PHARMACEUTICAL INORGANIC CHEMISTRY

COMPLETE UNIT 2 NOTES

- ACID BASE AND BUFFERS
- ELECTROLYTES
- DENTAL PRODUCTS

ACIDS BASES AND BUFFERS

GENERAL THEORY / CONCEPT

Acid :

Acid are those substances which
- Having sour taste
- Converts blue litmus paper into red
- Having pH < 7
- Reacts with bases to form salt

Base :

Base are those substances which
- Having bitter taste
- Converts red litmus paper into blue
- Having pH > 7
- Reacts with acids to form salt

Theories of Acids and Bases

There are basically 3 theories present to explain the nature of acids and bases

1. Arrhenius Theory
2. Bronsted and Lowry Theory
3. Lewis Theory

ARRHENIUS THEORY

Acids :

According to arrhenius acid are those substances which gives/releases hydrogen ion (H^+) when dissolved in water or aqueous solution

$$HCl \xrightleftharpoons{H_2O} H^+ + Cl^-$$

Bases :

According to arrhenius bases are those substances which gives hydroxide ion (OH^-) when dissolved in water or aqueous solution.

$$NAOH \xrightleftharpoons{H_2O} Na^+ + OH^-$$

Limitations of Arrhenius Theory

- Arrhenius theory defines the concept of acid and base in aqueous medium only, it fails to explain the nature of acid and base in Non- Aqueous medium
- It doesn't able to define those acids and bases which doesn't contain H^+ or OH^- ions i.e., SO_2, BF_3 (Acids) and NH_3 (Base)
- It doesn't explain conjugate acid- base theory

BRONSTED - LOWRY THEORY

Acid :

According to Bronsted and Lowry theory acids are those substances which are capable to donate the 'proton' (H^+) to any other substance Hence acid act as a 'proton donor'

$$H_2SO_4 \longrightarrow H^+ + HSO_4^-$$

Base :

According to Bronsted- Lowry theory bases are those substances which have the tendency to accept the 'proton' (H^+) from any other substance. Hence, base act as a 'proton acceptor'

$$NH_3 + H^+ \longrightarrow NH_4^+$$

Conjugate Acid - Base Concept

Let us consider a reaction

$$\underset{(Acid)}{HCl} + \underset{(Base)}{NH_3} \longleftrightarrow \underset{(Acid)}{NH_4^+} + \underset{(Base)}{Cl^-}$$

In the above reaction since HCl donates an H^+ to NH_3, hence it is an acid and since NH_3 accepts an H^+ from HCl, hence act as a base

But

At the same time if we see the reaction from backside then NH_4^+ donates an electron to Cl^- and convert into NH_3, hence it act as an acid while Cl^- accepts and H^+ from NH_4^+ & convert into HCl, hence act as a base

And this pair is basically known as 'Conjugate Acid- Base Pair'

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Some Conjugate Acid- Base Pair

- $HCl \longleftrightarrow Cl^-$
- $H_2SO_4 \longleftrightarrow HSO_4^-$
- $HSO_4^- \longleftrightarrow SO_4^{2-}$
- $H_2CO_3 \longleftrightarrow HCO_3^-$

Nature of Water

Nature of water is actually amphoteric, means sometimes it act like an acid and sometimes it act like a base.

(Acid)	$H_2O \longrightarrow H^+ + OH^-$
(Base)	$H_2O + H^+ \longrightarrow H_3O^+$

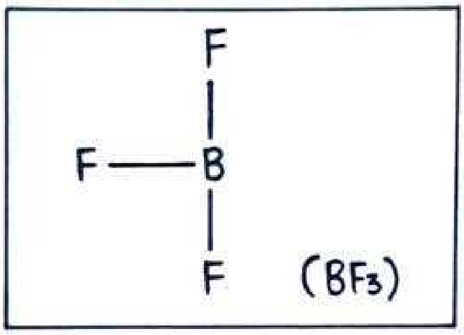
Limitations of Bronsted- Lowry Theory

This theory fails to define those acid- base in which protons are absent i.e. SO_2, BF_3 etc.

LEWIS THEORY

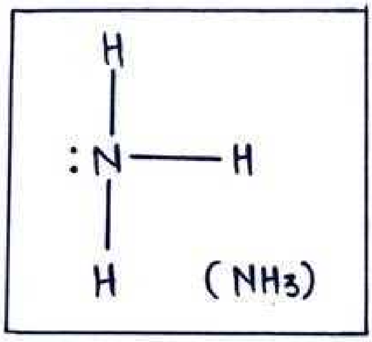
Acid :

According to Lewis acid are those substances which have the tendency to accept the lone pair of electron.

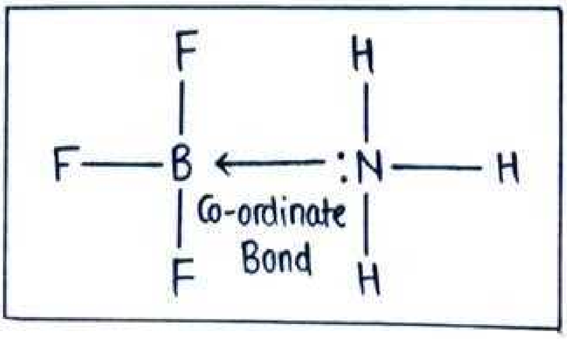


Base :

According to Lewis base are those substances which have the tendency to donate a lone pair of electron.



