ACIDS, BASES & BUFFERS

UNIT-II

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The concept of acid and base has undergone a considerable change. Some of these are described as follow —

* Earlier Concept of Acid and Base

→ An acid may be defined as any substance which has a sour taste and its aqueous solution turns blue litmus into red.

→ A base may be defined as any substance which has a bitter taste and its aqueous solution turns red litmus blue.

→ The earlier concept of acid and base couldnot explain the behaviour of all acids and bases.

① Arrhenius Concept

→ The concept of acid and bas was first of all introduced by Arrhenius.

→ According to him, an acid may be defined as any hydrogen containing substance which gives H^+ ions in aqueous solution.

And as base may be defined as a substance containing hydroxy groups and capable of providing hydroxide ions OH^- in acqueous soln.

→ Thus HCl is an acid while NaOH is a base.

$HCl \overset{H_2O}{\rightleftharpoons} H^+ Cl^-$ $NaOH \overset{H_2O}{\rightleftharpoons} Na^+ + OH^-$

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→ According to Arhenius, the neutralisation process can be represented by a reaction involving the combination of H^+ and OH^- ions to form water.

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

Limitations:

Although the arhenius acid-base theory is most simple and convenient in explaining the reaction in aqueous solution, it is having number of limitations —

→ The definations of acid and base are only in terms of aqueous solutions and not in terms of substance.

→ The theory is not able to explain acidic & basic properties of substances in non-aqueous solvents. eg- $NH_4 \cdot NO_3$ in liquid NH_3 acts as an acid, though it doesnot give H^+ ions.

→ The neutralisation of acid and base in absence of solvent could not be explained.

→ The basic substances contain hydroxide ion couldnot be explained by the theory

→ It cannot explained the acidic character of certain salts such as $AlCl_3$ in aqueous solutions.

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② Bronsted-Lowry concept (Proton donor concept)

→ Bronsted and Lowry proposed a general defination of acids and base in the year 1923.

→ According to them, acids are those compounds or species which have tendency to donate the proton (H^+) in any type of solvent by any method.

→ Base are those compounds or species which have tendency to accept the protons (H^+) in any type of solvent by any method.

Some example

Acid → $HCl \rightleftharpoons H^+ + Cl^-$

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

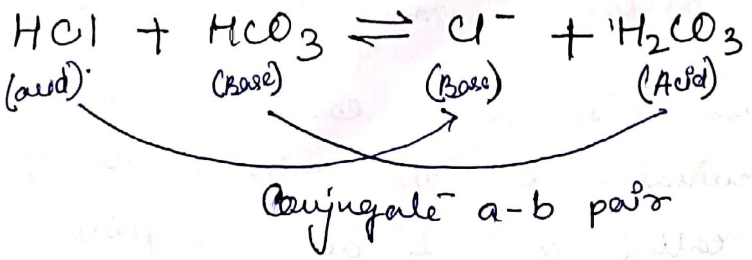
$HSO_4^- \rightleftharpoons H^+ + SO_4^{2-}$

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

$H_2O + H^+ \rightleftharpoons H_3O^+$

Conjugate acid base concept

In a neutralisation reaction, according to Bronsted-Lowry, always a pair of conjugate acid-base will be present.



$$\underset{(acid)}{HCl} + \underset{(Base)}{HCO_3} \rightleftharpoons \underset{(Base)}{Cl^-} + \underset{(Acid)}{H_2CO_3}$$

Conjugate a-b pair

Nature of water in Bronsted-Lowry concept

Nature of water is amphiprotic or amphoteric

→ which means sometimes acidic & sometimes basic.

$$\begin{tikzcd}[column sep=small] \underset{(Acid)}{HCl} \arrow[rrrr, bend left] & + & \underset{(Base)}{H_2O} \arrow[rrrr, bend right] & \rightleftharpoons & \underset{(Base)}{Cl^-} & + & \underset{(Acid)}{H_3O^+} \end{tikzcd}$$

**Special case

$$\underset{(Base)}{NH_3} + \underset{(Acid)}{H_2O} \rightleftharpoons \underset{(Acid)}{NH_4^+} + \underset{(Base)}{OH^-}$$

Conjugate Acid-Base Pairs

$$\underset{(Acid)}{HCl} + \underset{(Base)}{H_2O} \rightleftharpoons \underset{(Acid)}{H_3O^+} + \underset{(Base)}{Cl^-}$$

→ In this reaction, HCl donates a proton to H_2O & is therefore an acid. One the other hand, water accepts a proton from HCl and is therefore a base.

→ In this reverse reaction which at equilibrium proceeds at the same rate as the forward reaction.

→ The H_3O^+ ion donates a proton to Cl^- ion while Cl^- ion which accepts a proton from H_3O^+.

