Unit-2

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Acids, Basis and Buffers

Acids and basis are the define on the basis following theory-

1- Traditional / old theory.
2- Arrhenius theory
3- Bronsted Lowry theory.
4- Lewis theory.

- **Traditional / old theory :-**

Acid	Base
(1) Litmus paper blue to red.	Litmus paper red to blue.
(2) $pH < 7$	$pH > 7$
(3) Taste Sour.	Taste bitter
(4) React with base salt Example- HCl	Base react with acid to salt. Exam- NaOH

• Arrhenius Theory :-

This theory define acids & bases according to there formation of ions when dissolved in water.

• Acid :-

An acid is a substance when dissolve in water gives hydrogen ion (H^+) known as acid.

Example - $HCl \rightleftharpoons H^+ + Cl^-$

• Base :-
An base is a substance when dissolve in water give hydroxide ion (OH^-) known as base.

Ex → $NaOH \rightleftharpoons Na^+ + OH^-$

⇒ According to him when acid and base react then they form salt and water.

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

• Bronsted and Lowry Theory :-

⇒ Proton theory of acid & bases.

• **Acid** :- Acid is the substance which donate proton.

• **Base** :- Base is the substance which accept proton.

• Lewis Theory :-

• **Acid** :- The compound which accept lown pair of electrons called acid.

Exam → H^+, NH_4^+, Na^+.

• **Base** :- The compound which donate lown pair of electrons called base.

Exam - OH^-, Cl^-, CN^-.

Buffer

→ A buffer is a solution that can resist pH change upon the addition of an acidic or basic components.

→ It is able to neutralize small amounts of added acid or base, thus maintaining the pH of the solution relatively stable.

→ This is important for processes and reactions which require specific and stable pH ranges.

• **Properties of Buffer Solutions** :-

(1) pH of a buffer solutions is constant.

(2) pH of a buffer solution not not changes with dilution.

(3) The pH of a buffer solution not changes with addition of small quantity of acid or base.

(4) The pH of a buffer solution not changes with time.

(5) pH of a buffer solution it is usefull in various chemical reaction and also preparation of medicine and as a physiological buffer.

Henderson - Hassel batch equation -OR- Buffer equation

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

$$Ka = \frac{[H^+][A^-]}{[HA]}$$ (rearrange the equation)

$$[H^+] = Ka \frac{[HA]}{[A^-]}$$ (convert to logarithmic function)

$$\log [H^+] = \log Ka + \log \frac{[HA]}{[A^-]}$$ (multiply by (-1))

$$-\log [H^+] = -\log Ka - \log \frac{[HA]}{[A^-]}$$ ($-\log [H^+] = pH$ and $-\log Ka = pKa$)

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

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

$$pH = pKa + \log \left[\frac{\text{Proton acceptor}}{\text{Proton Donor}}\right]$$

Buffer capacity :-

→ The buffer capacity is the measure of the effectiveness of the buffer in controling the pH of the solution upon addition of an acid or base.

-OR-

It is the measurement of efficiency of a buffer in resistent changes in pH.

-OR-

Buffer capacity is defined as the quantities of acid or base in gram equivalence required to change the pH of 1 litre of a buffer solution by 1 unit.

⇒ Buffer capacity also known as buffer coefficient, buffer index, buffer efficiency etc. It is represented by β.

ΔB = gram equivalence of acid and base to change the pH by 1 unit.

ΔH = change in addition by acid or base.

Buffers in Pharmaceutical system :-

→ In pharmaceutical system buffer are mainly used in

(1) In biological process

(2) In industrial process.

(3) In analytical process.

(4) In bacteriological research.

• Biological buffers :-

These buffers maintained our body for normal physiological functions. Mainly they are maintained body fluids.

Fluid type	Buffer
(1) Extracellular fluid	Bicarbonates buffer proteins buffer.
(2) Intracellular fluid	Phosphate buffer Protein buffer.
(3) Erythrocytes	Hemoglobin buffer.

- **Industrial Process :-**

Leather industry, Photographic industry manufacturing of dies for Preservation of food items electroplatin.

- **In analytical chemistry :-**

In titration, removal of acid radicals to calibrate, In calibration of pH.

- **In Bacteriological research :-**

In bacteriological study be need a culture media which is Prepared in buffer solution for growth of bacteria.

Preparation of Buffer

During the preparation of buffer following point should be considered.

(1) Determine the pH of the product.
(2) Select a weak acid or base which having pKa value near to the deside pH.
(3) calculate the ratio of salt to acid required to produce the deside pH. (Henderson - Hassel batch equation).
(4) Determine the buffer capacity of the product (buffer capacity equation).
(5) calculate the total buffer concentration required to produce this buffer.
(6) Determine the pH of buffer by using pH meter or pH paper.