Lewis Acid- Base Pair



Lewis acid and Lewis base react together to form coordinate bond.

pH

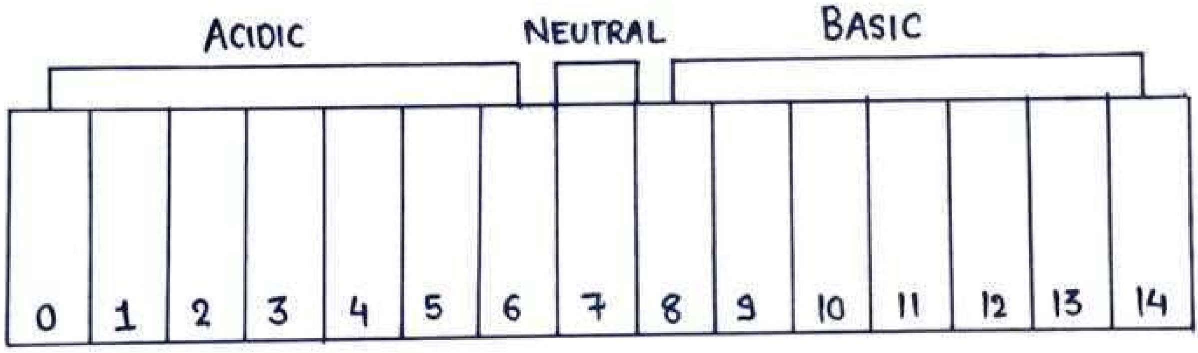
In 1909 Sørensen, a Danish chemist, introduced the concept of pH as a convenient way of expressing acidity or basicity.

pH = Potential / Power of Hydrogen

pH is simply defined as negative logarithm of hydrogen ion concentration.

$$pH = -\log [H^+]$$

pH Scale



- pH (0-7) = acidic
- pH (7) = neutral
- pH (7-14) = basic

BUFFERS

BUFFER SOLUTION

Buffer solution are those which resist change in their pH when a small amount of acid or base added in it.

Types of Buffer solutions / Buffers

Buffer solutions are of basically two types

- Acidic Buffer
- Basic Buffer

Acidic Buffers :

It is a combination of weak acid and its salt with strong base

$CH_3COOH + CH_3COONa$

Basic Buffers :

It is a combination of weak base and its salt with strong acid

$NH_4OH + NH_4Cl$

Buffer Capacity

The amount of acid / base required to produce a unit change in pH of a buffer solution is known as buffer capacity.
It is also known as :

- Buffer Index
- Buffer Value
- Buffer Efficiency
- Buffer Coefficient

$$\beta = \frac{\Delta A \text{ or } \Delta B}{\Delta pH}$$

where, β = Buffer Capacity
$\Delta A / \Delta B$ = Amount of acid or base added
ΔpH = change in pH

Application of Buffers

- Enzymes activity depends on pH, so the pH during enzyme assay must stay constant
- Most of the biological process occurs within a relatively small pH range and for that body have its own buffer system which maintains a constant pH
- Buffer solution also used to calibrate pH meter
- Buffers are often used in food industry to maintain the appropriate acidity / basicity of food.

BUFFER ACTION

It basically describes the mechanism of action of buffers means how buffers actually works to resist change in their pH if we add small amount of acid or base.

Mechanism of action of acidic buffers :

Let's consider a buffer system of CH_3COOH and CH_3COONa.
Now these CH_3COOH and CH_3COONa will dissociate like this :-

$$CH_3COONa \longrightarrow CH_3COO^- + Na^+$$

$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$

If we add an Acid (HCL)

If we add HCl into the above buffer solution then first HCl will dissociate into H^+ and Cl^- and these H^+ ions will react with CH_3COO^- ions and form CH_3COOH which is already present in the solution, i.e. no any other extra compound formed and that's how the pH of the buffer solution remains unchanged.

$$HCl \longrightarrow H^+ + Cl^-$$

$$H^+ + CH_3COO^- \rightleftharpoons CH_3COOH$$

If we add a Base (NaOH)

Now again if we add a base NaOH in the above acidic buffer solution then NaOH breaks into $Na^+ + OH^-$ and these OH^- reacts with H^+ ions and form water which doesn't affect the pH of water solution.

$$NaOH \longrightarrow Na^+ + OH^-$$

$$OH^- + H^+ \rightleftharpoons H_2O$$

Mechanism of action of basic buffers

Let's consider a buffer system of NH_4OH and NH_4Cl

Now :

$$NH_4OH \rightleftharpoons NH_4^+ + OH^-$$

$$NH_4Cl \longrightarrow NH_4^+ + Cl^-$$

If we add an acid (HCl)

$$HCl \longrightarrow H^+ + Cl^-$$

$$H^+ + OH^- \rightleftharpoons H_2O$$

If we add a base (NaOH)

$$NaOH \longrightarrow Na^+ + OH^-$$

$$OH^- + NH_4^+ \rightleftharpoons NH_4OH$$

BUFFER EQUATION / HENDERSON - HASSELBALCH EQUATION

Buffer equation also known as Handerson - Hasselbalch equation used to calculate the pH of a buffer solution.

