JES’s college of Pharmacy,Nandurbar

ACIDS, BASES AND BUFFERS

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Acids and Bases

- Acids are the substances having *sour taste*, and pH below 7. They can turn blue litmus paper Red.
- Bases are the substances having *bitter taste* and pH above 7. They can turn red litmus paper blue.
- To explain the properties of acids and bases, different concepts have been given viz.
  - Arrhenius Concept (1887)
  - Bronsted-lowry Concept (1923)
  - Lewis Concept (1923)

Arrhenius Concept

- In 1887 by Swante Arrhenius.
- Theory of Ionization
- Acids and bases are defined based on the ions formed during aqueous dissolution.

Arrhenius Concept

- Substances which ***gives H+ ions*** on dissolution in water are called ***acids*** where as substances which ***gives OH- ions*** on dissolution in water are called ***bases***.
- Eg.
- Acids: HCl, CH_3COOH
- Bases: NaOH, KOH

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

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

- **Acids and bases** when react with each other produce **salt and water.**

$$HCl + NaOH \dashrightarrow NaCl + H_2O$$

Arrhenius Concept

- Limitations:
- Based on **aqueous solution** and not the *substance*.
- Nature *in the absence of water*/non aqueous solvents can not be explained.
- Can't explain Basic nature of substances ***lacking (OH^- ions)*** like NH_3, Na_2CO_3 etc and acidic nature of substances ***lacking (H^+ ions)*** like CO_2, SO_2, $AlCl_3$ etc.

Bronsted-Lawry Concept

- In 1923 by Danish chemist J N Bronsted and British chemist T M Lowry independently.

- More generalized concept applied to both aqueous and non aqueous solutions

Bronsted-Lawry Concept

- Substances which donate proton are **acid** where as substances which accept proton are **bases**.

$$HA + H_2O \text{ ------------> } A^- + H_3O^+$$

$$B + H_2O \text{ -------------> } BH^+ + OH^-$$

- Eg.

$$HCl \text{ -------------> } H^+ + Cl^-$$

$$CH_3COOH \text{ -------------> } CH_3COO^- + H^+$$

$$NH_3 + H^+ \text{ -------------> } NH_4^+$$

$$OH^- + H^+ \text{ -------------> } H_2O$$

Bronsted-Lawry Concept

- **Conjugate Acid-Base Pairs:**

HA	+	H_2O	------------>	A^-	+	H_3O^+
Acid		Base		Conjugate Base		Conjugate Acid

B	+	H_2O	------------->	BH^+	+	OH^-
Base		Acid		Conjugate Acid		Conjugate Base

Bronsted-Lawry Concept

- **Conjugate Acid-Base Pairs**:
- As per the concept two acid-base pairs involved.
- The acid (HA) liberates H^+ ion and forms base A^-.
- The base (B) accepts H^+ ion and forms acid BA^+.
- Such **acids/bases** formed by **liberation/aceptance** of proton are called **conjugated acids/bases.**
- Certain species that can function as acid as well as base are termed as **amphiprotic**. Eg. H_2O

$$HCl + H_2O \dashrightarrow Cl^- + H_3O^+$$
$$NH_3 + H_2O \dashrightarrow NH_4^+ + OH^-$$

Bronsted-Lawry Concept

- Limitations:
- Limited to the concept of proton transfer. Acids lacking protons can not be explained. Eg. $CoCl_2$, SO_2, etc.

- Acid-base reactions in which no proton transfer take place can not be explained. Eg.

$$SO_2 + SO_2 \text{------------>} SO^{+2} + SO_3^{-2}$$
$$Acid_1 + Base_2 \text{----------->} Base_1 + Acid_2$$

- Can not explain acid-base reaction taking place in non-protonic solvents.

Lewis Concept

- In 1923 by Lewis.
- Electron pair Donor-acceptor theory
- Based on transfer of Electron pair in terms of chemical structure.

Lewis Concept

- Any species that can accept an electron pair is regarded as **acid** whereas any species that can donate an electron pair is called **base.**

- Eg.
  Acids: H^+, Na^+, NH_4^+, H_3BO_3, BF_3 etc.

- Bases: NH_3, H_2O, OH^-, Cl^-, CN^-, NaOH etc.

Lewis Concept

- **Limitations**
- Can not explain relative strength of acids and bases.
- Explains acids and bases **based on electron transfer** which is *very rapid*. Hence all the acids and bases should react very fast. But many lewis acids and bases react very slowly.

Buffer Solutions

- The solution of NaCl doesn't offer any resistance to change in pH when acid or alkali is added whereas ammonium acetate solution offers resistance.
- This **property by virtue of which a solution resists the change in pH on addition of acid or base is called** ***BUFFER ACTION***.
- The **solution that resists change in pH on addition of acid or base is known as** ***BUFFER SOLUTION.***
- A buffer solution has a **reserved pH** or a fairly constant pH even when small amount of acid or alkali is added to it.
- Buffer systems are pairs of related chemical compounds capable of resisting change in pH of a solution caused by the addition of small amounts of acid or base.

Buffer Solutions

- **Buffer Action:** The **property** by virtue of which a solution **resists the change in pH**, in response to addition of acid/base.
- **Buffer Solutions: Solutions** able to **resist the change in pH** values on addition of acid/base.
- Classified broadly into:

  Acidic Buffer Solution: Weak acid + its salt with strong base

  eg. Acetic acid + Sodium acetate [$CH_3COOH + CH_3COONa$]

  Alkaline Buffer Solution: Weak base + its salt with strong acid

  eg: Ammonium hydroxide + Ammonium chloride {$NH_4OH + NH_4Cl$}

  Neutral Buffer Solution: Salt of weak acid & weak base

  eg. Ammonium acetate {CH_3COONH_4}

Buffer Capacity

- It's the **quantitative measure** of the resistance to change in pH, a buffer solution has.

"Moles of strong acid or base required to change the pH of 1000 ml of buffer solution by one unit".

- Greater is the buffer capacity, better is the buffer as it can accommodate more acid or base without altering the pH significantly.

$$\beta = \frac{2.3\,Ka\,[H^+][C]}{(Ka + [H^+])^2}$$

Where,
β = buffer capacity
$[H^+]$ = Hydrogen ion concentration of buffer
$[C]$ = Buffer concentration

- From above equation, buffer capacity ∝ buffer concentration.

Buffer equations

- pH of acidic buffer solution and maximum buffer action:
- $[H^+]$ obtained from dissociation of weak acid HA,

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

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

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

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

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

- Its called **Henderson-Hasselbach equation** for acidic buffer.. Using it one can calculate the pH of a buffer solution of known conc. or one can make buffer solution of known pH.