Stability of buffer :-

Buffer are stable up to two years if unopen and in open conditions they are stable up to 3-6 months but usually they are recomended used for one month after opening.

(1) check the date of expiry before opening the container.
(2) cap in closed plastic container.
(3) store at 15-25°C temperature.

Buffer Isotonic Solution

Most of the pharmaceutical solution comes in contact with cell or cell membrane so they should be isotonic to the cellular fluid to avoid swelling contraction and this comfort.

→ According to the osmotic pressure or tonicity of the solution they are of 3 type.

(1) Isotonic solution.

no change in the size.
solution of cell

(2) Hypotonic solution

solution - swell the cell.

(3) Hypertonic solution

solution - shrink the cell.

Measurement of Tonicity :-

Tonicity depends on solute permeability.

→ The measure of the tonicity of a solution, or the total amount of solutes dissolved in a specific amount of solution, is called its osmolarity.

Three terms - hypnotic, isotonic and hypertonic - are used to relate the osmolarity of a cell to the osmolarity of the extracellular fluid that contains the cells, in a hypnotic solution, such as tap water, the extracellular fluid has a lower concentration of solutes than the fluid inside the cell, and water enters the cell.

→ The tonicity of the solution can be calculated by-

(1) Haemolytic method.

(2) Measurement of the slight temperature differences.

(3) calculating the tonicity using liso value.

- <u>Haemolytic method</u> :-

In this method effect of barriers of solution of the drug is observe on the appearance of red blood cells expanson in the solution.

$$\Delta T_f = i \times K_f \times m$$

ΔT_f = Depression in freezing point.

i = vanit haff factor.

K_f = cryscopic constant.

m = metabolite of the solution.

Methods of Adjusting Tonicity

Method are divided in two classes.

(1) Class I[st] method :-

(A) cryoscopic or freezing point depression method.

(B) sodium chloride equivalent method.

(ii) Class IInd method :-

(A) white vincent method.

(B) The sprowls method.

- **Cryoscopic or freezing point depression method :-**

The experimental method to determine the molecular mass of non-volatile solute by determining freezing points of pure solvent and solution of known concentration is called cryoscopy.

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

where -

W = weight in gram of the added substance in 100ml of final solution.

a = Depression of the freezing point of water produced by the medicament (solute already in the solution).

b = Depression of the freezing point of water produced by 1% added substance (solute w/v).

→ freezing point depression ΔT_f given theoretical.

→ Plasma and blood freezing point temperature -0.52°C so any solution freezes add -0.52°C temperature will be isotonic to the blood and tears.

- **Sodium chloride equivalent method :-**

→ Sodium chloride equivalents, also known as E-values or tonicity equivalents, are used to indicate the potency or strength of a drug.

→ This is simply the amount of sodium chloride equivalent to a gram of a drug that has a similar osmotic effect (i.e, is equivalent to) the sodium chloride.

→ Deviation of E-value: it is a collective property, so freezing point depression is dependent on both particle numbers, as well as particle dissociation and association.

$$E\ 1\% = \frac{\text{freezing point depression sample/ Drug solution.}}{\text{Freezing point depression produced by NaCl of same strength.}}$$

- **White vincent method :-**

For class II tonicity calculations, the drugs are mixed with water to create an isotonic solution, and then they are diluted with an isotonic diluting agent until their concentration is the final concentration.
In white and vincent's approach, such calculations are simplified.
→ The weight of the drug is multiplied by the sodium chloride equivalent E to prepare 30 ml. of 1% (w/v) Procaine hydrochloride solution isotonic with body fluid (0.3g).

- **Sprowls method :-**

sprowls developed a simplified version of the white-vincent method. For this experiment, 0.3 g of a 1% solution was chosen for use because it is the amount for one fluid.

$$\frac{W \times E}{V} = \frac{0.9\,g}{100\,ml}$$

w = drug / soluti.
E = sodium chloride, equivalent of drug.
V = volume of water to be added.

Major Extracellular and Intracellular electrolyte

Total Body water

- Extracellular fluid 33 %
  - Interstitial fluid 75 %
  - Plasma
  - Transcellular 1 %
- Intracellular fluid 66 %

→ The body fluid and solutions mainly contains inorganic and organic solute and it is about 56 % of body weight and it is divided into intracellular and extracellular fluid. Intracellular body fluid remains inside the cell and extracellular in the constant motion throught the body.

→ Body fluids, nutrients and ions are essential for maintenance of cellular life.

According to the distribution of fluid body is divides into three compartment.

