

  $H2S + I2 \rightarrow 2HI + S$

  $2Na_2S_2O_3 + I_2 \rightarrow 2NaI + Na_2S_4O_6$

- It reacts with alkali to form an iodide and iodate.

  $3I_2 + 6NaOH \rightarrow 5NaI + NaIO_3 + 3H_2O$

Assay

- Iodine is assayed by Redox method.

Iodine preparations

1. **Aqueous Iodine solution (Lugol's solution).**

- It is 5% w/v iodine and 10% w/v potassium iodide in purified water.

- It is prepared by dissolving iodine and KIin100 ml water with trituration or shaking and made up to 1000ml with purified water.

Uses :

- It acts as a good source of iodine and is taken internally.
- It possess germicide and fungicide action and does not produce irritation on cuts and wounds.

Storage – In well closed glass or plastic containers.

2. Weak Iodine solution (Iodine tincture).

- It is 2% w/v iodine and 2.5% w/v potassium iodide in 50% alcohol
- KI and iodine are first dissolved in sufficient alcohol(50%) and made up to 1000ml with alcohol(50%).

Uses :

- It acts as a good source of iodine and is taken internally.
- It possess germicide, fungicide and antiseptic action on cuts and wounds.

Storage – In well closed glass or plastic containers.

3. Strong Iodine solution

- It is 10% w/v iodine and 6% w/v potassium iodide in purified water and 90% alcohol
- KI and iodine are first dissolved in purified water and add sufficient alcohol(90%) to produce1000ml.

Uses :

- It possess antiseptic action.

Storage – In well closed glass or plastic containers.

4. Povidone - Iodine solution

- It is aqueous solution of povidone-iodine.
- It is a complex produced by interaction between iodine and povidone (polyvinyl pyrrolidine).

- The complex is having 10% w/v of available iodine.

properties :

- It is yellowish brown amorphous powder with iodine smell
- It is soluble in water and alcohol.
- Its aqueous solution is having acidic pH.

Uses

- 10% povidone-iodine is used as bactericidal
- It is also used as disinfection of skin, mouth or wounds.
- It is also effective in the management of burns and cuts.

Storage – In well closed glass or plastic containers.