→ The acid-base pairs which canbe formed form each other mutually by the gain or loss of proton are called conjugate acid-base pairs.

Advantages

→ This concept can explain the acid base in any type of solvent.

→ Able to explain the stability of proton.

Limitations

→ The Bronsted - Lowry concept lays excessive emphasis on the proton transfer. Although it is true that most common acids are protonic in nature yet there are many which are not.

→ A large no. of acid-base reaction are known in which no proton transfer can takes place.

eg- $\underset{\text{(Acid)}}{SO_2} + \underset{\text{(Base)}}{SO_2} \rightleftharpoons \underset{\text{(Acid)}}{SO^{2+}} + \underset{\text{(Base)}}{SO_3^{2-}}$

→ Thus, the protonic defination cannot be used to explain the reaction occuring in non-protonic solvents such as $COCl_2$, SO_2, N_2O_4 etc.

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③ Lewis Concept (Electron-Donor- Acceptor System)

→ This theory explain the acid- base phenomena in terms of the acid and base along with the formation of a co-ordinate bond.

→ According to Lewis, (1923)

→ An acid may be defined as any species that can accept an electron pair to form a coordinate bond.

→ Base may be defined as any species that can donate an electron pair to the formation of a co-ordinate bond.

→ Thus, in Lewis system, an acid is an electron-pair acceptor and a base is an electron-pair donor.

→ Let us consider a reaction :

$$H^+ + :NH_3 \rightarrow \underset{\text{Adduct}}{H \leftarrow NH_3}$$

↳ In the above reaction, proton (H^+) accepts one electron pair from $:NH_3$ molecule and is therefore an acid.

↳ Whereas NH_3 molecule which donates an electron pair is a base.

Ex : Lewis acid : H^+, NH_4^+, Na^+, K^+

Lewis base : NH_3, H_2O, OH^-, Cl^-

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Limitations

→ Since the length of Lewis acids and bases is found to depend on the type of reaction, it is not possible to arrange them in any order of their relative strength.

→ As Lewis acid-base reactions involve electrons, they are expected to be very fast reaction. However, there are many Lewis acid-base which are slow.

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Buffer Solutions

→ The solution that are able to resist the change in pH value and termed as buffer soln.

→ A buffer soln consists of a mixture of weak acid and its salt or a weak base and its salts.

→ To such soln when small amount of ~~HCl~~ acid or alkali is added no significant change in the pH takes place.

Types

ⓐ Acidic Buffer Solution

The solution having a mixture of weak acid (eg. acetic acid) and its salt (eg. sodium acetate).

ⓑ Basic Buffer Solution

The solution having a mixture of weak base (eg. ammonium hydroxide) and its salt. (eg. ammonium chloride)

Properties

→ The pH of buffer solution remains constant.

→ The pH doesnot change even after addition of small quantities of acids or bases.

→ The pH of solution remaining constant is useful in number of chemical reaction.

→ The pH of buffer solution doesnot change on keeping for long time.

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Buffer Capacity

→ Often it is necessary to know the effectiveness of a buffer on a quantitative basic.

→ To do so, we employ the term buffer capacity (β) first introduced by Van Slyke in 1922.

→ It is defined as the amount of acid or base that must be added to the buffer to produce a unit change of pH.

Hence, $\beta = \frac{d[B]}{dpH}$, it always has a (+ve) value.

Role of Buffers in Pharmacy

The buffer plays an important role in pharmaceutical preparation to ensure pH conditions for the medicinally active compound:

ⓐ Solubility

→ Solubility of compounds can be frequently controlled by providing a medium of suitable pH.

→ Many inorganic salts such as Fe^{+3} phosphates, borates become soluble in acid media but precipitate in alkaline media.

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→ Similarly, there are many insoluble organic substance with acidic functional group which are soluble in alkaline media.

→ Amines and alkaloids are soluble in acidic media but almost are insoluble in alkaline media.

→ Thus, pH plays an important role in solubility behaviour of compounds. The required pH is adjusted by buffers.

ⓑ Colour

→ Colour of many natural dyes present in fluid extract or certain synthetic drugs hasbeen found to be pH dependent. eg- Red colour of cherry & raskery syrups hasbeen maintained at acidic pH which become pale yellow to nearly colourless at alkaline pH.

→ The colour of synthetic compounds like phenolphthalein, phenolsulphonapthalein hasbeen also pH dependent.

ⓒ Stability of certain compound to redox conditions :—

→ eg- Adrenaline with dissolved oxygen in presence of alkaline medium.

→ So its solution for injection is to be buffered to most stable pH ranges 2.5-5.