Body compartment

- Intracellular fluid: present inside the cell. Ex → cytoplasm 40-50% of body weight volume = 30 litre.
- Interstitial fluid: present b/w the cells 12-15% of body weight volume = 10 litre.
- Vascular fluid: also called plasma present within blood vascular system 4-5% of body weight volume = 3.5 litre.

→ All the body fluids contained electrolytes and the concentration of electrolyte differ according to the body compartment i.e intracellular, interstitial and vascular compartment or fluids.

→ The balance of these compartment is maintained by the process homeostasis.

In a healthy person electrolyte concentration is maintained in the body fluids and give a person undergoes surgery or faces undesirable or unfavourable conditions then electrolyte balance become inbalance.

→ In these conditions electrolytes are given which called as replacement therapy.

→ In replacement therapy various products like electrolytes, acid base, carbohydrates, proteins, amino acids and blood products are given to the patient as per the requirement.

- **Important function of electrolyte :-**

(1) To maintain acid base balance in the body.
(2) To control osmosis of water between body compartment.
(3) For transmition of nerve impulse.
(4) For contraction of muscle.
(5) For secretion of hormones and neurotransmitters.
(6) To generate action potential and gratid potential.

- **Electrolyte inbalance :-**

If electrolytes are not inbalance condition it may causes - kidney diseases, vomiting.

→ Dehydration.
→ Acid base inbalance.
→ Heart diseases.

→ Difficulty in muscular contraction.
→ Nervous system related diseases:

Major physiological ions and their function :-

The important electrolyte are mainly divided in two category.
(1) Cations (sodium, potasium, calcium, magnesium).
(2) Anions (chloride, sulphate, bicarbonate, phosphate).

• **Cations :-**

(a) **Sodium (Na) :-**

Location :- extracellular compartment as salt Na^+
Normal level :- 136-142 mEq/L.

Functions :-
→ absorbed and excreted by cells (maintain charge balance between the body fluids.).
→ Along with Cl^-, maintain osmotic balance of all body fluids.
→ In kidney, maintain blood-urine volume level.

Hyponatremia :-
→ Low level of sodium (Na^+) in body.
• **Reasons :-** extreme urine loss (in diabetic insipidus), kidney damage, diarrhea, vomiting, excessive sweating.
• **Symptoms :-** muscular weakness, headache, respiratory depression.
• **Treatment :-** replenishment therapy.

Hypernatremia :-

Increased level of sodium in body.

- **Reasons** :- dehydration, high sodium intact.
- **Symptoms** :- intense thirst, fatigue.
- **Treatment** :- diuretics, cardiotonic drugs, low salt diet.

(b) Potassium :-

- **Location** :- It is majorly found in intracellular fluid.
- **Normal level** :- 3.8 - 5.0 mEq/L.
- **Functions** :-

→ contraction of muscles, especially cardiac muscle.
→ maintains osmotic balance.
→ Transmission of nerve impulses.
→ regulate pH by exchange against for hydrogen ion.

Hypokalemia :-

Decreased K^+ ion level in body.

- **Reasons** :- lower absorption, malnutrition, diarrhoea, much urine loss (diuretic treatment), heart disease.

Hyperkalemia :-

Increased K^+ ion level in body.

- **Reasons** :- Kidney damage (renal failure), dehydration, cardiac disease, C.N.S. depression.
- **Symptoms** :- bradycardia, mental confusion, muscle weakness.

(c) Calcium :-

Location :- 1% in extracellular and 99% in bones and teeth.

- Functions :-

→ Blood cloating.
→ Muscle contraction.
→ Release of Ach from neurons.
→ Bones and teeth.

Hypocalcemia :-

Decreased Ca^{++} level in body.

- Reasons :- lower absorption, vit D deficiency, bone cancer.
- symptoms :- titanic spasms, convulsions.

Hypercalcemia :-

Increased level of Ca^{++} in body.

- Reasons :- hypervitaminosis D, bone neoplastic disease.
- symptoms :- muscle weakness, constipation, cardiac irregularities.

(d) Magnesium :-

- Location :- It is majorly found in intracellular fluid. about 54% in bones and about 45% in intracellular fluid.
- Functions :-

→ To activate enzymes which are involved in protein metabolism.
→ Neuronal transmission.

→ Myocardial function.
→ for the function of Na^+/K^+ ATPase pump.

Hypomagnesemia :-

Decreased Mg^{++} ion level in body.

- **Reasons** :- lower absorption, malnutrition, diarrhoea, chronic alcoholism.
- **Symptoms** :- muscle weakness, confusion, nausea, cardiac arrhythmia.

Hypermagnesemia :-

Increased Mg^{++} ion level in body.

- **Reasons** :- Addison's disease, acute diabetic acidosis, renal failure.
- **symptoms** :- hypotension, cardiac arrest.