For Acidic Buffer :

As we know that acidic buffer contains weak acid and its salt Let's consider a weak acid 'CH_3COOH', Now :

$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$

Now If we assume CH_3COO^- as A^-, then we can write above equation like

$$HA \rightleftharpoons H^+ + A^-$$

Now Here HA → Acid
and A^- → salt

Why A^- represented as salt

As we know an acidic buffer contains a weak acid and salt of it with strong base. If we take example of CH_3COOH & CH_3COONa

then $\underline{CH_3COOH} \rightleftharpoons \underline{CH_3COO^-} + \underline{H^+}$

$\underline{CH_3COONa} \longrightarrow \underline{CH_3COO^-} + \underline{Na^+}$

Now Here in the above equation as we know CH_3COOH is a weak acid and it will only partially dissociated and further its ~~depression~~ dissociation is depressed / slow down by the addition of salt CH_3COONa, hence the maximum number of CH_3COO^- in the above solution coming from CH_3COONa and that's why we represent CH_3COO^- as 'Concentration of salt'

And Since we assume $CH_3COO^- = A^-$, Hence A^- → Salt

Now,

$$HA \rightleftharpoons H^+ + A^-$$

After applying law of mass action

$$(\text{Dissociation Constant})\ Ka = \frac{[H^+][A^-]}{[HA]}$$

$$\frac{Ka\,[HA]}{[A^-]} = [H^+]$$

or, we can write like

$$[H^+] = ka\,\frac{[HA]}{[A^-]}$$

Now as we already see, $HA \rightarrow$ Acid
$A^- \rightarrow$ salt
we can write above equation like

$$[H^+] = ka\,\frac{[Acid]}{[salt]}$$

taking - log on both sides

$$-\log[H^+] = -\log\left(ka\,\frac{[Acid]}{[Salt]}\right)$$

$$-\log[H^+] = -\log ka - \log\frac{[Acid]}{[salt]}$$

Now $-\log[H^+] = pH$ and similarly we can write $-\log ka = pka$

$$pH = pka - \log\frac{[Acid]}{[salt]}$$

Or we can write

$$pH = pka + \log\frac{[Salt]}{[Acid]}$$

BUFFERED ISOTONIC SOLUTIONS

TONICITY

The word tonicity is simply defined as concentration of a solution as compared to another solution

Now, In pharmacy, the pharmaceutical buffer solution that are meant for application inside the body must have the same osmotic pressure or the same concentration as that of the body fluids / blood.

Tonicity / Concentration of blood = 0.9% w/v of NaCl

Types of solutions (As Per Tonicity)

There are basically three types of solutions :-

① Isotonic
② Hypotonic
③ Hypertonic

Isotonic Solution

A buffer solution whose concentration / osmotic pressure is equal to the 0.9% w/v of NaCl, is known 'Buffer Isotonic solution'

Hypotonic Solution

A buffer solution whose concentration / osmotic pressure is less than 0.9% w/v of NaCl, is known as 'Hypotonic solution'

Hypertonic Solution

A buffer solution whose concentration / osmotic pressure is greater than 0.9% w/v of NaCl, is known as 'Hypertonic solution'

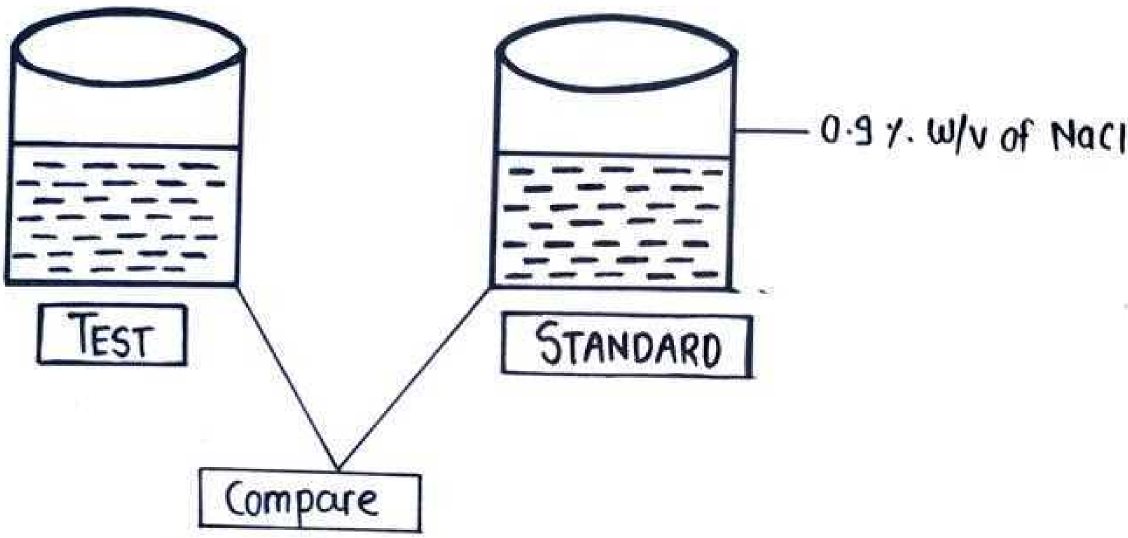
Measurment / Determination of Tonicity

- Cryoscopic / Colligative Method
- Haemolytic Method

Cryoscopic / Colligative Method

This method is based on the colligative properties of the solution such as freezing point, boiling point, vapour pressure and temperature difference.