→ Ascorbic acid and penicillin are unstable in an alkaline pH.

ⓓ Some compounds hasbeen found to be structurally unstable within certain pH ranges usually auto oxidation, disproportionations giving rise to insoluble solids or gases.

→ eg- Sodium thiosulphates and sodium polysulphids preparation have to be stored at alkaline conditions to prevent separation of sulphur.

→ Nitric become brown in acid media because of formation of coloured nitrogen oxides.

ⓔ Patient comfort

→ Injectables and preparations for internal or external use become irritating if their pH is different greatly from that normal for the particular tissues involved.

→ An extremely acid or alkaline must be avoided because of tissue damage.

ⓕ Optimum pH conditions for activity of medicinal compounds have to be maintained.

↳ Buffering methanamine with sodium dihydrogen phosphate.

↳ Adjustment of the pH of sodium hypochlorite to lower values tends to increase the germicidal effectiveness of the preparation.

Physiological Acid-Base Balance

→ The no. of hydrogen ion present in a sol^n refers to a measure of the acidity of the solution.

→ Body fluids are having balance quantities of acid and base.

⇒ The maintenance of the normal pH range within the body fluids become essential since the biochemical reaction that take place in the living system are very sensitive to even small change in acidity or alkalinity.

For example

→ The low pH value in the stomach provides the environments which is best suited to the functioning of the enzyme pepsin that helps in digestion of dietary protein.

→ pH value of body fluids

Saliva (~~4.5 - 8.0~~) 5.4 - 7.5
Urine (4.5 - 8.0)
Gastric Juice (1.5 - 3.5)
Bile (6.0 - 8.5)
Blood (7.4 - 7.5)
Semen (7.2 - 7.6)

Buffer Equation

The relationship between pH, pk concⁿ of a weak acid and conjugate base is expressed by Henderson-Hasselbalch equation.

$$pH = pk - \log \frac{[Base]}{[Acid]} \text{ or } pH = pk + \log \frac{[Salt]}{[Acid]}$$

For acidic Buffer

Let us consider dissociation of weak acid (HA)

$$\underset{(acid)}{HA} \rightleftharpoons H^+ + \underset{(salt)}{A^-}$$

The dissociation const (K) of the acid is —

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

$$[H^+][A^-] = Ka[HA]$$

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

Applying log on both side —

$$\log[H^+] = \log\left\{Ka \times \frac{[HA]}{[A^-]}\right\}$$

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

$\log a \times b = \log a + \log b$

Multiplying both side by −1

$$-\log[H^+] = -\log K_a - \log \frac{[HA]}{[A^-]}$$

$$pH = pK_a - \log \frac{[HA]}{[A^-]}$$

$$pH = pK_a + \log \frac{[A^-]}{[HA]}$$

$$pH = pK_a + \log \frac{[\text{Conjugate base}]}{[\text{Weak acid}]}$$

∴ This represents the Henderson-Hasselbalch equation for pH of buffer solution.

For Basic Buffer

Let us consider dissociation of weak base (BOH)

$$\underset{(\text{Base})}{BOH} \rightleftharpoons \underset{(\text{Salt})}{B^+} + OH^-$$

The dissociation const. (k) of the base is —

$$K_b = \frac{[B^+][OH^-]}{[BOH]}$$

$$[B^+][OH^-] = K_b \times [BOH]$$

$$[OH^-] = K_b \frac{[BOH]}{[B^+]}$$

Applying log on both side and multiply by -1.

$$-\log[OH^-] = -\log\left\{K_b \times \frac{[BOH]}{[B^+]}\right\}$$

$$-\log[OH^-] = -\log K_b - \log\frac{[BOH]}{[B^+]}$$

$$pOH = pK_b - \log\frac{[BOH]}{[B^+]} \quad \left\{\begin{array}{l}-\log[OH] = pOH \\ -\log[K_b] = pK_b\end{array}\right.$$

$$pOH = pK_b + \log\frac{[B^+]}{[BOH]}$$

$$pOH = pK_b + \log\frac{[\text{conjugate acid}]}{[\text{Weak base}]}$$

This represents Henderson-Haselbalch equation for calculation of pOH of buffer solution.

Tonicity : Relative concentration of solute, which is dissolve in a solution, which determine the direction & extent of diffusion.

Hypertonic

A solution having higher osmotic pressure than the body fluids (0.9% NaCl).

→ This solution draws water from the body tissues and the cells become shrink/ wrinkled in shape.

Hypotonic : A solution having lower osmotic pressure than the body fluids.
The net movement of water into the cell causes them to swell up.

Isotonic : Both internal and external environment have same solute concentration (0.9% soln)

Methods used to determine tonicity value

(i) Haemolytic method

In this method, RBC's are suspended in various solution and the appearance of RBC's is observed for swelling, bursting, shrinking and wrinkling of the blood cell.