• Anions →

(1) Chloride :-

- **Location** :- It is majorly found in all body fluid. Nearly 66% of ion content in plasma is chloride ion.
- **Normal level** :- about 50 mEq/Kg.
- **Functions** :-

→ absorbed and excreted by cells (maintain charge balance between the body fluids).
→ Along with Na^+, maintains osmotic balance of all body fluids.
→ Takes part in formation of gastric acid.

Hypochloremia :-

Decreased Cl^- level in body.

• **Reasons** :-

→ metabolic acidosis seen in diabetes mellitus and renal failure.
→ Lack of reabsorption from kidney.
→ Therapy of diuretics.
→ Excessive vomiting - loss as gastric acid (HCl).

• **Symptoms** :-

alkalosis, respiratory depression, muscle spasm.

Hyperchloremia :-

Increased Cl^- level in body.

• **Reasons** :- excess loss of bicarbonate ions, dehydration, CHF.

(2) Phosphate :-

It is mainly intracellular fluid and normal conc. is 1.7 to 2.6 meq/l.

→ Present in bones, teeth and remaining is present as a phospholipids, ATP in nucleic acid i.e DNA & RNA.

• **Sources of phosphate** :-

Protein rich food like.
(1) Seafood
(2) Dairy products
(3) Meat.

• **Daily requirement** :- for normal adult is about 700 mg/day.

• Functions :-

→ Mild laxative property.
→ For the development of teeth and bones.
→ Metabolism.
→ urine pH is lowered by phosphate.
→ Treatment of hypophosphatimia is done by the phosphates.

Hypophosphatimia :-

low level of phosphate.
→ Due to alcoholism and the symptoms are teeth and bones gets weak, lack of formation of DNA & RNA.

Hyperphosphatimia :-

High level of phosphate.
→ Deficiency of calcium, Deficiency of glucose.

(3) Bicarbonate :-

The second most common extracellular anion is the bicarbonate (HCO_3^-).
→ It is utilised as the most important buffer system of the body, along with carbonic acid. Metabolic alkalosis and acidosis may occurs due to the deficiency of bicarbonate ions.

• Sources of bicarbonate :-

fruits and vegetables.

• Daily requirement :-

325 mg to 2 grams.

• Functions :-

→ Metabolic acidosis and Kidney disturbances are treated with sodium bicarbonate due to its alkaline nature.

→ Acid - base balance is maintained by the bicarbonate ion.

(4) Sulphate :-

→ Present in interstitial fluid. They are present in small quantity and the important function is protein stablization.

→ It also an element of vitamin D i.e Biotic and thymine also component of a hormone i.e insulin.

• Functions :-

→ It is mainly responsible for detoxification, respiration process, enzymatic activity.

→ Due to the deficiency of sulphur decreases in insulin level, deficiency of protein and increase in amount of fat i.e obesity, heart diseases, increases in toxic level in the body, pain in bones.

Electrolytes used in replacement therapy

(1) Sodium chloride :-

• Molecular formula :- NaCl.

• Molecular weight :- 58.44g.

• Physical Properties :-

→ It is white, anhydrous crystalline powder.
→ odourless but having salty taste.
→ It is soluble in water but insoluble in alcohol.

• Chemical properties :-

→ when react with permanganate it liberate chlorine gas.
→ It react with silver nitrate and forms white precipitates of silver chloride.

$$NaCl + AgNO_3 \longrightarrow AgCl + NaNO_3.$$

• Method of Preparation :-

→ Sodium chloride (NaCl) can be obtained from natural source as well as it can also be prepared in laboratory.
→ Naturally it can be obtained from rock salt & sea water. But from these sources it can be obtained in impure form. The pure form of salt can be obtained by the filtration process & finally the dried form can be collected by evaporation process.
→ It can also be prepared in laboratory in small scale by the acid- base reaction. In which strong acid (HCl) reacts with strong base (NaOH) & finally it gives sodium chloride.

• Assay :-

→ about 0.1 g and dissolve in 50ml of water.
→ Add 50 ml of 0.1 M silver nitrate, 5 ml of 2 M nitric acid and 2 ml of dibutyl Phthalate.

Titrant :- 0.1M ammonium thiocyanate.

Indicator :- ferric ammonium sulphate solution.

End point :- colour becomes reddish yellow.

→ 1 ml of 0.1M silver nitrate is equivalent to 0.005844 g of NaCl.

• Storage :- tightly closed container in dry place.

• Uses :-

→ It is used as electrolyte replenisher.
→ sources of sodium and chloride ions (sodium replacement).
→ Making other pharmaceutical formulations like Ringer's injection, ORS.