In this method we basically compare the colligative properties of our test solution (whose tonicity have to be determined) with standard isotonic solution (0.9% w/v of NaCl)



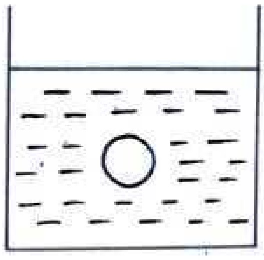
- Freezing Point
- Boiling Point
- Vapour Pressure
- Temperature difference

After Comparison, If

- Test = Standard → Isotonic
- Test < Standard → Hypotonic
- Test > Standard → Hypertonic

Haemolytic Method

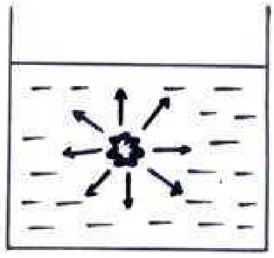
In this method we determine the tonicity of the solution on the basis of appearance of red blood cell suspended in the solution



We know that according to osmosis solvent particles move from area of low concentration to area of high concentration.
In this method first we dissolve the red blood cell in the given test solution, then following 3 condition can be occured.

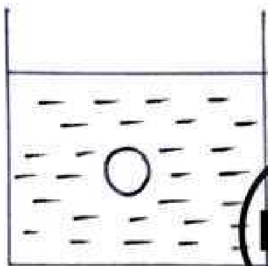
Condition - I (Cell Shrinkage)

If the concentration of solution is greater than concentration of blood cell the solvent move from blood to solution and this cause cell shrinkage and the solution will be 'Hypertonic'



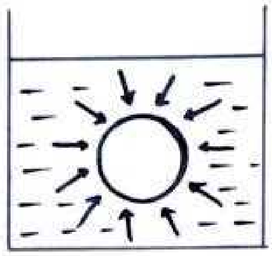
Condition - II (No Change)

If the concentration of solution is equal to the concentration of blood cell, then there will be no net movement of solvent and due to this there will be no change in the size of blood cell or it will remain constant and the solution will be 'Isotonic'



Condition - III (Cell Swelling)

If the concentration of solution is less than the concentration of blood cell, then solvent particles move from solution to blood cell and this cause cell swelling and the solution will be 'Hypotonic'



Methods of Adjusting Tonicity

It basically includes two classes :-

- Class - I (For Hypotonic)
- Class - II (For Hypertonic)

Class - I

~~Cryoscopic / Freezing~~ This method is basically used to adjust the tonicity of hypotonic solution. In this we basically add sodium chloride to make the solution Isotonic.

It includes :

① Cryoscopic / Freezing point depression method
② Sodium chloride equivalent method.

Cryoscopic / Freezing point depression method :

$$W\% = \frac{0.52 - a}{b}$$

where,

W = amount of adjusting substance
a = freezing point of 1% solution of un-adjusted solution
b = freezing point of 1% solution of adjusting substance.

Sodium Chloride equivalent method :

$$E = \frac{17 \times L_{iso}}{M}$$

where,

E = Sodium chloride equivalent
Liso = Liso value (constant)
M = molecular weight of drug solution.

Class - II

This method is basically used to adjust the tonicity of hypertonic solutions. In this method we basically add the water to make the solution Isotonic.

This includes:

1. White - Vincent method
2. Sprowls - Method

White - Vincent Method

$$V = W \cdot E \times 111.1$$

where,

V = volume of isotonic solution prepared by mixing drug with water
w = weight of drug in gram
E = sodium chloride equivalent.

Sprowls Method

This is basically the simplification of white-vincent method. In this we set the value of w = 0.3

$$V = 0.3 \cdot E \times 111.1$$ or $$V = 33.33E$$

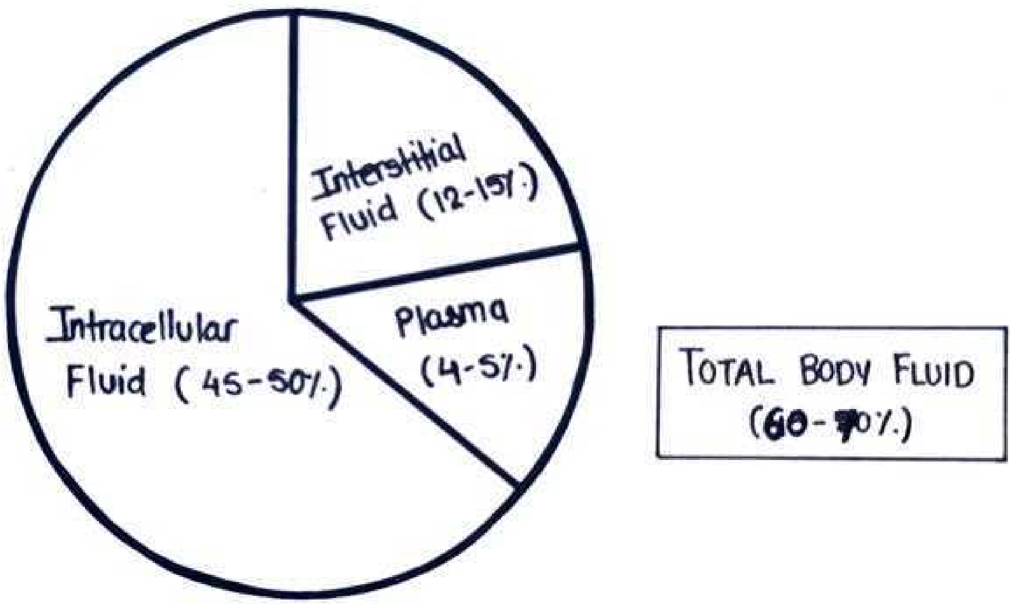
MAJOR INTRA & EXTRACELLULAR ELECTROLYTES