(ii) Cryoscopic method

Freezing point depression property is most widely used.

Freezing point is 0°c and when any substance such as Nacl is added, the freezing point decreases.

Freezing point depression, ΔTf of blood is $-0.52°C$. Hence, ΔTf value of the drug solution must be $-0.52°C$.

Methods of Adjusting Tonicity

ⓐ Class-I method

Nacl or some other substances is added to the solution of the drug to lower the freezing point of solution to -052°C and thus make the solution isotonic.

eg- cryoscopic & Nacl equivalent

Nacl equivalent method

Nacl equivalent (E) of a drug is the amount of Nacl i.e equivalent to 1g of the drug.

$$PSA = 0.9 - (PSM \times E \text{ of medicament})$$

PSA = Percentage strength of medicament

PSM = Percentage of Nacl for adjust tonicity.

ⓑ Class-II method

H_2O is added to the drug in sufficient amount to make it isotonic.

Then the preparation is brought to its final volume with an isotonic or buffer isotonic solution (0.9% Nacl).

White Vincent Method

This method involve addition of H_2O to a given amout of drug.

The volume of H_2O that shouldbe added in given amout of the drug to make it isotonic solution..

It is calculated by using this formula,

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

where,

V = Volume of H_2O needed to make the solution isotonic.

W = Given weight.

E = NaCl equivalent of the drug.

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Official Buffers

It is essential to control pH of some solutions which are used in pharmaceutical chemistry and practice. This is brought about by using buffer solution. These buffer solution can be categorised into two types —

ⓐ Standard buffer system

These are designed to provide a soln having a pH for analytical purposes towards quality assurance.

ⓑ Actual pharmaceutical buffers

These are designed to maintain pH limits in pharmaceutical preparations.

→ It shouldnot take part in redox reactions.

→ It shouldnot alter the solubility of other ingredients.

→ It should not reacts with active ingredients to form complexes.

→ It shouldnot undergo any acid-base reaction other than that needed as a part of the buffer functions.

* Volatile substance such as NH_3 or CO_2 should be avoided because if they escape from pharmaceutical preparation, they will alter pH and the buffer capacity of the system.

Example of official buffers

a) Standard Buffer solution

① Boric acid & potassium chloride, 0.2M :—
Dissolve 12.366 g of boric acid and 14.911 g of potassium chloride in water, and dilute with water to 1000 ml.

② Disodium Hydrogen Phosphate 0.2M :
Dissolve 71.630 g of disodium hydrogen phosphate in water and dilute with water to 1000 ml.

③ Hydrochloric Acid, 0.2M :
Hydrochloric acid diluted with freshly boiled and cooled water to contain in 1000 ml 7.292 g of HCl. Standardise as directed under Volumetric Reagents and Solutions.

b) Actual pharmaceutical buffers

(i) Acetate buffer pH 3.9 → Dissolve 15.0g of sodium acetate in 100 ml of 6N acetic acid.

(ii) Ammonium buffer pH 10.0 → Ammonium Buffer Solution. Dissolve 5.4g of ammonium chloride in 70 ml of 5N ammonium and dilute with water to 100 ml.

(iii) Copper Sulphate soln pH 4.0, buffered → Dissolve 0.25g of copper sulphate and 4.5g of ammonium acetate in sufficient 2N acitic acid to produce 100 ml.

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Major Extra and Intracellular Electrolytes

Electrolytes: It is a substance that ionized when dissolved in suitable ionizing solvents, such as water.

→ These include more soluble acid, base & gases.

→ An electrolyte maybe defined as concentrated if it has high concentration of ions or dilute if it has low concentration of ions.

→ The various body fluid components are :

(i) Intracellular fluid

(ii) Extracellular fluid

(iii) Plasma fluid.

(i) **Intracellular fluid** : This is the fluid which is present inside the cell.
eg- cytoplasm, it consist 12-15% of body weight and it's volume is 30 litr.

(ii) **Extracellular fluid** : This is the fluid which is present between the cell.
example – Blood plasma, it consist 12-15% of body weight and it's volume is 10 litr.

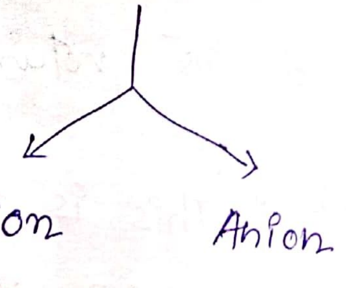
(iii) Plasma: This is the fluid which is present within the blood vascular system. This consist of 4-5% of body weight and its volume is 3-5 litre.