Buffer equations

- pH of alkaline buffer solution and maximum buffer action:
- $[OH^-]$ obtained from dissociation of weak base BOH,

$$BOH \Leftrightarrow B^+ + OH^-$$

$$Kb = \frac{[B^+][OH^-]}{[BOH]}, \text{ or}$$

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

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

$$pOH = pKb + \log \frac{[B^+]}{[BOH]} = pKb + \log \frac{[Conjugate\ acid]}{[base]}$$

$$\text{Now, } pH = 14 - pOH$$

Buffer equations

Now, pH = 14 – pOH

$$pH = 14 - \left(pKb + \log \frac{[Conjugate\ acid]}{[base]}\right)$$

- This is also called as Henderson-Hasselbach equation.
- In case of basic buffer, most of the conjugate acid formed is from salt of weak base and strong acid. Hence the term conjugate acid can be replaced by salt. Hence,

$$pH = 14 - \left(pKb + \log \frac{[salt]}{[base]}\right)$$

Buffers in pharmaceutical system

- Buffers are very frequently used in pharmaceutical preparations as well as processes.
- **Solid Dosage Forms**:
- In solid dosage forms such as tablets, capsules, and powders buffers are used to control the environment around the solid particles and assures the absorption of the drugs which was otherwise dissolution rate limited.
- Reduce the gastric irritation caused by acidic drugs.
- Reducing toxicity.
- **Semisolid Dosage Forms**:

- Semisolid dosage forms undergo pH change on long time storage leading to instability. Buffers like citric acid buffer, phosphoric acid buffers are incorporated to maintain stability.

Buffers in pharmaceutical system

- Buffers are very frequently used in pharmaceutical preparations as well as processes.
- **Parenteral Preparations:**
- **pH below 3** causes **pain** whereas **pH above 10** causes **tissue necrosis**. So buffers are used to maintain **pH near 7.4 (pH of blood)** eg. Phthalate, citrate, glutamate, acetate etc. pH optimization helps in optimum solubility, stability & reduced irritancy.

- **Ophthalmic products:**
- Change in pH can affect stability as well as solubility.

Desired characteristics of Buffers

- Should not form complexes with active ingredients.
- Should not precipitate in redox reactions.
- Should not alter the solubility of other ingredients.
- Should not undergo acid-base reaction other than required as a part of the buffer functions.
- Should be safe
- Should not interfere in the pharmacological actions of the active ingredients.
- Should not made up of volatile substances.
- Should not promote microbial growth.

Standard Buffer Solutions

- Having Standard pH.
- Used for reference purposes in the measurement of pH and carry out tests which require maintenance of pH.

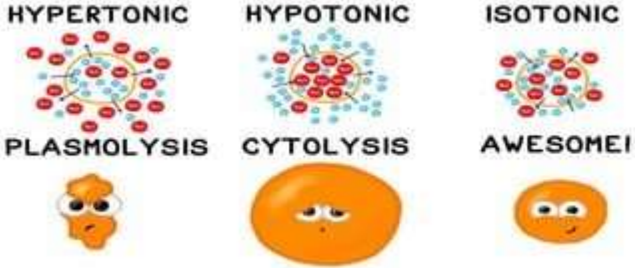
Buffers	pH	Preparation
Hydrochloric acid buffer	1.2 – 2.2	50 ml 0.2M KCl and qs 0.2M HCl → volume make up to 200 ml with H_2O
Acid phthalate buffer	2.2 – 4.0	50 ml 0.2M potassium hydrogen phthalate and qs 0.2M HCl → volume made up to 200 ml with H_2O
Neutralized phthalate buffer	4.2 – 5.8	50 ml 0.2M potassium hydrogen phthalate and qs 0.21M NaOH → volume made up to 200 ml with H_2O
Phosphate buffer	5.8 – 8.0	50ml 0.2M potassium dihydrogen phosphate and qs 0.2M NaOH → volume made up to 200ml with H_2O
Alkaline borate buffer	8.0 – 10.0	50ml 0.2M Boric Acid and qs 0.2M NaOH → volume made up to 200 ml

Other buffer solutions

- Mentioned in Appendix 13.1 of IP. Eg.
- Acetate buffer solution pH 2.8; 3.4; 3.5; 3.7; 4.0; 4.6; 4.7; 5.0; 5.5; 6.0
- Acetic acid – ammonium acetate buffer solution
- Acetic acid – ammonium acetate buffer pH 3.7 ethanolic
- Acetone solution buffered
- Ammonia buffer pH 9.5; 10.0; 10.9;
- Phosphate buffer pH 2.0; 2.5; 3.6; 4.0; 4.9; 5.0; 5.5; 6.5; 6.8; 7.0; 7.5; 8.0
- Saline, phosphate buffered
- Saline pH 6.4; 7.4 phosphate buffered
- Carbonate buffer pH 9.7

Buffered isotonic solutions

- Pharmaceutical preparations are meant for application to delicate membranes and should be adjusted to the same osmotic pressure as that of body fluids in order to avoid any discomfort to the patient when preparation is applied.
- There are three type of solutions based on solute concentration.



Buffered isotonic solutions

- **Isosmotic solutions**: Solutions having same osmolarity to the reference.
- **Osmolarity**: Colligative property that measures the concentration of the solutes independently of their ability to cross cell membrane.
- **Tonicity**: property of a solution in reference to a particular membrane and is equal to the sum of the conc. Of the solutes having capacity to exert an osmotic force across the membrane.

  Depends on solute permeability

Tonicity measurement

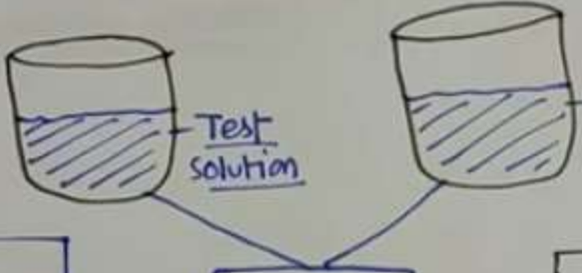
- Pharmaceutical preparations must be isotonic to the solution to which they are being administered. There are two methods to determine the tonicity of different solutions:

I. Colligative Method

II. Hemolytic method

Cryoscopic method

- Isotonic Solutions behave identically in terms of their colligative properties viz. vapor pressure lowering, boiling point elevation, freezing point depression, osmolarity.
- In cryoscopic method freezing point depression (ΔT_f) property is exploited.
- Freezing point (T_f) of water is 0°C. When any solute is added to it there is depression in freezing point.
- Blood plasma as well as lachrymal secretions due to presence of different salts has freezing point -0.52°C.
- **If any solution has freezing point equivalent to -0.52°C, it will be isotonic to blood plasma and lachrymal secretions.**