• Official Preparation of sodium chloride :-

sodium chloride injection I.P
sodium chloride hypertonic injection I.P
sodium chloride eye lotion B.P
sodium chloride solution B.P
sodium chloride & Dextrose injection I.P
sodium chloride & Mannitol injection I.P.
sodium chloride tablets U.S.P.

(2) Potassium Chloride :-

• Molecular formula :- KCl

• Molecular weight :- 74.55

- Physical properties :-

→ It is white crystalline powder, odourless and strong saline taste.

→ Like sodium chloride it is freely soluble in water & insoluble in alcohol.

- chemical properties :-

→ Another important reaction of KCl is used to produce metallic potassium, by reducing KCl with metallic sodium at 850 °C.

$$KCl + Na \longrightarrow NaCl + K$$

- Method of Preparation :-

(a) Lab scale :-

Reaction of HCl with K_2CO_3 or $KHCO_3$

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

$$KHCO_3 + HCl \longrightarrow KCl + CO_2 + H_2O$$

- Industry scale :-

→ From mineral carnallite $KCl \cdot MgCl_2 \cdot 6H_2O$.

→ Carnallite is dissolved by treating with hot water.

→ Less soluble KCl will crystallizes out on cooling the solution.

- Assay :-

→ Principle : Mohr's method (Argentometric titration).

→ about 0.15g and dissolve in some of water.

→ Titrant :- 0.1M silver nitrate.

→ Indicator :- potassium chromate solution.

→ 1ml of 0.1M of silver nitrate is equivalent to 0.007455 g of KCl.

- **Uses :-**

→ Source of potassium ions (potassium replacement).
→ Making other pharmaceutical formulations like Ringer's injection, ORS.
→ As diuretic.
→ In treatment of hypokalemia.
→ Used in treatment of digitalis poisoning.
→ Used in treatment of myasthenia gravis.

- **Official preparation of Potassium chloride :-**

Potassium chloride and glucose IV infusion B.P. injection I.P.

Potassium chloride and sodium chloride I.V infusion I.P/injection.

potassium chloride & Dextrose (Glucose) I.V infusion I.P.

(3) Calcium gluconate :-

- **Molecular formula :-** $C_{12}H_{22}CaO_{14}$
- **Molecular weight :-** 430.373 g/mol.
- **physical properties :-**

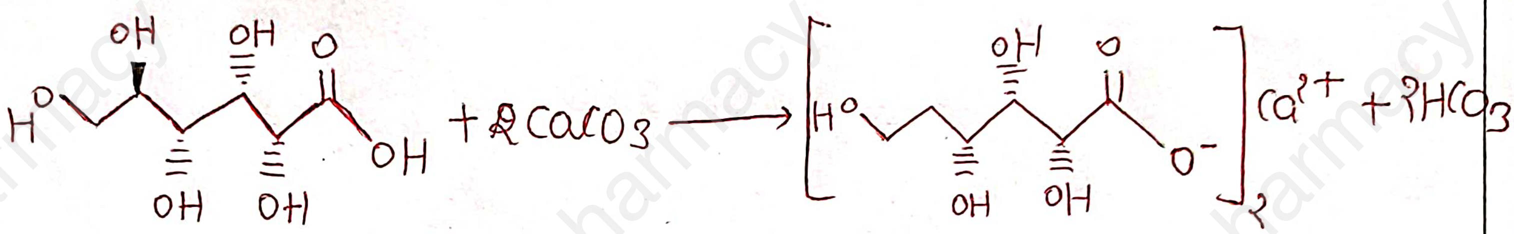
→ white crystals, granules or powder.
→ Stable in air, does not lose it ($C_{12}H_{22}O_{14}Ca \cdot H_2O$) water of crystallization on drying.
→ Neutral to litmus paper.

- **Chemical properties:-**

→ When treated with dil. HCl, it is decomposed into gluconic acid and calcium chloride.

- **Method of Preparation:-**

Solution of gluconic acid is boiled with an excess of calcium carbonate. The calcium gluconate separates on cooling and letting stand, and is filtered off.



- **Assay:-**

Principle:- complexometric titration.

→ 0.5g sample is dissolved in warm water, cool and add 5.0 ml of 0.05 M $MgSO_4$ and 10 ml of strong ammonia solution.

Titrant:- 0.05 M disod. edetate.

Indicator:- mordant black II mixture.

End point:- until deep blue color develops.

→ From the volume of 0.05 M disod. edetate required, subtract the volume of the $MgSO_4$ solution added for actual reading.

- **Factor:-**

1 ml 0.05 M disod. EDTA = 0.02242g of Ca. gluconate

• Uses :-

→ Used in calcium deficiency.
→ Used to treat cardiac arrest.

Oral Rehydration Salt (ORS) :-

→ ORS is a fluid / liquid solution develop by (WHO) world health organization.