- Electrolytes are used in replacement therapy and for the acid-base balance in various body fluids.

- The electrolyte concentration of body fluid havebeen different in various body fluid compartments.

- Major electrolytes found in body are calcium, potassium, phosphate, Iron, magnesium, chloride, sodium.

- Major Physiological ions:



Major physiological Ions

① **Calcium:** It is an important constituent of bones and teeth and it is also concerned with the functioning of muscles and clotting mechanism of blood.

→ Children require higher amount of calcium as it is needed for growth of tissues and bones.

→ Milk, milk-products and green vegetables are rich in calcium. Wheat, jowar and bajra are good source of calcium.

→ Bone is also a storage tissue for calcium. At night, when a person sleeps or more without food intake, reabsorption of the bone occurs in order to maintain blood calcium levels.

→ Hypocalcaemia is a condition resulted from calcium deficiency.

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(ii) Magnesium

→ It is the second most cation in concentration in the intracellular fluid compartment.

→ Half amount of the total body magnesium (10-20 g) is combined with calcium and phosphorus in bone.

→ It is used for protein synthesis and for the smooth functioning of the neuromascular system.

(iii) Sodium

→ Sodium is the principal cation in the extracellular fluid compartments.

→ This ion is required to maintain normal hydration and osmotic pressure.

→ Sufficient amounts of sodium are present in the daily diet.

→ Excess sodium is excreted by kidneys. About 80-95% of the sodium is reabsorbed in the glomerular filtrate by a hormonal control.

→ Defeciency/Excess of sodium - Hyponatremia/Hypernatremia

(iv) Potassium

→ It is the major intracellular cation, present in about 23 times higher than present in the extracellular fluid compartment.

→ During transmission of a nerve impulse, potassium leaves the cell and sodium enters the cell and this mechanism is called the sodium-potassium pump.

→ Excess of potassium is rapidly excreted by the kidney.

Deficiency – hypopotassemia
Excess – hyperpotassemia.

(v) Chloride

→ It is the major extracellular anion of both interstitial and vascular fluids compartments.

→ It is required for maintaining proper hydration, osmotic pressure and normal cation-anion balance.

→ Food is the main source of chloride and it almost completely absorbed from the intestinal tract.

→ It is removed from the body by glomerular filtration and is reabsorbed by the kidney tubules.

→ Deficiency / Excess – Hypochloremia / Hyperchloremia.

(vi) Bicarbonate

→ It is the second most prevalent anion in the extracellular fluid compartments.

→ Along with carbonic acid it is utilized as the body's most important buffer system.

→ A lack of bicarbonate causes metabolic acidosis and metabolic alkalosis.

(vii) Phosphate

→ It is present in intracellular fluid compartment.

→ It is also an important buffer system which is related with the utilization of calcium, carbohydrates and fats.

→ Essential for development of bones and teeth.

(viii) Sulphate

→ It is present in small quantity in extracellular fluid compartment.

→ Sources are animal & plants protein having sulphur containing amino acid.

→ It is important in detoxification mechanisms

Electrolyte used in replacement theory

In normal conditions, the body is able to adjust the electrolyte valence while in some condition such as prolonged fever, severe vomiting or diarrhoea, there occure a heavy lose of water and electrolytes. So, there is a need to administration of lose electrolyte.

There are some electrolyte that are used in replacement theory –

ⓘ Sodium chloride and its salts such as sodium chloride injection hypertonic solution, sodium lactate injection.

ⓘⓘ Potassium chloride and its salts.

① Sodium Chloride [NaCl] M.W = 58.44 g/mol

In nature it is found in sea water, in salt wells, lakes and in deposites of rock salt.

Preparation

→ In laboratory it is prepared from common salts in water by passing HCl gas, the crystals are precipitate out.

→ In industry, it is prepared by evaporation of sea water.

→ It contain certain impurities which are removed by dissolving common salts in water in cemented tanks.

→ Some alum and lime are added. The suspended impurities are settled down.

Properties

(i) It is odourless, colourless crystal or white crystalline powder.

(ii) It is soluble in water, glycerol and slightly soluble in alcohol.

(iii) It can oxidize chemically.

Use

(i) It is used as electrolyte replenisher, emetics.

(ii) It can be used in homopathic medicine.

(iii) Soln of NaCl may be used as eyedrop, nasal drops and as mouth washes.

Assay : Weigh accurately 0.5 gm NaCl

↓

Dissolve in 50ml of water

↓

Titrate with 0.1N silver nitrate using solution of potassium chromate (indicator).

② Potassium chloride [KCl] M.W = 74.55 g/mol

In nature it is found as sylvine (KCl) & carnallite, $KCl.MgCl_2.6H_2O$ contaminated with magnesicum sulphate and chloride.