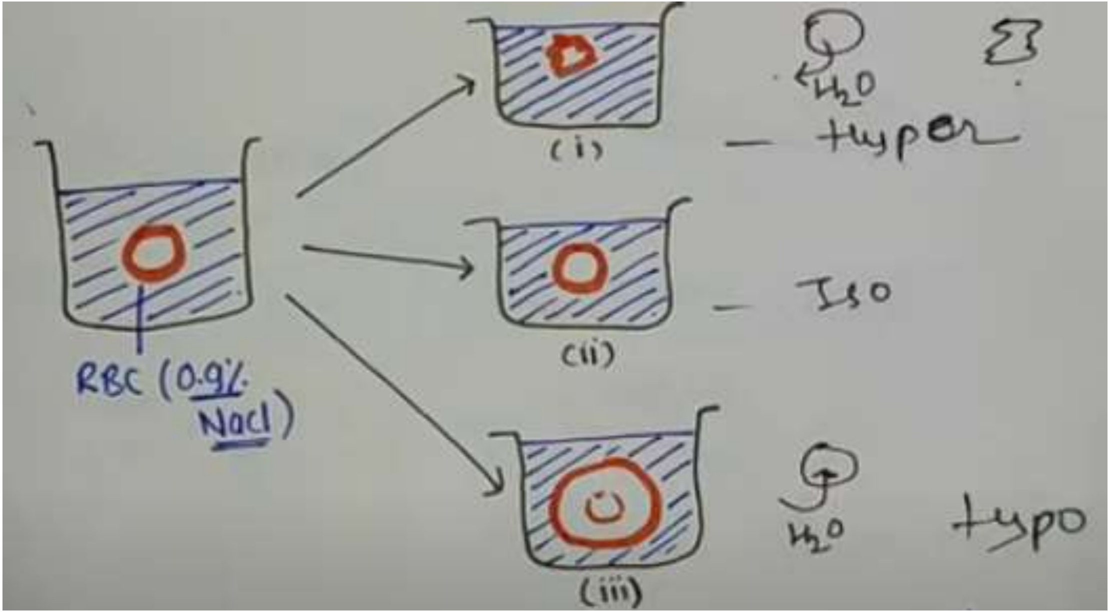
Compare
- freezing point
- Boiling point
- Vapour pressure

eg.
f.p. of std. 0.9% NaCl → −0.52°C

Same → Isotonic
>0.9% → Hypertonic
<0.9% → Hypotonic

Haemolytic method

- Shape of RBCs change based on the tonicity of the solution they are placed in. When placed in hypertonic solution they shrink or get wrinkled, when placed in hypotonic solution they swell or burst and when placed in isotonic solution they remain in their original shape.
- RBCs are placed in test solution and kept suspended for some time.
- Than they are observed for their shape under microscope.



RBC (0.9% NaCl)
(i)
(ii)
(iii)
H_2O
— Hyper
— Iso
H_2O
Hypo

Tonicity Adjustment

- Isotonic Solutions behave identically in terms of their colligative properties viz. vapor pressure lowering, boiling point elevation, freezing point depression, osmolarity.
- Hence, isotonicity can be calculated in terms of colligative properties.
- Preparations meant for administration must be isotonic otherwise they will cause discomfort, pain, tissue necrosis etc.
- To make the solution isotonic, tonicity adjusting agents are added.
- Amount of tonicity adjusting agents required to make the solution isotonic can be calculated with the help of colligative prooerties.

Tonicity Adjustment Methods

- **Class I Methods**: NaCl or some other substance is added to the solution of the drug to lower the freezing point of the solution to -0.52°C making the solution isotonic to body fluids.

  Eg. Sodium chloride equivalent method, Cryoscopic method

- **Class II Method**: Sufficient amount of water is added to the solution to make the solution isotonic to body fluids. Volume is than made up with a buffered isotonic solution.

  Eg. White-Vincent method

- **Class III Method**: Theoretical values of L. iso and ΔT_f are calculated with the help of molecular weight of the drug and are used to determine the quantity of adjusting agent required to make the solution isotonic.

  Eg. L.iso method

Class I Methods

- **Sodium chloride equivalent method:** (Tonicity equivalent method)
- **Sodium chloride equivalent (E):** Amount of sodium chloride equivalent to 1 gm of the drug.

$$PSA = 0.9 - (PSM \times E)$$

Where,

PSA = Percent of sodium chloride for adjustment of isotonicity

E = sodium chloride equivalent of medicament

PSM = Percent strength of medicament

- The equation can be used to calculate amount of NaCl required to make solution isotonic.

Class I Methods

- **Cryoscopic Method**:
- Quantity of drug required to obtain isotonic solution can be calculated from Freezing point depression (ΔT_f).
- Freezing point depression (ΔT_f) of blood is -0.52°C.
- The drug solution must have (ΔT_f) values equal to -0.52°C in order to be isotonic to blood.

Class I Methods

- **Cryoscopic Method:**

ΔT_f (for drug solution) = ax

ΔT_f) of 1% drug solution = x

Suppose adjusting agent required to make 100 ml solution isotonic = w gm

ΔT_f of adjusting solution = w X ΔT_f of 1% adjusting substance

= w X b

For making solution isotonic

x + wb = 0.52

$$w = \frac{0.52 - x}{b}$$

Class I Methods

Substance/1% w/v solution	Sodium chloride equivalent (E)	ΔT_f in °C
Apomorphine HCl	0.14	0.08
Boric Acid	0.50	0.29
Calcium gluconate	0.16	0.09
Potassium chloride	0.76	0.45
Sodium sulphacetamide	0.23	0.14
Sodium chloride	1.00	0.58
Pilocarpine nitrate	0.23	0.14

Class II Methods

- **White Vincent method:**
- Drug solution is made isotonic by diluting it with water and final volume is mad up by buffered isotonic solution
- $V = w \times E \times 111.1$

  Where,

  V = Volume of osmotic solution prepared by mixing drug with water

  w = weight of drug (gm)

  E = Sodium chloride equivalent of drug

Class III Methods

- **L-iso Method:**
- Freezing point depression equation is used to calculate the amount of the adjusting agent that must be added to hypotonic solutions of drug to bring to tonicity

$$\Delta T_f = L\ iso\ C$$

ΔT_f of 1% drug solution is equal to $L\ iso\ C$, hence,

$$\Delta T_f = L\ iso\ {}^{1gm}/_{M}$$

Where,

M = molecular weight of drug

$L\ iso$ value of NaCl = 3.4, Hence,

$$\Delta T_f = \frac{3.4 \times E}{58.45}$$

Class III Methods

Drug	*L iso* value
Urea, Propylene glycol, sucrose	1.9
Boric acid, phenobarbital	2.0
Magnesium sulphate, zinc sulphate	2.0
Sodium chloride, amphetamine HCl	3.4
Sodium sulphate, atropine sulphate	4.3
Zinc chloride, calcium broide	4.8
Sodium phosphate, sodium itrate	5.2
Aluminum chloride, ferric iodide	6.0
Sodium borate, potassium borate	7.6

THANK YOU

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Major Extra And Intra Cellular Electrolytes

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Electrolytes

- **Electrolytes:** A substance that forms ions when dissolved in water is an **electrolyte**.
- An ions can have either a **positive** charge (**cation**) or a **negative** charge (**anion**).
- Human body contains several primary ions of electrolytes. The major electrolytes found in the human body are;-