BODY FLUIDS

- 60-70% part of the body is consist of fluid (water)
- The body fluid can be divided into two compartments :

① Intracellular Fluid (45-60%)

② Extracellular Fluid (20-25%)
- Interstitial Fluid (12-15%)
- Plasma (4-5%)



Electrolytes

- Electrolytes are the substances when dissolved in aqueous solution or body fluids dissociates into ions (cations & anions)
- Now electrolytes present inside body can be further divide into two categories :

① Intracellular Electrolytes (Present inside cell)

② Extracellular Electrolytes (Present outside cell)

MAJOR PHYSIOLOGICAL IONS

Cation	Anion
• Sodium ion (Na^+) • Potassium ion (K^+) • Calcium ion (Ca^{2+}) • Magnesium ion (Mg^{2+})	• Chloride (Cl^-) • Bi-Carbonate (HCO_3^-) • Phosphate (PO_4^{3-}) • Sulphate (SO_4^{2-})

Sodium

- It is present in the most abundant amount in extracellular fluid.
- It transmit nerve impulse in the nerve fibres.
- It associate with chloride and bi-carbonate and regulate acid-base balance of the body.
- It also protects body against excessive fluid loss.
- Low level of sodium leads to Hyponatremia.
- High level of sodium leads to Hypernatremia.

Potassium

- It is present in the most abundant amount in intracellular fluid.
- It plays major role in contraction of muscles specially cardiac muscles.
- It performs various biological activity inside cell.
- It also helps in transmission of nerve impulse.
- Low level of potassium leads to Hypokalemia.
- High level of potassium leads to Hyperkalemia.

Calcium

- It mainly found in bones (approx 98%) and remaining found in extracellular fluid.
- It is essential in clotting of blood
- It helps in contraction of various smooth muscles.
- Low level of calcium leads to Hypocalcemia.
- High level of calcium leads to Hypercalcemia.

Magnesium

- It is consider as second most common intracellular electrolyte
- It helps in formation of bone and teeth.
- It also plays important role in myocardial function.
- Low level of magnesium leads to Hypomagnesemia.
- High level of magnesium leads to Hypermagnesemia.

Chloride

- It is mainly present in the extracellular fluid.
- It helps to maintain acid- base balance
- It also helps to maintain the osmotic pressure of the body.
- The main source of chloride is common salt which is used in cooking.
- Low level of chloride leads to Hypochloremia
- High level of chloride leads to Hyperchloremia.

Phosphate

- It is present mainly in the intracellular fluid.
- It helps to maintain acid- base balance of the body.
- Main dietary source for phosphate is milk, nuts etc.
- Low level of phosphate leads to Hypophosphatemia.
- High level of phosphate leads to Hyperphosphatemia.

Bi- Carbonate

- It is present in extracellular fluid.
- Along with carbonic acid, it act as one of the most important buffer system of the body maintaining acid-base balance.
- It also protects tissues of the central- nervous system.

Sulphate

- It is present in very small amount in extracellular fluid.
- They play vital role in detoxification mechanism.
- It also helps in various biological process.

REPLACEMENT THERAPY

- In different abnormal conditions like Diarrhoea, Vimiting, Dehydration electrolytes in our body get imbalance.
- The main purpose of electrolyte replacement therapy is to overcome the electrolyte imbalance and restore the composition of body fluid and body volume.
- There are following three compounds which are used as the major source of electrolyte :

① Sodium Chloride
② Potassium Chloride
③ Calcium Gluconate

SODIUM CHLORIDE

Molecular Weight : 58.44
Molecular Formula : NaCl
Synonyms : Rock salt, Table Salt, Common Salt.

Method of Preparation

Sodium chloride can be obtained from natural source as well as it can also be prepared in laboratory.

Natural Source : Naturally it can be obtained from rock salt & sea water, but from these source obtained NaCl is in impure form. The pure form of salt can be obtained by the process of filteration and evaporation.

Laboratory Method : It can be prepared in laboratory in small scale by the acid- base reaction. In which strong acid (HCl) reacts with strong base (NaOH) & finally gives 'Sodium Chloride'

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

Properties

① Physical Properties

State : Powder or Crystalline form

Colour : White or colourless

Taste : Saline / Salty

Odour : Odourless

Solubility : Solube in water but insolube in alcohol.