→ Oral rehydration therapy (ORT) is a type of fluid replacement used as a treatment for dehydration.

→ Most diarrhoea-related deaths in children are due to dehydration ----
loss of large quantities of water and electrolytes from the body in the liquid stool.

→ It involves drinking water mixed with sugar and salt and other fluids.

→ ORS is a cheap, simple and effective way to treat dehydration caused by diarrhoea.

• Types of ORS :-

(1) Sodium bicarbonate based.
(2) Trisodium citrate based.
(3) Reduced osmolarity ORS.
(4) Super ORS.

• Sodium bicarbonate based ORS :

Composition :-

contents	(gm)
NaCl	3.5
glucose	20.0
KCl	2.5
sodium bicarbonate	2.5

(2) Trisodium citrate based ORS :-

- Composition :-

Contents	(gm)
NaCl	3.5
glucose	20.0
KCl	1.5
Trisodium citrate	2.0

(3) osmolarity based ORS :-

Ingredients	standard (WHO) 1975
Na^+	90 mM
Cl^-	80 mM
Glucose	110 mM
K^+	20 mM
citrate	10 mM
Total	310 mM

- **Possible adverse effects :-**

Hypertonicity in net fluid absorption.

→ To overcome this we should reduce the osmolarity of the ORS

Ingredients	Standard WHO (2002)
Na^+	75mM
Cl^-	65mM
Glucose	75mM
K^+	20mM
Citrate	10mM
Total	245mM

- **Advantages :-**

→ Increased efficacy of ORS in non cholera diarrhoea.
→ vomiting decreased by 30%.
→ Stool output decreased by 20%
→ safe and effective.

- **Dosage and how to administer :-**

→ <2 yrs :- give 1-2 teaspoon every 2-3 minutes.
→ older children :- offer frequent sips out of a cup.
→ Adults : drink as much as they can.
→ Give the estimated amount within 4 hrs.

Physiological acid base balance

→ Body fluids having balanced quantity of acid & base and this quantity is maintained by a complex mechanism which mainly involves homeostasis feed-back mechanism etc, and it is necessary because the bio-chemical reactions take place at a specific pH that is -

→ Blood = 7.4 - 7.5 pH
→ Urine = 4.5 - 8 pH
→ Gastric juice = 1.5 - 3.5
→ Bile = 6 - 8.5 pH
→ saliva = 5.4 - 7.5
→ semen = 7.2 - 7.6.

Major physiological acid base systems

(1) Renal regulations
(2) Respiratory mechanism.
(3) Buffer action.
(4) Bicarbonate buffer
(5) Phosphate buffer
(6) Protein buffer.

→ Renal regulations:-

Kidney is a very important part to maintain acid base balance in the body and it mainly excreat acidic material present in the body because urine is acidic in nature.

→ Kidney is able to generate ammonia which neutralises the acidic products of protein metabolism and excreted from the body i.e sulphur phosphoric acid hydrochloric acid.

If kidney is not working properly than carbonic acid (H_2CO_3) excreted by respiratory system.

⇒ Respiratory mechanism :-

→ when CO_2 accumulated combines with water it forms carbonic acid which is further dissociated into H^+ + HCO_3^- and increases the pH and causing acidosis condition.

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

• Buffer action :-

① Bicarbonate buffer system :-

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

→ This system is mainly found in plasma, kidney.

→ If H^+ concentration increase bicarbonate ions act as a weak base and accept H^+ ions to forms carbonic acid which disociated into CO_2 and water.

→ If the concentration of H^+ is less than carbonic acid disociated H^+ and HCO_3^-.

② Phosphate buffer :-

Mainly in kidney.

→ pH 7.4 and mainly consist of monohydrogen phosphate and di hydrogen phosphate.

(i) If acidity increase :-

$HCl + Na_2HPO_4 \longrightarrow NaCl + NaH_2PO_4$ (weak acid)

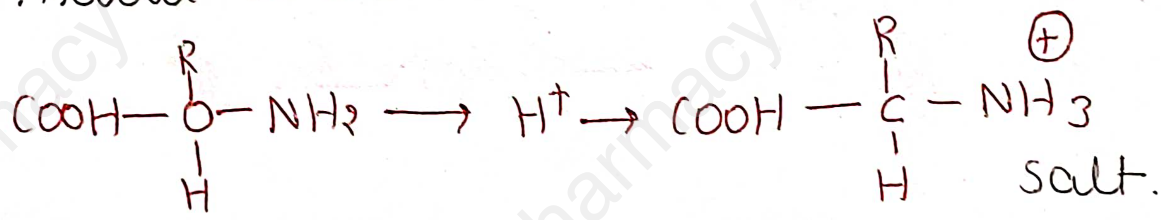
(ii) If basicity increase :-

$NaOH + Na_2HPO_4 \longrightarrow H_2O + NaH_2PO_4$ (weak base).