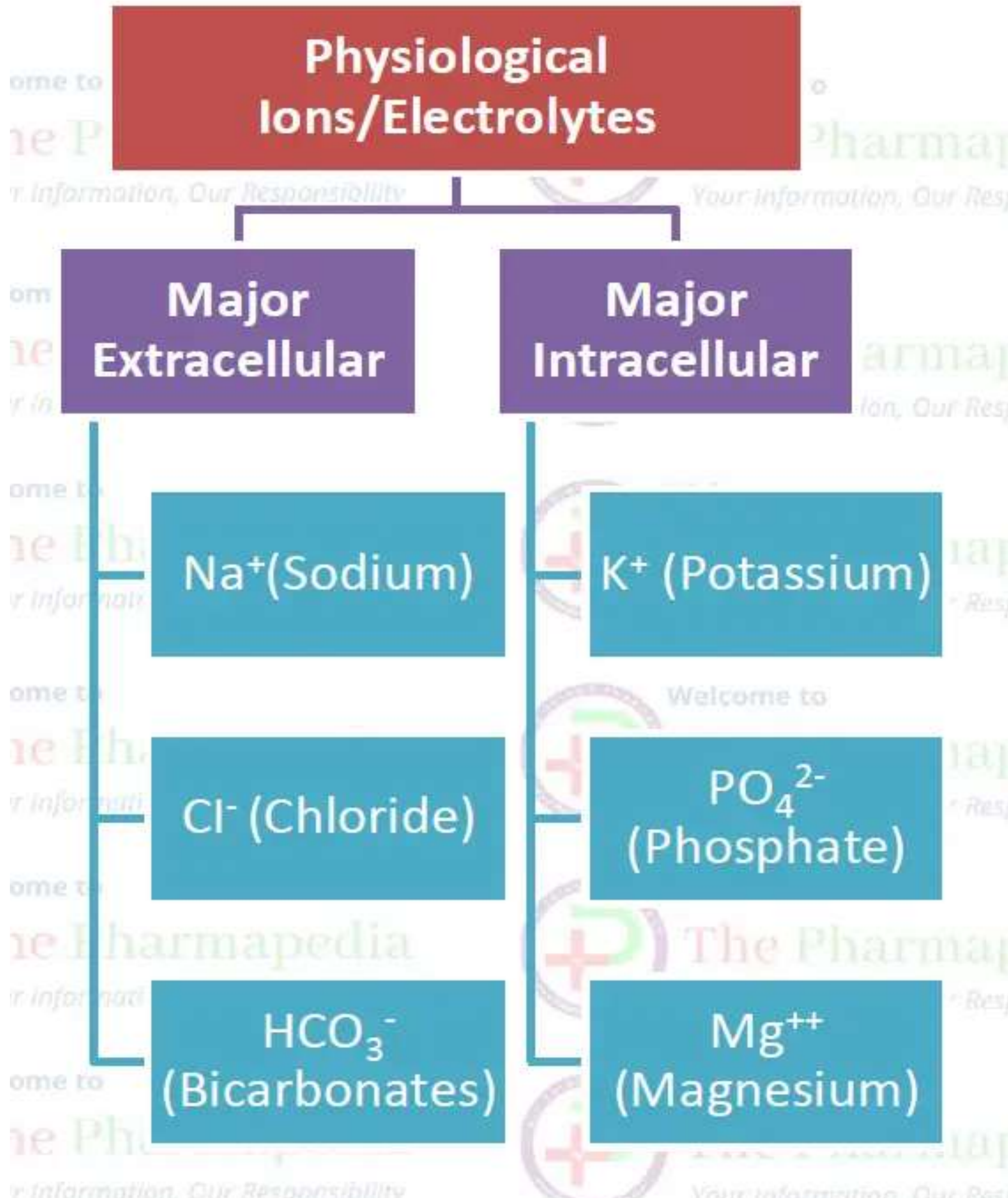
MAJOR ELECTROLYTES

Cation	Anion
Sodium (Na^+)	Chloride (Cl^-)
Potassium (K^+)	Phosphate (HPO_4^-)
Calcium (Ca^{++})	Sulfate (SO_4^-)
Magnesium (Mg^{++})	Bicarbonate (HCO_3^-)

Major electrolytes

Physiological Ions:

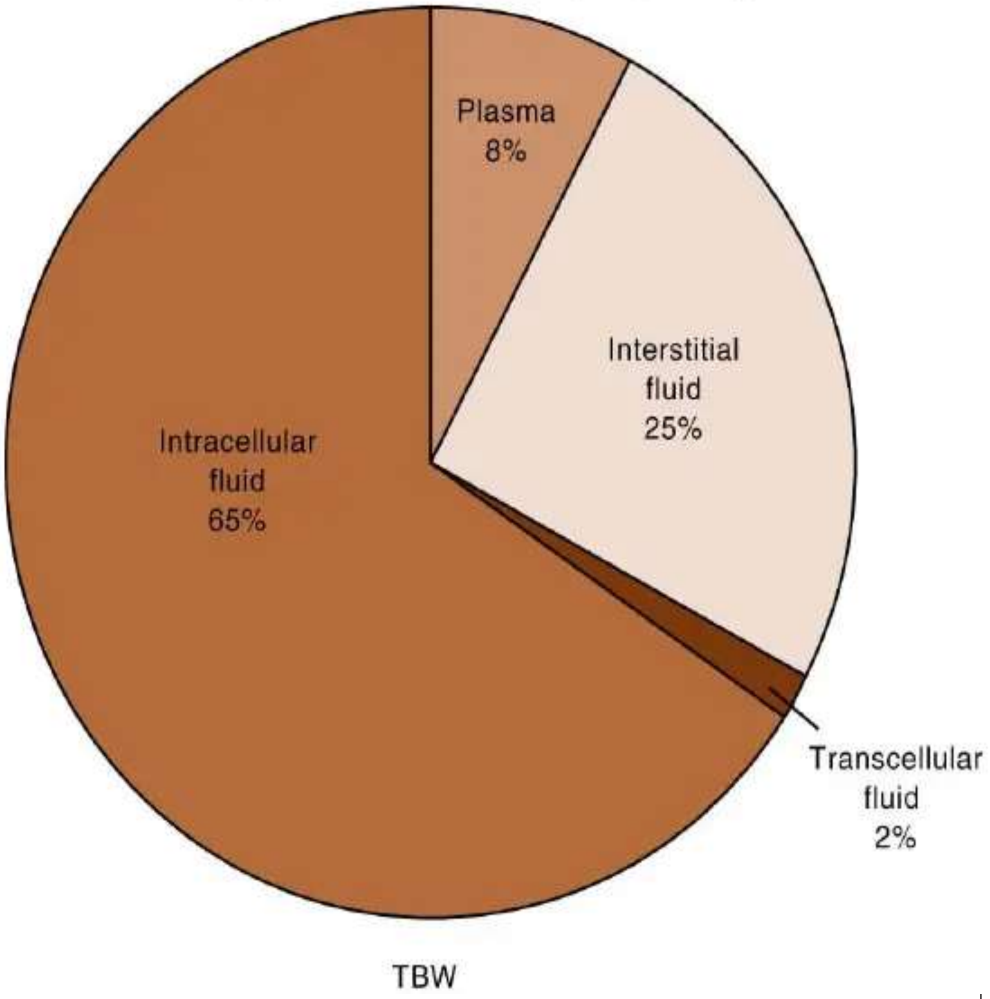
- The ions which help or maintain normal physiology of our body known as **Physiological Ions.**
- These ions are directly associated with normal function & physiology of human body.
- Physiological Ions are present in both extracellular & Intracellular fluid.



- The body fluids are solutions of **inorganic and organic solutes.**
- The concentration balances of the various components are maintained in order for the **cells and tissues to have a constant environment.**
- To maintain the electrolyte balance, there are regulatory mechanisms which **controls pH, ionic balances, osmotic balances, etc.**
- The electrolytic concentration will vary with a particular fluid compartment.