② Chemical Properties

- It reacts with silver nitrate and forms white precipitate of silver chloride. ($NaCl + AgNO_3 \longrightarrow AgCl + NaNO_3$)
- It reacts with sulphuric acid and gives hydrochloric acid. ($2NaCl + H_2SO_4 \longrightarrow 2HCl + Na_2SO_4$)

Uses

- It is used as electrolyte replenisher.
- Its 0.9 % solution is isotonic.
- It is used as taste enhancer and diuretics.

Assay

Its assay is based on the Argentometric Titration.

Procedure

- Weight 1 gm of sample & dissolve it in 50 ml water.
- Now add 50 ml of 0.1 M silver nitrate
- To this add 5 ml of 2M nitric acid & 2 ml concentrated $KMnO_4$
- Now shake this properly and titrate with 0.1 M ammonium thiocynate using 2 ml ferric ammonium sulphate as indicator.
- Titration continues until Reddish Brown colour appears.

POTASSIUM CHLORIDE

Molecular Formula : KCl
Molecular Weight : 74.55
Synonyms : Potassium moriate

Preparation

- It can be obtained by separation & purification of its minerals like carnalite ($KCl, MgCl_2 \cdot 6H_2O$).
- In laboratory, it can be obtained by reacting potassium carbonate and hydrochloric acid.

$$K_2CO_3 + 2HCl \longrightarrow 2KCl + H_2O + CO_2$$

Properties

- It occurs as colourless or white crystalline powder
- It is odourless.
- It having saline / salty taste.
- It is freely soluble in water and ~~st~~ insoluble in alcohols.
- KCl is used to produce metallic potassium, by reducing KCl with metallic sodium at 850° C ($KCl + Na \longrightarrow NaCl + K$)

Uses

- It is used as electrolyte replenisher.
- It is used in the case of potassium deficiency.
- It is used as substitute for sodium chloride salt.
- It is also used in the digitalis poisoning.

CALCIUM GLUCONATE

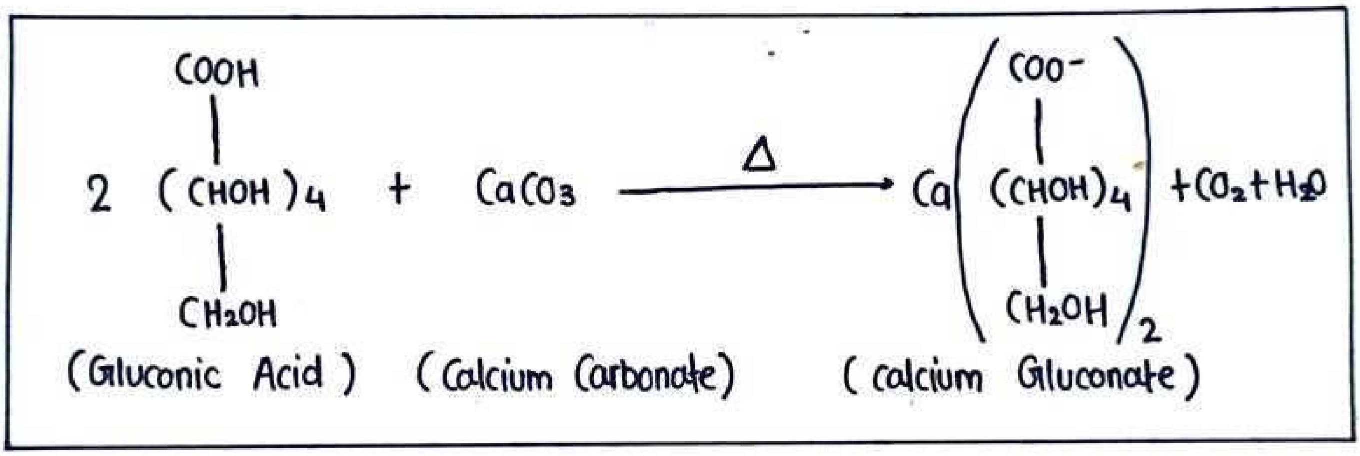
Molecular Formula : $C_{12}H_{22}O_{14}Ca \cdot H_2O$

Molecular Weight : 430.373

Synonyms : Calcium salt, D- gluconic acid

Preparation

Calcium gluconate is prepared by boiling the solution of gluconic acid with excess of calcium carbonate.



Or

$$(C_6H_{12}O_7)_2 + CaCO_3 \longrightarrow C_{12}H_{22}O_{14}Ca + CO_2 + H_2O$$

Properties

- It appears in the form of white crystalline granules or powder.
- It is odourless and tasteless
- It is soluble in water and insoluble in alcohols

Assay

Assay of calcium gluconate is based on complexometric titration

Procedure :

- Weight 0.5 g sample and dissolve in 50 ml warm water.
- Now add 5.0 ml of 0.05 M magnesium sulphate and 10 ml strong ammonium solution.
- The resulting solution is titrated against 0.05 M disodium EDTA until deep blue colour develops.

Uses

- It is used as electrolyte replenisher.
- It is used in the case of calcium deficiency.
- It plays vital role in bone building & development.

ORS

- The full form of ORS is Oral Rehydration Salt.
- It is also known as Oral Rehydration Therapy (ORT).
- It is a type of fluid replacement used mainly in the treatment of Dehydration occurs due to Diarrhoea.
- ORS is the cheap, simple and effective way to treated dehydration caused by diarrhoea.
- ORS drink contains the main elements that are lost from the body during diarrhoea.