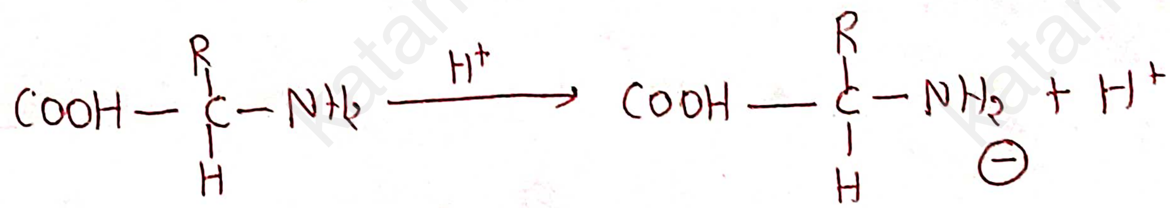
③ Protein buffer system :-

→ Protein buffer system mainly occurs in amino acid. The amino acid contains both acidic and basic growth when condition are acidic it accept is H^+ ion and forms NH_3 and if condition are basic than it disociated into COO^- and H^+.

- Acidic condition :-



- Basic condition :-



Dental Products

→ Dental Products are used to maintain the dental hygiene and to prevent the decay of tooth. It is well known that the cleaner teeth keep good health and clean teeth can not decay.

→ In order to maintain dental hygiene numerous products are available in market. A large number of inorganic compounds is used in maintaining oral and dental hygiene.

Classification of Dental Products

Dental products include-

(1) Anticaries agent :-

These are the agents which help in prevention of dental decay e.g- sodium fluoride, stannous fluoride, sodium monofluorophosphate.

(2) Cleaning agent (Dentifrices/ Polishing agents) :-

Dentifrices are agents used along with a toothbrush to clean and polish natural teeth. They must be abrasive to some degree to remove the stains from the teeth. They are supplied in paste, Powder, gel or liquid form e.g→ calcium carbonate, Dibasic calcium phosphate, calcium phosphate, sodium metaphosphate.

(3) Disentizing agents :-

These reduce sensitivity of teeth to heat and cold Examples include strontium chloride and zinc chloride.

(4) Cement and fillers :-

Used to temporarily cover or protect the area that has undergone operation in dental surgery.
e.g → Zinc eugenol cement.

Dentifrices

→ Dentifrice is a material which is used for cleaning of teeth and adjacent gums.

→ The cleaning is dependent on abrasive property and the rubbing force used.

→ They may be applied as pastes or powders with the help of fingers or toothbrush.

→ Flavors and colors are usually added to dentifrice formulations to improve their acceptance.

Types of Dentifrices

→ Toothpaste.
→ Tooth powder.
→ Mouthwash.
→ Tooth soap.

Examples of dentifrices

→ Calcium carbonate
→ Dibasic calcium Phosphate.
→ Calcium Phosphate
→ Sodium metaphosphate
→ Pumice.

* Role of fluoride in treatment of Dental caries

→ Fluoride ion is a trace material, which occurs in our body. It is generally adequated in food and water. In some parts of world, ground water is totally lacking fluoride. In such places dental caries is a common problem.

→ Addition of fluoride to the municipal water supply. Known as fluoridation is able to help in reducing and preventing dental caries.

→ But this is not true because those who take continue ingestion of fluoride may suffer from mottling of teeth (excess fluoride in teeth), increased density of bones, gastric problem, muscular weakness and even heart failure.

→ when a fluoride having salt or solution is taken internally, it is readily absorbed, transported and deposited in the bone or developing teeth and the remaining gets excreted by kidneys. The deposited fluoride does not allow the action of acids or enzymes in producing lesions.

→ A small quantity of fluoride (1 ppm) is necessary to prevent caries. But when its amount becomes high it gives rise to mottled enamel.

- Fluoride is administered by 2 routes.

(i) orally (ii) Topically.

→ The use of fluoridation is the way of oral administration. Alternatively it can be given in drinking water or juice of about 1 ppm per day.

→ Sodium fluoride tablets or sodium fluoride in a dose of 2.2 mg per day are used. Topically 2% of solution is used on teeth.

Desensitising agents

→ Usually teeth are sensitive to heat and cold especially during tooth decay.

→ Therefore some desensitising agents are used in dental preparations to reduce sensitivity of teeth to heat and cold.

→ They act as local anaesthetic.

Example → Strontium chloride, zinc chloride.