1. **Intracelluar fluid** – (45 – 50% of body weight and present with in the cell). E.g.-Cytoplasm
2. **Extracellular fluid** – (12 – 15% of body weight and present outside the cell). E.g.- Tissue fluid
   a. **Interstitial fluid –** (12 – 15% of body weight and
   b. **Plasma or vascular fluid** (4 – 5% of body weight)

- **Intracellular water:** Fluid inside cells
- **Extracellular water:** Fluid is outside the cells
- i.e. within interstitial tissues surrounding cells, blood plasma, and lymph
- The electrolytes are necessary for maintaining osmotic pressure and electro neutrality (equal number of cations and anions).
- The electrolytes also essential to transmit impulses.



SODIUM

- **Location :** Extracellular compartment as salt Na+
- **Normal level :** 136 – 142 mEq/L
- **Normal intake / day :** 5 to 20 gm
- **Daily requirement :** 2 to 5 gm
- Excess amount of sodium intake is excreted by urine.
- Na+ level in blood controlled by aldosterone and antidiuretic hormone (ADH).

Function :

- Contraction of muscle
- Transmission of nerve impulses in the nerve fiber
- Maintain electrolyte composition of various body fluid and normal hydration.
- Maintain osmotic balance along with Cl-
- In kidney , maintain blood-urine volume level

HYPONATREMIA

Low Level of Sodium Na^+ In Body

Reason :

- Extreme urine loss (diabetic patient)
- Kidney damage
- Diarrhea
- Vomiting
- Excessive sweating
- Addison's disease

Recognized by :

- Muscular weakness
- Dizziness
- Headache
- Hypotension
- Tachycardia

HYPERNATREMIA

High Level of Sodium Na+ In Body

Reason :

- Dehydration
- High sodium intact

Recognized by :

- Intense thirst
- Fatigue
- Restlessness
- Agitation
- Coma

Treatment :

- Hyponatremia = electrolyte replacement therapy
- Hypernatremia =low sodium diet , diuretic

CALCIUM

- **Location :**1% in extracellular and 99% in bones and teeth combined with phosphate to form crystal lattice of mineral salt.
- **Dietary source :** milk , cheese, green veg, eggs and fish.
- Absorbed in all part of small intestine.
- Excreted by sweat, urine and faeces.
- Daily intake in adult is about **800-1000mg**
- Per day minimum requirement in adult is about **400mg.**
- More calcium require in children, during pregnancy and lactation.
- Total plasma calcium is **8.8-10.4mg/100ml**

Function :

- Blood coating
- Muscle contraction
- Release of Ach from neuron
- Bones and teeth

Hypocalcemia

- Decrease calcium level in body

Reason :

- Lower absorption
- Vit. D deficiency
- Bone cancer

Symptoms :

- Titanic spasm
- convulsion

Hypercalcemia

- Increase calcium level in body

Reason :

- Hypervitaminosis
- Bone neoplastic disease

Symptoms :

- Muscle weakness
- Constipation
- Cardiac irregularity

CHLORIDE

- **Location :**found in all body fluid. 60% chloride present in plasma.
- Normal plasma chloride concentration is about **95 to 103 mEq/litre.**
- Chloride ion absorbed in intestine and excreted by urine and by sweating.

Function :

- Maintain hydration
- Maintain osmotic pressure
- Maintain normal cation-anion balance in vascular and interstitial fluid compartment

Hypochloremia

Decrease Cl- ion in body

Reason :

- Metabolic acidosis seen in diabetes mellitus / Renal failure
- Lack of reabsorption from kidney
- Therapy of diuretic
- Excessing vomiting / Loss of gastric acid

Symptoms :

- Alkalosis
- Respiratory depression
- Muscle spasm

Hyperchloremia

- Increase Cl- ion in body

Reason :

- Excess loss of bicarbonate ion
- Dehydration / vomiting or diarrhea.
- High fever that causes sweating and dehydration
- Too much salt intake.
- Diabetes insipidus, which causes the kidneys to pass large amounts of fluid.
- Addison's disease

Symptoms :

- Irregular heart rate
- Confusion, difficulty concentrating, and personality changes
- Numbness or tingling
- Seizures and convulsions
- Fluid retention / high blood pressure / muscle weakness , spasms, or twitches

POTASSIUM

- **Location :** found in intracellular fluid 23 times higher than in extracellular fluid.
- Normal plasma K+ concentration is **3.8 to 5.0 mEq/litre.**
- Daily require 5 to 7 gm/day.

Function :

- Contraction of muscle specially cardiac muscle
- Transmission of nerve impulse
- Maintain electrolyte composition in various body fluid
- Help to regulate pH
- Maintain osmotic balance

Hypokalemia

Decrease K+ ion in body

Reason :

- Lower absorption
- Malnutrition
- Diarrhea , Vomiting
- Burn
- Urine loss
- Heart disease

Symptoms :

- Fatigue
- Cramp
- Low B.P
- Mental confusion
- Increase urine output

Hyperkalemia

Increase K+ ion in body

Reason :

- Kidney damage , Dehydration
- Cardiac disease
- C.N.S. depression

Symptoms :

- Anxiety
- Abdominal cramping , Weakness
- Diarrhea , Burning sensation
- Bradycardia

MAGNESIUM

- **Location :** found in intracellular fluid. 54% in bones and 45% in ICF and 1% in extracellular fluid.
- Adult human body contain 25 gm magnesium.

Function :

- Myocardial infraction
- It activate enzyme involved in carbohydrate and protein metabolism
- Important in neural transmission
- Neuromuscular activity
- Require for the function of sodium / potassium ATPase pump system.

Hypomagnesemia

- Decrease Mg^{++} ion in body

Reason :

- Lower absorption
- Malnutrition
- Diarrhea
- Chronic alcoholism

Symptoms :

- Weakness , cardiac arrythmia
- Tetany
- Convulsion , confusion
- Nausea , anorexia

Hypermagnesemia

- Increase Mg++ ion in body

Reason :

- Addison's disease , Hypothermia
- Acute diabetic acidosis , Renal failure
- Severe dehydration

Symptoms :

- Slurred speech
- Hypotension
- Cardia arrest
- Drowsiness
- Impaired muscular co-ordination

Electrolyte Used In Replacement Therapy

- In a healthy person, at least 70 liters of fluids are exchanged (secreted and reabsorbed) across the walls of the intestines per day.
- The brain, heart, kidney, and virtually every other vital organ depend on these fluids to function.
- As the body takes in the water and salts it needs, it loses or excretes those it does not need through urine, stools, and sweat.
- Thus, the **secretion and absorption** rates are kept in balance.

- In various condition like prolonged fever, sever vomiting or diarrhea creates a tremendous outpouring of water (heavy loss of water) & electrolytes (body salts) state of dehydration and impairs the capacity to reabsorb the fluid & electrolytes in our system.

- To compensate this loss, Electrolyte Replacement Therapy / Oral Rehydration Therapy is required

There are 2 type of solution used in replacement therapy.

1. Rapid replacement
2. Subsequent replacement

1. A Solution For Rapid Initial Replacement

Solution contain sodium in concentration range of :-

130-150 mEq/L Sodium

98-110 mEq/L Chlorine

28-55 mEq/L Bicarbonate

4-12 mEq/L Potassium

3-5 mEq/L Calcium

3mEq/L Magnesium

- This concentration closely resemble with the concentration of extracellular fluid.