Principle of ORS

Glucose, when given orally enhances the intestinal absorbtion of salt and water, and thus maintain the electrolyte and water imbalance.

Formula of ORS

The formula of ORS recommended by WHO and UNICEF.

- 2.6 g/L sodium chloride
- 2.9 g/L trisodium citrate dehydrate
- 1.5 g/L potassium chloride
- 13.5 g/L glucose

Total weight = 20.5 g

Equipment Needed

- Take one litre boiled and cooled drinking water.
- Clean glass of 200 ml capacity.
- A clean vessel to mix the solution.
- A clean spoon to mix the solution & feed the child.

Procedure

- Wash hands
- Take one litre of clean water into a vessel
- Open the ORS packet and pour all the content into the vessel.
- Mix the ORS into water.
- Take some solution in a clean glass.
- Feed the child frequently with small doses of solution.

PHYSIOLOGICAL ACID BASE BALANCE

- Acid- Base balance is a part of homeostasis process deals with the maintainance of pH
- Most of the reactions in our body occurs only in a specific pH & change in this pH will can cause major disturbance.
- The normal pH value of blood is approx 7·42; and survival range of pH in the blood is between 6·8 – 8·0 and if the pH limit crosses this value, then it may lead to death, so it becomes very important to maintain the pH balance of our body.

System that Regulates pH Balance

① Buffer System
② Respiratory System
③ Renal System

BUFFER SYSTEM

- Buffer system converts strong acid and base into weak acid & weak base so that they do not allow rapid and drastic change in pH.
- There are three major buffer systems in our body that regulates the acid- base balance in our body.

① Bicarbonate buffer system
② Phosphate buffer system
③ Protein buffer system

① Bicarbonate Buffer System

- It is an important regulator of blood pH
- It occurs in plasma & kidneys.

Case - I : When there is excess of H^+ ions, that means acidity increases then bicarbonate ions (HCO_3^-) combines with H^+ and converted into ~~weak aci~~ carbonic acid (H_2CO_3) which is a weak acid.

$$H^+ + HCO_3^- \rightleftharpoons H_2CO_3$$

Case - II : When there is shortage of H^+ ions then carbonic acid ionises to release H^+ ions to maintain the pH

$$H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$$

② Phosphate Buffer System

- Phosphate buffer system found in intestinal fluid because phosphate concentration is highest in ~~intestinal fluid~~. intracellular Fluid.
- This system consist of Monohydrogen Phosphate ions (HPO_4^{2-}) and Dihydrogen Phosphate Ions ($H_2PO_4^-$)
- In our body they are exist in combined form with sodium Ions :-

(i) Na_2HPO_4 (Disodium Monohydrogen Phosphate)
(ii) NaH_2PO_4 (Sodium Dihydrogen Phosphate)

Case - I : When there is excess of H^+ ions (Acidity Increases) Na_2HPO_4 combines with H^+ & Converted into NaH_2PO_4

$$H^+ + Na_2HPO_4 \longleftrightarrow NaH_2PO_4$$

Case - II When there is shortage of H^+ ions (Basicity Increases) then NaH_2PO_4 ionises to release H^+ ions to maintain the pH balance.

$$NaH_2PO_4 \longleftrightarrow Na_2HPO_4 + H^+$$

③ Protein Buffer System

- It is important buffer system in blood and plasma.
- Proteins are made up of amino acids and amino acids contains one carboxyl group (-COOH) and one amino group (NH_2)

Case - I In case of excess H^+ ions, amino group act as a base and accepts or combines with H^+ ions.

$$NH_2-C(H)(R)-COOH + H^+ \longrightarrow NH_3^+-C(H)(R)-COOH$$

Case - II In case of shortage of H^+ ions, carboxyl group releases an H^+ ions to maintain the pH balance.

$$NH_2-C(H)(R)-COOH \longrightarrow NH_2-C(H)(R)-COO^- + H^+$$

RESPIRATORY SYSTEM

- The increasement or decreasement of CO_2 is responsible for disturbance in pH of the body's internal environment.
- Respiratory system works by increasing or decreasing the breathing rate in our body.

CASE - I

↓

CO_2 Increases

↓

Acidity Increases

↓

Breathing Rate ↑

↓

Excess removal of CO_2

↓

pH Balanced

CASE - II

↓

Basicity Increases

↓

Breathing Rate

↓

Retention of CO_2

↓

PH Balanced

RENAL SYSTEM

- It is the most effective regulator of pH
- The pH of urine is normally acidic (nearly 6.0)
- When the amount of H^+ increases in our body then it is eliminated from our body through Urine, while the bicarbonate ions HCO_3^- reabsorbed in our body and that's how it maintains the acid-base balance.

DENTAL PRODUCTS

- Dental products are used to maintain the dental hygiene and to prevent the decay of tooth and to give freshness and cleanness to the teeth and mouth.
- There is a wide range of dental products available in the market.

Classification of Dental Products

1. Anticaries Agent
2. Dentifrices
3. Desensitizing Agent
4. Cement and Fillers

ANTICARIES AGENT

- Dental Caries is the medical term for tooth decay or Cavity.
- Dental Caries or tooth decay is caused by acids produced by the action of microorganism on carbohydrates.
- The disease is characterised by decalcification of tooth.