Sodium fluoride

- Chemical formula → NaF
- Molecular weight → 41.99 g/mole.
- Category → Anticaries agent.
- Standards :-

Sodium fluoride contains not less than 98% and not more than 102% of sodium fluoride, calculated with reference to the dried substance.

- Method of preparation :-

(1) It may be prepared by neutralizing hydrofluoric acid with sodium carbonate.

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

(2) Another method includes the double decomposition of calcium fluoride with sodium carbonate wherein insoluble calcium carbonate can be removed by filtration.

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

- **Properties :-**

→ A white powder or colourless crystals.
→ soluble in water practically, insoluble in ethanol.

- **Identification Tests :-**

1 gm of sodium fluoride is placed in a platinum crucible in a well-ventilated hood. To this, 15 ml of sulfuric acid is added and covered with a piece of clean polished glass. The crucible is heated on a water bath for an hour. After an hour the glass covered is removed and rinsed with water and wiped dry. it will be observed that the surface of glass has been etched.

- **Uses :-**

(1) sodium fluoride due to its fluoride ion is an important agent in dental practice for retarding or preventing dental caries.
→ Fluoridised teeth have been resistant to micro-organisms causing dental caries. It also decreases microbial acid production.
→ sodium fluoride in 2% aqueous solution is widely used topically.

- **Usual dose :-**

2.2 mg (equivalent to 1 mg of fluoride) once a day.

• **Caution :-**

when consumed in larger doses, sodium fluoride is Poisonous. High fluoride water greater than 3 PPm) brings about mottling of teeth, gastric disturbances, etc still larger doses may lead to systemic toxicities effecting central nervous, cardiovascular, musculo-skeletal and respiratory systems.

Calcium carbonate

- Molecular formula :- $CaCO_3$
- Molecular weight :- 100.1 gm / mole
- category :- Dentrifrices or cleaning agent.
- synonym :- precipitated chalk.

→ It has been regarded as one of the most abundant and widely distributed of calcium salts. In nature, it is found as chalk, marble, lime stone, aragonite and calcite and one of the main constituents of pearls and shells.

• **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.

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

→ The precipitate is collected on filter and washed with boiling water, until becomes free from chloride ions, finally the precipitate is dried.

- **Properties:-**

→ It occurs as fine, white, micro-crystalline powder.
→ It is odorless and tasteless.
→ It is stable in air.
→ It is almost soluble in water and alcohol.
→ calcium carbonate neutralises acids with effervescence.

- **Identification:-**

It gives the reaction of calcium and carbonate.

- **Assay:-**

It can be assayed by the complexometric titration.

- **Uses:-**

(1) Precipitated chalk, which is having a fine powdery mixture, is used in dentifrice, both powders and pastes.
(2) It furnishes both abrasive and antacid effect in the mouth.
(3) It is having a tendency to cause constipation and hence it is usually administered alternatively or along with magnesium salts.
(4) It is rapidly acting non-systemic antacid. It neutralizes gastric acid and forms calcium chloride.

Zinc eugenol cement

→ zinc oxide eugenol (ZOE) is a material formed by the combination of zinc oxide and eugenol contained in oil of cloves.

→ They are cements of low strength. Also they are the least irritating of all dental cements and are known to have an obtundent effect on exposed dentin.

- Chemical composition of zinc eugenol cement:-

ZnO → 69.0%

white rosin → 29.3%

Zinc acetate → 1%

zinc stearate → 0.7%

Liquid eugenol → 85%

→ 70 to 85% of eugenol is used because it produces less burning sensation for patients. when it comes in contact with soft tissue.

→ Rosin is added to the paste because it facilitates the speed of reaction and yield smooth and more homogenous product.

- Classification of ZOE :-

Type I ZOE : For temporary cementation

Type II ZOE : Permanent cementation.

Type III ZOE : Temporary filling and thermal base.

Type IV ZOE : Cavity Liners.

ZOE cement is available as:-

(1) Powder or liquid.

(2) paste system.

- **Method of Preparation:-**

→ In the first step hydrolysis of zinc oxide to its hydroxide takes place. water is essential for the reaction (dehydrated zinc oxide will not react with dehydrated eugenol).

$$ZnO + H_2O \longrightarrow Zn(OH)_2.$$

→ The reaction proceeds as a typical acid-base reaction.

$$Zn(OH)_2 + 2HE \longrightarrow ZnE_2 + 2H_2O$$

- **structure of set cement:-**

The set cement consists of particles of zinc oxide embedded in a matrix of zinceugenolate.

→ setting time is around 4-10 minute.

- **Uses:-**

(1) zinc oxide eugenol is used in temporary and permanent cementation and also used as pulp capping agent.

(2) It is used to reduce pain sensation in teeth and also has anesthetic and anti bacterial activity.