2. A Solution For Subsequent Replacement

Composition of Electrolyte solution include :-

40-120 mEq/L Sodium

30-105 mEq/L Chloride

16-53 mEq/L Bicarbonate

16-35 mEq/L Potassium

10-15 mEq/L Calcium

3-6 mEq/L Magnesium

0-13 mEq/L Phosphorus

Sodium Chloride

- **Chemical formula** – NaCl **Molecular weight** – 58.5
- **Synonym** – Rock salt / Common Salt / Table Salt
- **Properties –**
- ✓ **Color** – white crystalline powder / colourless cubic crystal
- ✓ **Odour** – odourless
- ✓ **Taste** – saline taste
- ✓ **Solubility** – soluble in water, glycerine. Slightly soluble in alcohol
- **Method of Preparation –**
- ✓ **From Sea-Water** :- it is prepared commercially by evaporation of sea water in shallow pan. It contain numbers of impurity so need to filter to remove impurity. .

- **Method of Preparation –**

✓ Laboratory Method:- in laboratory on small scale it is prepared by acid base reaction between a strong acid HCl and strong base NaOH. The sodium chloride is present in dissolved form, solid obtained by evaporation of water.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

- **Assay –**

it is analyzed by precipitation titration (Mohr's) Method. Accurately weighed sample 0.25gm is dissolved in water 50ml. And titrated with 0.1N silver nitrate solution using Potassium chromate as a indicator.

$$NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$$

$$2\,AgNO_3 + K_2CrO_4 \rightarrow Ag_2CrO_4 + 2KNO_3$$

Uses

- It act as source of Na and Cl
- 0.9 % of NaCl solution is isotonic with blood. Used in wet dressing and irrigation body cavity
- Used as electrolyte replenisher , emetic , topical anti inflammatory.
- 0.9% solution used in eye drop, nasal drop, mouth wash
- Its ingredient of ORS.
- It act as emetic so used as antidote in case of poisoning
- Used as a taste enhancer .
- Used as hydrating agent in dermatological preparation.

Marketed preparation of Sodium Chloride :-

- Sodium chloride injection
- Sodium chloride hypertonic injection
- Compound sodium chloride injection
- Sodium chloride and dextrose injection
- Sodium chloride tablet

Potassium Chloride

- **Chemical formula** – KCl **Molecular weight** – 74.5
- **Synonym** – kalii Chlordium / chloropotassuri
- **Properties –**
- **Color** – colorless / cubical crystal or white granular powder
- **Odour** – odorless
- **Taste** – saline taste
- **Solubility** – freely soluble in water and glycerin . Insoluble in alcohol

Method of preparation –

- In laboratory is prepared by action of HCl on potassium carbonate or bicarbonate.

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

Uses

- Used as electrolyte replenisher in case of hypokalaemia
- Used as diuretic
- Used in treatment of familial paralysis and myasthenia gravis.
- Used as antidote in digitalis poisoning
- Ingredient of ORS

Calcium Gluconate

- **Chemical formula** – C12H22O14Ca.H2O
- **Molecular weight – 448.40**
- **Synonym –** Calcium D- gluconate / gluconic acid / calcium salt / hemi calcium salt
- **Properties –**

✓ **Color –** white crystalline or granular powder

✓ **Odour –** odourless

✓ **Taste** – tasteless

✓ **Solubility –** soluble in water, more soluble in boiling water, insoluble in alcohol and other solvent.

Method of Preparation –

- it is prepared by boiling solution of gluconic acid with excess of calcium carbonate. The precipitate obtained are than filtered and product is concentrated to crystallization.

$$C_6H_{12}O_7 + CaCO_3\ C_{12}H_{22}O_{14}Ca.H_2O + CO_2$$

Assay –

- According to I.P, assay based upon complexometric type of titration which involve replacement of magnesium using 5ml standard magnesium sulphate solution. The pH is adjusted with ammonia-ammonium chloride buffer. The volume of disodium edetate equivalent to magnesium sulphate solution is subtracted from total disodium edetate used and then result is calculated with standard.

Uses

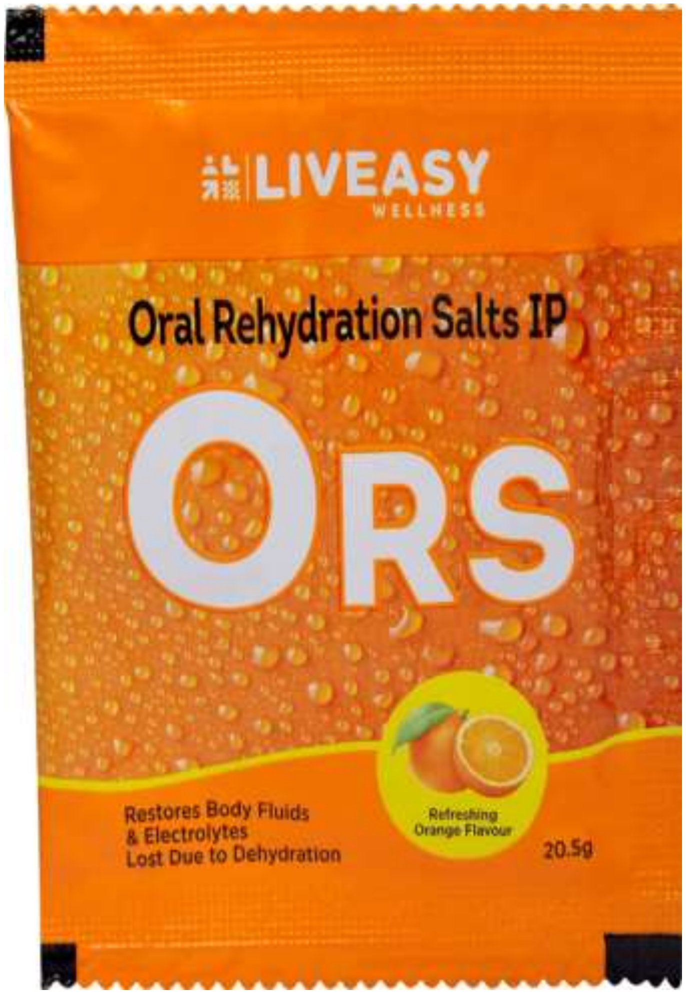
- It used in treatment of calcium deficiency.
- It used by orally , I.V., I.M.
- It used as calcium replenisher.
- It is used in treatment of hypocalcemictetany.
- Injection found to be useful in treatment of black widow spider bite.