Preparation

It can be prepared by ~~[illegible]~~ reacting HCl with potassium carbonate.

$$2HCl + K_2CO_3 \longrightarrow H_2CO_3 + 2KCl$$

Properties

(i) It is colourless, odourless, cubical crystalline powder.

(ii) It is having saline taste.

(iii) It is soluble in water, glycerol and insoluble in alcohol.

Uses :
(i) Electrolyte replenisher.
(ii) Treatment of potassium deficiency.
(iii) Treatment of myasthenia gravis (muscle weakness)
(iv) Used as antidote ~~of~~ in digitalis intoxication.

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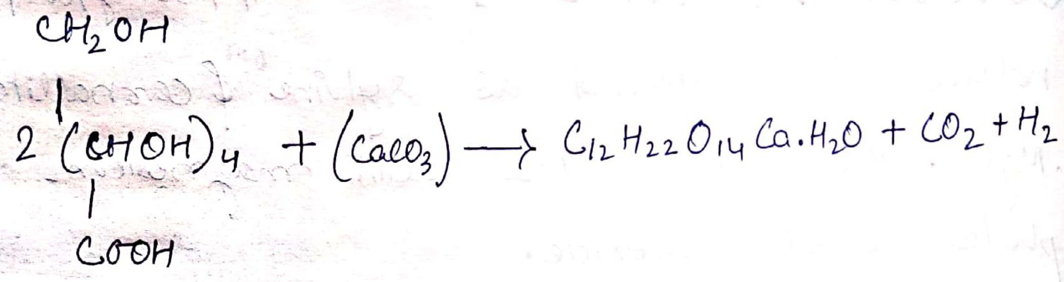
③ Calcium gluconate [$C_{12}H_{22}O_{14}Ca.H_2O$]

M.W = 448.4 g/mol

Preparation

It is prepared by boiling a soln of gluconic acid with excess of calcium carbonate.



$$2\begin{array}{c}CH_2OH\\|\\(CHOH)_4\\|\\COOH\end{array} + (CaCO_3) \longrightarrow C_{12}H_{22}O_{14}Ca.H_2O + CO_2 + H_2$$

Properties

① It is odourless, tasteless white crystalline powder.

② It is soluble in boiling water and sparingly soluble in water.

③ Insoluble in alcohol, ether & chloroform.

Use

Source of calcium ion, used in treatment of calcium deficiency (Hypocalcaemia)

Assay

Weigh accurately 800 gm of $C_{12}H_{22}O_{14}Ca.H_2O$

↓

Dissolved in 150 ml of water containing 5 ml of dil. HCl acid.

↓

Add 5 ml of 1/20 M of $MgSO_4$ soln.

↓

Add 10 ml of pH 10 buffer soln.

↓

Titrate the content of flask against 1/20 M of EDTA soln using eriochrome black tea indicator.

ORS [Oral Rehydration Salts/soln]

→ ORS contain anhydrous glucose, NaCl, KCl and either sodium bicarbonate or sodium citrate.

→ These dry preparation are to be mixed in pacific amount of water along with certain flavouring agent & as suitable agent for free flow of powder.

→ In ancient time for home made, ORS is used which consist of one table spoon of salts and two tablespoon full of sugar in 1 litre of water.

→ The following three formulate usually prepared when glucose is used. Na_2CO_3 is packed separately.

→ The quantity given below aree preparing in 1 litre soln.

	Ingredient	Formula 1st	Formula 2nd	Formula 3rd
01	NaCl	1 gm	3.5 gm	3.5 gm
02	KCl	1.5 gm	1.5 gm	1.5 gm
03	Sodium bicarbonate	1.5 gm	2.5 gm	—
04	Sodium citrate	—	—	2.9 gm
05	Anhydrous glucose	36.4 gm	20 gm	20gm
06	Glucose	40 gm	22 gm	—

→ The formula 2nd & 3rd aree recommended by WHO and UNICEF for control in diarial disease.

Physiological Acid- Base Balance

→ Body fluids are having balanced quantity of acids and bases. and this quantity is maintained by intricate mechanism.

→ The maintanence of this balance quantity is necessary for biochemical reaction taking places in body because biochemical reaction are very sensitive to even small change of acids and bases.

example: Low pH value in stomach is requiring for functioning of enzyme pepsin which is useful for digestion of food.

pH value of body fluids

Gastric juice	(1.5 - 3.5)
Urine	(4.5 - 8.0)
Saliva	(5.4 - 7.5)
Bile	(6.0 - 8.5)
Semen	(7.2 - 7.6)
Blood	(9.4 - 7.5)

→ Body is having its own buffer system which prevents drastic changes in the pH value of blood. It also helps to convert strong acids & bases into weak acid or bases.