Some of Bacteria / Microorganism

↓

Turns Carbohydrates into Acids

↓

Decalcification

↓

Dental Caries / Cavity

- Dental caries can be prevented by maintaining oral and dental hygiene.
- Anti-Caries Agents are the chemical compounds used to prevent the dental caries produced by action of microorganism.
- Currently flouride is the main anti-caries agent which is used in the treatment of dental caries.

Role of Fluoride in the treatment of Dental Caries

- Fluoride is the most commonly used anti-caries agent.
- Fluoride occurs naturally in our body and also found in small amounts in a variety of foods.
- When a Fluoride having salt or solution is taken internally, it is readily absorbed, transported and deposited in the bone or developing teeth and remain gets excreted by kidney.
- The deposited fluoride on the surface of teeth prevent the action of acids or enzyme in producing cavities.

- A small quantity (1 PPM) of fluoride thus becomes necessary to prevent dental caries.
- However more than 2-3 ppm is ingested then it is carried to bones and teeth and cause dental fluorosis.

Administration of Fluoride

- Fluoride can be administered both (i) internally and (ii) topically for the prevention of dental caries.
- Orally it can be given in drinking water or juice of about 1 PPM / day.
- Sodium fluoride tablets in a dose of 2.2 mg per day are also used.
- For topical applications 2% solution is generally used on teeth.

Sodium Fluoride

Chemical Formula : NaF
Molecular Weight : 41.99 g/ mol

Method of Preparation

- It can be prepared by neutralising HF with Na_2CO_3

$$2HF + Na_2CO_3 \longrightarrow 2NaF + H_2O + CO_2$$

- It can also be prepared by double decomposition of calcium fluoride with sodium carbonate, where insoluble calcium carbonate can be removed by Filteration

$$CaF_2 + Na_2CO_3 \longrightarrow 2NaF + CaCO_3$$

Properties

- It occurs as colourless, odourless crystals or as white powder.
- It is soluble in water but insoluble in alcohol.
- Its aqueous solutions corrode ordinary glass bottles and hence it is prepared in distilled water and stored in dark pyrex bottles.

Uses

- It is used in the prevention of dental caries.
- It is also used as insecticides.
- It is used in the preparation of toothpaste.

Storage

Stored in well closed air tight container at a dark place.

TOOTH

A tooth is mainly consist of three layers:

① **Enamel** — A white hard material covering the portion of tooth above the gum.

② **Dentine** — Surrounds the pulp cavity and extends throughout the entire portion of tooth.

③ **Cementum** — A layer covering the portion of tooth buried in the gum.

DENTIFRICES

- Dentifrices are the products that are used for cleaning of teeth and adjacent gums.
- It can be used with fingers or tooth brushes.
- It is available as paste as well as powders.
- The cleaning action of dentifrices depends upon abrasive property and rubbing force used.

Properties of Dentifrices

- Dentifrices are responsible for physical removal of plaque.
- A good dentifrices must remove stains from teeth and provide freshness to mouth.

Drawbacks

- Dentifrices are not be able to clean surfaces inside cavities

CALCIUM CARBONATE

Chemical Formula : $CaCO_3$
Molecular Weight : 100.09 g/mol
Synonym : Precipitated Chalk

Method of Preparation

On commercial scale, calcium carbonate is obtained by mixing the boiling solution of calcium chloride and sodium carbonate and allowing the resulting precipitate to settle down.

$$CaCl_2 + Na_2CO_3 \longrightarrow CaCO_3 + 2NaCl$$

Properties

- It is occurs as white crystalline powder
- It is odourless
- It is tasteless
- It is soluble in dilute HCl and HNO_3 but insoluble in water and alcohols.

Uses

- It is used as dentifrices and polishing agent.
- It is also used as insectisides.
- It is also used as antacid.

DESENSITIZERS

- The teeth are usually sensitive to heat and cold.
- During tooth decay, the perception to heat and cold has been felt strongly.
- Desensitizing agents reduce the pain in sensitive teeth caused by heat or cold, they reduce the sensitivity of teeth.
- They act as local anaesthetics

ZINC CHLORIDE

Chemical Formula $ZnCl_2$

Molecular Weight 136.28 g/mol

Method of Preparation

It is prepared by heating granulated zinc with HCl

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

Properties

- It occurs as white crystalline powder
- It is odourless
- It is soluble in both water and alcohol.

Uses

- It is used as densensitizers.
- It is also used as antiseptic
- It is also used in dental fillings.

Cement And Fillers

- Dental cements are used to temporarily cover and protect areas that have undergone operations in dental surgery.
- The cementing material is applied as a paste which gets hardened and forms a protective layer.
- After healing of the area, the cement can be removed by dentist.

Zinc Eugenol Cement

- Zinc oxide eugenol cement have been used in dentistry since 1890.
- It is consider as the best cementing material in dental practice.
- They are the cement of low strength.
- They are the least irritating of all dental cements.

Composition

It is mainly composed of

- Eugenol
- Olive Oil / Clove Oil
- Zinc Oxide

Properties

- It is the cement of low strength & used for temporary fillings
- It contains eugenol that provides mild antiseptic & anaesthetic effect.