Marketed preparation –

- Calcium gluconate injection
- Calcium gluconate tablet

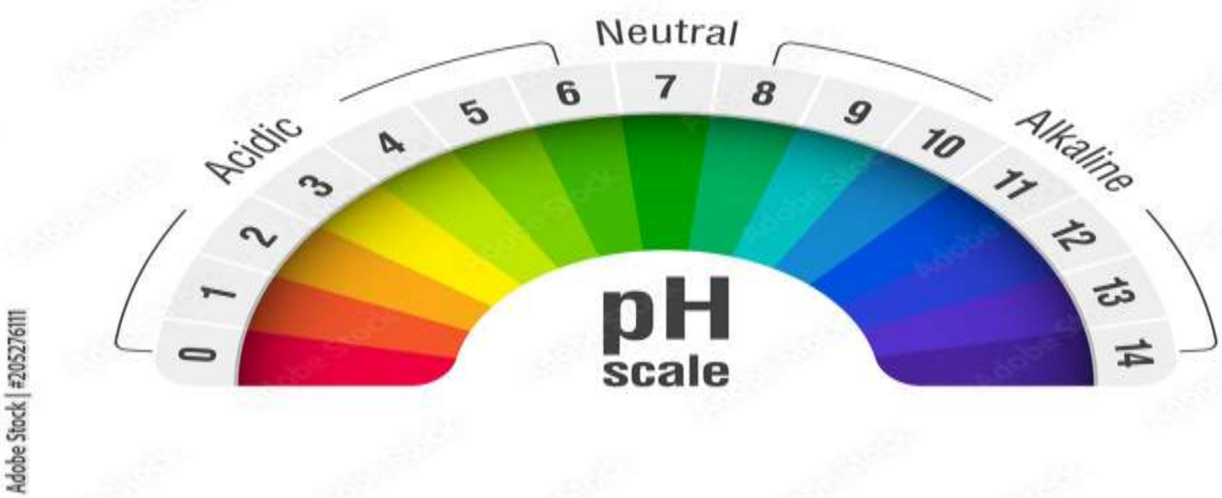
ORS (Oral Rehydration Salt)

- In acute diarrhea, loss of water and electrolyte leads to dehydration and metabolic imbalance.
- Oral administration of fluid that contain suitable combination of carbohydrate and electrolyte is known as **Oral rehydration therapy (ORT).**
- It is a liquid preparation developed by WHO that can decrease fluid loss in person suffering from diarrhea, dysentery and severe vomiting.
- Its like a fluid replacement.



Physiological Acid-Base Balance

- Electrolytes also play an important role in regulating body's acid-base balance
- Body fluids contain balanced quantities of acids & bases.
- Acidity of the solution: No of [H+] present in fluid/solution - ECF
- Sources: [H+]
- Food
- Cellular metabolism of Glucose, Fatty acids, & Amino acids etc
- Reabsorption



- **Biochemical reactions:** Very sensitive to change in pH (acidity/alkalinity)

  e.g., **enzyme Pepsin in the stomach**– helps in digestion of dietary proteins at low pH. ,**enzyme Ptyalin in saliva** – helps in digests carbohydrates at pH between 5.4 - 7.5.
- Kidney remove excess acid and make urine acidic
- **Metabolic activity –** produce acid/base and alter blood pH
- Strong acid and base are continually taken and formed by body.
- pH of fluid inside and outside cell remain constant because of presence of buffer system.
- Most buffer in human body consist of weak acid and their salt.

Function of buffer system is

- convert strong acid or base into weak acid or base.
- To prevent drastic change in **pH of the blood.**
- Major buffer of metabolic acid/base present in Plasma & Kidneys.
- Regulates blood Ph
- Some CO_2, the end product of cellular metabolism, is carried to the lungs for elimination.
- Rest of dissolve in body fluid and form carbonic acid that dissociate to produce bicarbonate HCO_3^- and hydronium H_3O^- ions.

Regulation of Blood pH

- The lung and kidney play important role in regulation of pH of blood.
- Lung regulate pH through retention or elimination of CO_2 by changing rate and volume of ventilation
- The kidney regulate pH by excreting acid, primarily ammonia NH_4^- and by reclaiming HCO_3^- from glomerular filtrate.
- In case of over breathing , excess excretion of CO_2 occur, which leads to alkalosis.
- Kidney have ability to generate ammonia which neutralize acid product of protein metabolism

- Electrolyte also play important role in regulating acid base balance.
- It maintain by controlling H+ concentration of body fluid, particularly extracellular fluid.
- In healthy adult, pH of extracellular fluid remain 7.35 – 7.45
- Normal concentration of H+ in body fluid is only 40 nEq/liter.
- Some hydrogen ion enter the body by food, cellular metabolism of glucose, fatty acid and amino acid produce hydrogen ions.

Thank you

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Dental Products

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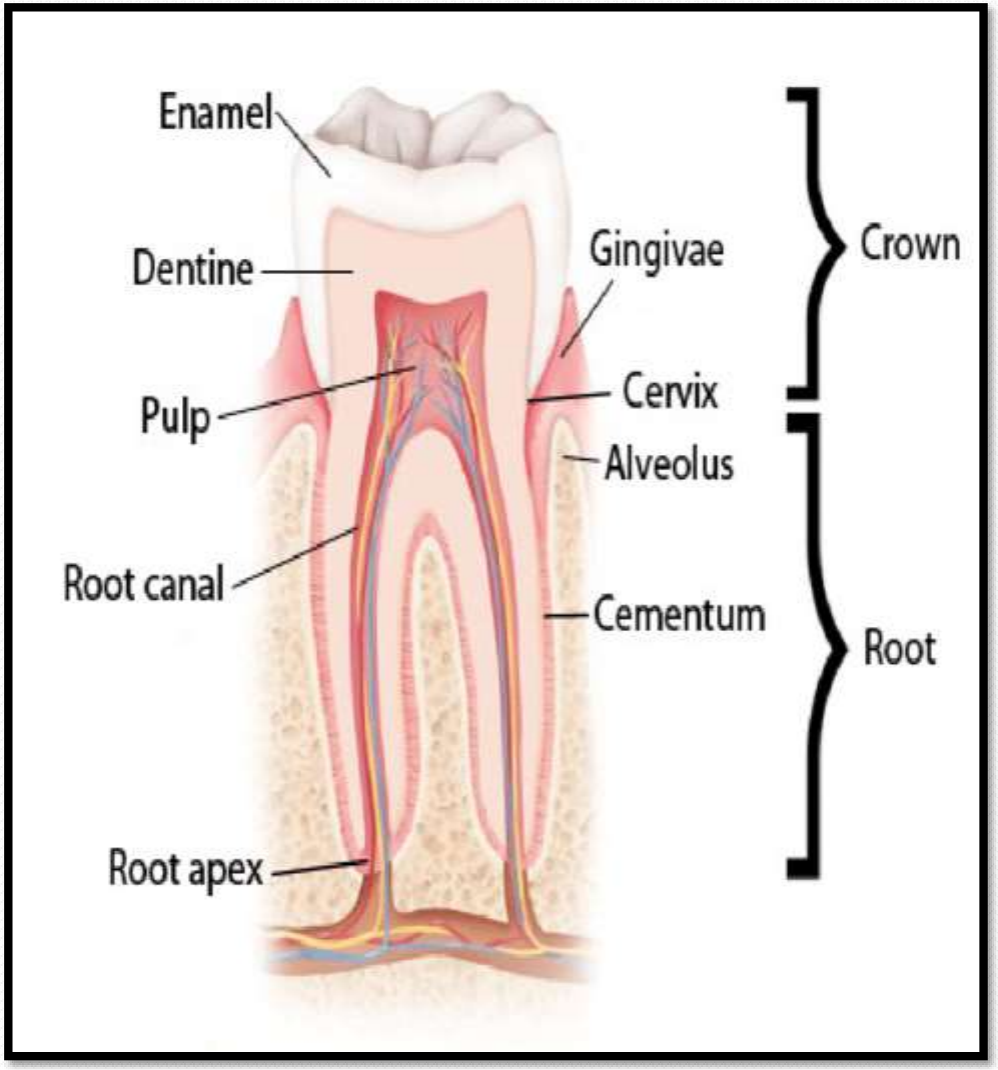
Dental Anatomy

- **Enamel:** Crystalline calcium salts cover the crown to protect the tooth.
- **Dentin:** Largest part of the tooth beneath the enamel and protect pulp.
- **Pulp:** Consist of free nerve endings.
- **Cementum:** Bone like structure, cover the root and provide the attachment of the tooth with periodontal ligaments.