→ Lungs and Kidney are the main organs which help to maintain buffer system in the body.

→ In case of low respiration, the accumulated carbon dioxide combines with H_2O and formed carbonic acid which releases hydrogen ions and causes acidosis.

$$CO_2 + H_2O \longrightarrow H_2CO_3 \longrightarrow H^+ + HCO_3^-$$

→ In over breathing, excessive of carbon dioxide occurs and causes alkalosis.

→ Kidney has ability to generate ammonia which neutralises acid products of protein metabolism and excrete in urine.

Conditions where metabollic alkalosis occurs

(i) Loss of chloride ions.

(ii) Administration of diuretics.

(iii) Excessive injection of alkaline drugs.

(iv) Endocrine dissorder.

Conditions where metabolic acidosis occurs

ⓘ Absorption of excess metabolic acid.

ⓘⓘ Formation of excessive quantities of metabolic acid like carbonic acids.

ⓘⓘⓘ Failure to excrete metabolic acid.

ⓘⓥ Loss of base from body fluids.

ⓥ Diabetes mellitus.

ⓥⓘ Diarrhoeia

ⓥⓘⓘ Excess vomitting.

To maintain pH, there are different buffer system in the human body. These are extremely efficient. These systems work at different rate.

① The action of chemical buffers (blood plasma buffer) is so fast adjustment to pH. This system includes plasma protein, phosphate, bicarbonate & carbonic acid buffer.

② Another system is the respiratory track, which adjust the blood pH in minutes. (exhalling CO_2 from the body).

③ The renel system can also adjust blood pH through the excretion of hydrogen ions, the conservation of bicarbonate, but this process takes lots of days to have an effect.

→ The excretion of hydrogen ions and generation of bicarbonate ions is done by the kidney. This generated bicarbonate ions help in maintaining blood plasma pH and this control the acid-base balance.

A) Buffer System in the body

(i) Protein buffer in blood plasma & cell.
(ii) Phosphate buffer.
(iii) Bicarbonate - Carbonic acid buffer.

B) Respiratory regulation of Acid-base balence.

c) Reneal regulation of Acid-base balance.

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Dental Products

The poor dental health is very common problem in the Third World countries around the world. In India, the problems have been compounded by ignorance, poor literacy levels, having of chewing betal leaves, tobacco and pan masala.

The tooth consist of three layers of calcified tissue :-

① **Enamel** : It is white outermost covering present on the tooth projecting above the gum. It contain 98% of minerals and it is very dense.

② **Cementum** : A layer covering the portion of tooth lying buried in the gum.

③ **Dentine** : Which surrounds the pulp cavity and extends throughout the entire portion of tooth. It consists of 75% of minerals and is hard & dense.

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The common problems associated with tooth are –

(i) The formation of cavity.

(ii) Cleaning of tooth & deduction of shining over tooth.

These problems are over combined, the use of anticarries agents, dentifrices and polishing agents.

Anticarries agents

→ Dental carries are tooth decay or cavities.

→ It is caused by pacific type of bacteria, they produce acid that destroy the tooth enamel and the layer under it (dentine).

→ The probable cause of carries (cavity) is associate with the diet of peoples consuming high carbohydrate.

→ Brushing of tooth prevents loading of food particles over the tooth surfaces and helps to keep it hygeinic.

→ The ammoniated toothpaste are used to utilize lactic acid & also decrease count.

Flouride (F)

→ This are commonly used to prevent caries. It may be used systemic or topically.

→ It is the inorganic compound that are used for cavity-filling.

→ Tooth decay is attributed to action of lactic acid which aids in building up of plague on the tooth surface.

→ Decomposition of flourides in the bones and teeth is due to replacement of hydroxine by flourides in hydroxy apetite.

→ The mechanism by which flouride inhibits caries formation may be due to decrease acid solubility of enamel and bacterial inhibition.

Role of flouride in dental carries

→ Brushing of teeth regurarly is necessary to remove any particles from the tooth surface before it hardens into the calculas.

→ Because a smooth surface and brushing prevents the adherence of food particles, bacteria & consequent bacterial action.

→ Flouride in low concentration (1-2 ppm) if present in drinking water results in decrease of dental carries.

→ Flouride may be an essential element for the composition of enamel and its presence might help the enamel to resist the solvent action of acids. (decreased acid solubility of the enamel).

→ It may act locally by inhibiting the enzyme that produce organic acids.

→ Therefore flouride products such as flouridated water flouride drops, topical flouride application to teeth,

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flouride containing vitamins and flouride dentrifrices i.e paste & powders aree available in the market as having anticarries properties.

→ The other ways for carries prevention include flossing & brushing accompanied by flouride which are administered internally or topically to the teeth.

→ To such flourides are stannous flouride & sodium fluoride.

Sodium Flouride [NaF] M.W = 41.99

It contains not less than 98.5% and not more than 100.5 %.

Properties : Colourless crystal or white powder. Soluble in water & insoluble in ethanol. It is odourless.

Preparation

It is prepared by treatment of hydroflouric acid with sodium carbonate.

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

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→ It is also prepared by double decomposition of calcium flouride with sodium carbonate. The insoluble calcium carbonate is filtered out.

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

Use

→ It is used for the prophylaxis of dental caries in communities where the intake of fluoride from drinking water and food is low.

→ A 2% solution of sodium fluoride in water may be applied to children's teeth.

→ It is a constituent of some insecticides & rodenticides.

Dentrifrices

→ A dentifrice is a substance used with a tooth brush for the purpose of cleaning the accessible surfaces of the teeth.

→ Commercial dentrifrices are available in the form of pastes and powders.

→ Many dentifrices contain flavours and soap or detergent.

→ The powders and pastes contain abrasives such as calcium carbonate, one or more of calcium phosphates, calcium sulphate, sodium bicarbonate and sodium chloride.

→ Tooth pastes contain liquids e.g. glycerin, propylene glycol, sorbitol solution and thickeners e.g. starch, tragacanth etc.

→ Dentrifrices usually contain non carbohydrate sweetening agents, but few may contain sugar.

→ Certain individuals may need an abrasive containing dentifrices.

Calcium Carbonate [$CaCO_3$] M.W = 100.09

It contain calcium not less than 98% and not more than 100%.

Properties

→ White colour, odourless.

→ Very slightly soluble in water but solubility is increased by presence of CO_2 and any ammonical salt soluble in dilute acids.

Preparation

① When boiling solution of Na_2CO_3 is added with $CaCl_2$ then precipitate of calcium carbonate is obtained.

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

⑪ When CO_2 gas passes through lime water precipitate of calcium carbonate is formed.

$$CO_2 + Ca(OH)_2 \longrightarrow CaCO_3 + H_2O$$

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Storage : Stored in lightly closed container.

Uses

→ It is used as dentifrices.

→ It is used as dental cleaning polishing agent.

→ It is also used as antacid.

Desensitizing agents

→ Teeth are sensitive to heat and cold specially during teeth decay or tooth aches.

→ The perception to heat and cold has being felt strongly.

→ Therefore some desensitizing agents are used in dental prepartion so as to reduce sensitivity of teeth from heat and cold.

→ The mechanism is not known but they act like local anasthetic.

eg - zinc oxide, eugenol cement.

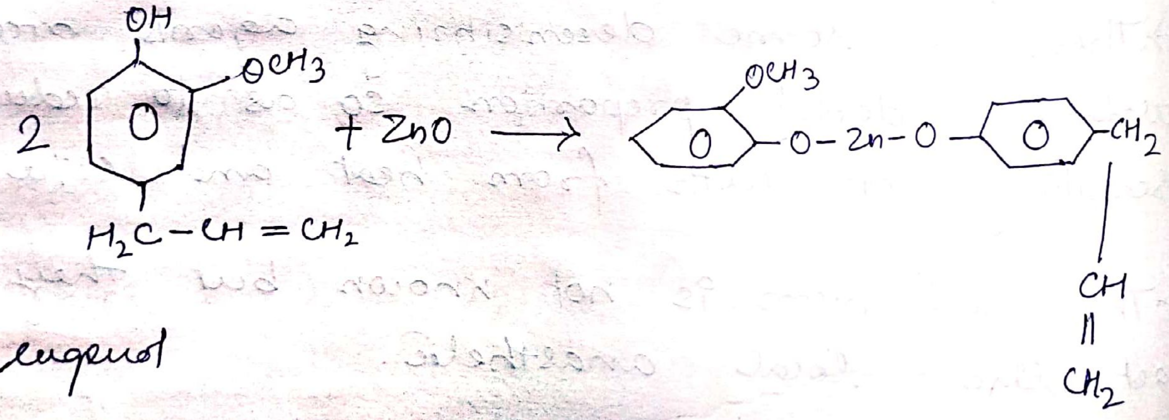
Zinc Oxide

→ It is a meaterial created by combination of zinc oxide and eugenol.

→ It is used as temporary cement filling in the event that the patient will return at a later date for a semipermanent

→ The powder is mainly zinc oxide and eugenol.

Reaction



Properties

→ Formulation of ZnO eugenol cement have been develope for nearly every use of dental cement.

→ Odourless, amorphous white or yellowish white powder.