Dentifrices

- According to American Dental Association Council on Dental Therapeutics:
- “ A dentifrices is a substance used with a toothbrush for the purpose of cleaning the accessible surface of the teeth”

Types of dentifrices

1.Cosmetic dentifricesit must clean and polish teeth

2.Therapeutic dentifricesit must reduce disease process caries, sensitivity

Dentifrices

Forms of dentifrices

- Pastes
- Tooth powder
- Gels

Function of dentifrices

- Mouth freshener
- Removal of stains
- Anti-caries action
- Minimizing plaque build up

Anticaries Agents

Definition:

Agents those are used to prevent the tooth decay (caries)

Dental Caries-

- Tooth decay due to bacterial metabolism
- Due to action of lactic acid, where food is attaches

Example of anticaries agent

- Sodium Fluoride, Stannous fluoride

Fluorides

Role of fluoride

- It is able to help in reducing and preventing dental caries
- A small quantity (1 ppm) of fluoride necessary to prevent caries
- Addition of fluoride to the the municipal water supply known as ***fluoridation***
- Topical fluoride can also provide antimicrobial action

❖ However, excessive fluoride intake during the period of tooth development can cause dental fluorosis.

Routes of administration

1. Orally
2. Topically-

- Public water supply containing 0.5 to 1 ppm(should not more than 1 ppm)
- For topical application 2 percent solution is generally used on teeth.

Mode Of Action

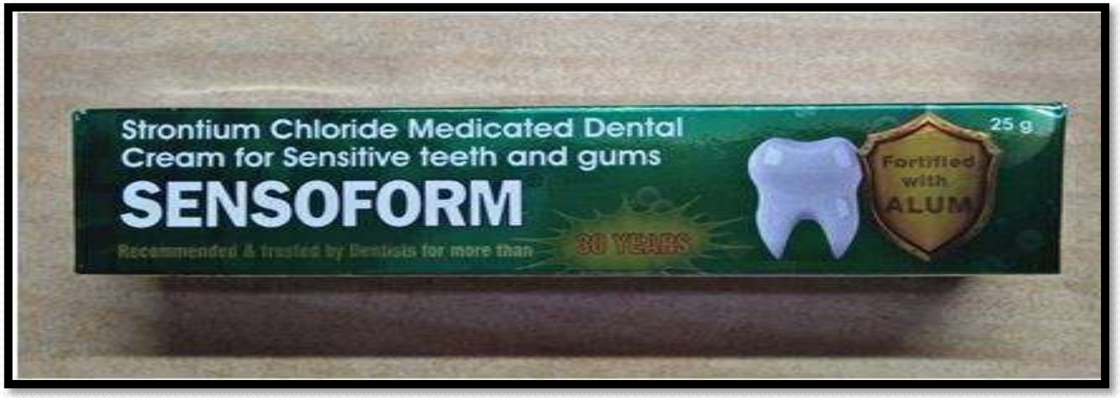
- When a fluoride having salt or solution is taken internally, it is readily absorbed, transported and deposited in the bone or developing teeth and remained get excreted by kidneys.
- The deposited fluoride on the surface of teeth does not allow the action of acids or enzymes.

Desensitizing Agents

- Teeth are somewhat sensitive to **hot and cold** Especially during teeth decay or in toothache
- Therefore, some desensiting agents are used in dental preparations so as to reduce sensitivity of teeth to hot and cold.

Mechanism of action

- Exact mechanism of action of desensiting agent is not known with certainty.
- However they act probably like local anaesthetic.
- **Examples:** Strontium chloride and Zinc chloride



Sodium Fluoride

- **Formula:** NaF **Molecular weight:** 41.99
- **Preparation:** It may be prepared by neutralizing HCl with Na2CO3.

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

- Another method involves the double decomposition of Calcium Fluoride with Sodium carbonate wherein insoluble Calcium carbonate can be removed by filtration.

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

Properties Of Sodium Fluoride

- Occurs as colourless,
- odourless
- Crystals or as white powder.
- Soluble in water but is insoluble in alcohol.

Storage

- Aqueous solution of NaF corrodes ordinary glass bottles and hence the solution should be prepared in distilled water and stored in dark, Pyrex bottles.

Pharmaceutical Uses:

- NaF is used in prevention of dental caries because of its fluoride ion concentration.
- It is constituents of some insecticide and rodenticides.
- Used in the preparation of a tooth paste which constituents about 75% of NaF and 25% of glycerol.

Usual Dose:

- 2.2 mg (Equivalent to 1mg of fluoride ion)

Applications

- 1.5-3.0 in drinking water

Calcium Carbonate

Chemical formula: $CaCO_3$ **Molecular Weight:** 100.09

Synonym: Precipitated Chalk, Precipitated Calcium Carbonate.

- It is the most abundant and widely distributed in nature as limestone, Iceland spar and shells of sea animals.

Method of preparation:

- Calcium carbonate is precipitated when CO_2 is passed through lime water or solution of sodium carbonate is added to calcium chloride which results into the formation of calcium carbonate.

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

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

Physical Properties

- Calcium carbonate occurs as white
- Odourless
- Tasteless,
- Micro crystalline powder which is stable in air.
- Practically soluble in dil HCl and HNO3 but is insoluble in water and alcohol.

Uses:

- Externally as dentifrices, as a dental cleaning-polishing agent for most tooth paste and tooth powders.
- Used as insecticide.
- Due to its fast action, Calcium carbonate is used as an antacid, as a calcium supplement in deficiency states; as a food additive.
- Also used in homeopathic medicine.

Zinc Eugenol Cement

- Zinc oxide eugenol (ZOE) cement have been used extensively in dentistry since 1890’s.
- 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 expected dentin.

Composition

a. Liquid-

- Eugenol (react with zinc oxide)
- Olive oil (Plasticizer)

b. Powder

- Zinc oxide (Principal ingredient)
- Zinc stearate (accelerator, plasticizer)
- Zinc acetate (accelerator, improve strength)
- White rosin (to reduce brittleness of set cement)

Properties

- It is the cement of low strength, low abrasive resistance, and flow after setting, so it is used for temporary filling not be more then few days.
- It has adhesive effect on exposed dentin.
- It is least irritating than other dental cements.

Uses:

- It is used as impression material during construction of complete dentures
- Is used in the mucostatic technique of taking impressions.
- Temporary fixing contents and filling materials
- For gingival dressings

Thank you