Unit - 2

Earlier Concept

Acids : Substances which has sour taste and its aqueous solution turns blue litmus Red

Bases : Substances which are bitter in taste and turns Red litmus blue.

Arhenious Concept :

Acid : Substances containing Hydrogen and gives Hydrogen ion in aqueous solution.

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

Base : Substances which contain Hydroxy groups and Hydroxyl ions in aqueous solution

$$\text{Eg:-}\ NaOH \xrightleftharpoons{H_2O} Na^+ + OH^-$$

* According to this concept neutralisation can be Represented as combination of $H^+ + OH^-$ to form water —

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

Limitations :

1). Definition of Acid and Bases are only in terms of aqueous solution not in terms of non-aqueous solution

2) Neutralization of Acid and base in absence of Solvent could not be Explained.

3) Basic Substances which do not contain Hydroxide ion still show basic Characters which could not be Explained

Eg:- NH_3

4) Cannot Explain acidic Characters of Certain Salts like $AlCl_3$ in aqueous Solution

Brownsted - Lowry Theory:

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

Acid: Substances Capable of donating proton

Base: Substance Capable of Accepting proton

$OH + H \rightleftharpoons H_2O$

Conjugate acid - base pair:

The acid base pairs, The members which can be formed from Eath other mutually by gain & loss of proton is called Conjugate acid - base pair

$HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$

Acid$_1$ Base$_2$ Acid$_2$ Base$_1$

→ HCl donates proton, where H_2O accepts proton

→ in Reverse Reaction The H_3O donates proton to Chloride and Chloride accepts proton from H_3O

Limitations:

1) not all acids are protonic in nature

2) Could'nt Explain the Reactions occuring in non-protonic Solvents Such as $COCl_2$, SO_2 N_2O_4

Lewis Theory

Acid: Species that Can accept Electron pair to form Co-ordinate Bond

Base: Species that Can donate Electron pair to form Co-ordinate Bond

According to Lewis neutralisation is simply the formation of Co-ordinate between acid and base $H^+ + NH_3 \longrightarrow NH_4$

In the above Reaction H^+ accepts one Electron pair and NH_3 donates Electron and it is base

Limitations :

* Lewis acids and bases are found to depend on Reaction, it is not possible to arrange them in order of Relative Strength.
* As Lewis acid - base Reactions Involve Electrons They are Expected to be fast Reactions, However They are Some Reactions which are Slow.

Relative Strengths of Acids and Bases

* The Efficiency depends on which acid donates proton and base accepts proton.
* Strong acids and bases are Completely dissociated
* Weak acids and bases are
* Strengths of acids and bases determined by dissociate Constant "K"

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

A = Concentration of Conjugate Base of acid

H = Concentration of Hydrogen ion

H_A = Concentration of

* If A is a Strong Base it has high affinity towards H^+ So BH^+ is weak acid Conjugate
* If A is a weak Base it has low affinity towards H^+ So BH^+ is Strong acid Conjugate

Importance of acids and Bases in pharmacy:

1) Preparation of Salts
2) Acid - base titrations
3) As a therapatic acid
4) Conjugate Base - Base are used as Buffers

Buffer Solution:

The Solutions which are able to Resist the Changes in pH Value are known as buffer Solutions.

Types 1) Acidic buffer:

Solutions having mixture of weak acid and its Salt

→ basic buffer: Solutions having mixture of weak base and its Salt.

→ Properties:

The pH of buffer Solutions should not Change on keeping for long time on dilution, on addition of Small Quantities of acids and bases, and should Remain Constant.

→ **Buffer action:**

The Resistance to Change in pH is called Buffer action, when small amount of acid & base is added.

→ **Buffer Capacity:**

It is the amount of acid & base, that must be added to buffer to produce unique change of pH

$$\beta = \frac{d\,(B)}{d_{pH}}$$

* Addition of Base Increases pH, Addition of acid decreases pH:
* β depends on nature of Buffer and pH which is determined to Relative Concentration of acids and its Conjugate Base
* **Buffers in Biological System:**

(1) **Blood:** pH 7.35 - 7.45 which is a primary buffer in plasma Secondary buffer in Erythrocytes

(2) **Tears:** pH 7 - 8

(3) **Urine:** pH 4.5 - 7.8

pH below normal, H^+ Excreted by kidneys

pH above normal, H^+ Retained by kidneys

Pharmaceutical Buffers

* They are used for Reference purposes and for Carrying out Specified which Require adjustment
* There are used for Specific, microbiological, Antibiotic assay.
* prepared by combination of chemicals which are Specified in pharmacopeia.

Eg:- HCl Buffer (pH = 1.2 - 2.2)

preparation

Take 50 ml of 0.2 M KCl in 200 ml Volumetric flask and add Specified volume 0.2N HCl

→ (2) Acid pthalate Buffer (pH = 2.2 - 4)

preparation

Take 50 ml of potassium Hydrogen pthalate, Specified volume of HCl followed by water to make 200 ml

(3) neutralize pthalate Buffer pH = 4.2-5.8

preparation

Take 50 ml of potassium Hydrogen pthalate, Specified volume of NaOH and vol was made upto 200 ml with water

→ Buffered Isotonic Solution

Isotonic Solutions :

Solutions which produce same osmotic pressure as that of cell contents are known as Isotonic Solutions.

* These Solutions doesn't Cause Swelling and Shrinkage

Eg: 0.9 % NaCl , 5% dextrose , 2% Boric acid Solution.

* Hypertonic Solutes :

Solutions in which Solute in High Concentration than that Required for Isotonic Solution is Called Hypertonic Solution

Example : Cell Shrinkage Occurs as water moves out of the cell , when RBC is Suspended in Hypertonic Solution.

* Hypo

Solutions Containing the Solute in Lower Concentration, than that Required for Isotonic Solutions is Called Hypotonic Solutes

Eg: Cell Haemolysis Occurs, as water moves into the Cells when RBC is Suspended in Hypotonic Solutions.

Iso-osmotic Solutions :

Solutions which produces same osmotic pressure as the cell contents, beet Solute molecules are permeable through cell membrane altering the tone of cell

→ Buffer Equations.

The pH of a buffer solution & the change in the pH upon addition of acid & base can be calculated by buffer equation.

→

→ $HAC + H_2O \longrightarrow H_3O^+ + AC^-$

HAC ↓ Acid — Acid — Conjugate Base.

$$K_a = \frac{[H_3O][AC^-]}{[HAC]}$$

→ **K_a = dissociation Constant**

$$H_3O = \frac{K_a \cdot [HAC]}{[AC]}$$

Applying $-\log$

$$-\log [H_3O] = -\log K_a - \log \frac{[HA]}{[AC]}$$

$$pH = pK_a - \log \frac{\text{Acid}}{\text{Conjugate base}}$$

$$pH = pK_a + \log \frac{\text{Conjugate base / salt}}{\text{Acid}}$$

Ionic product of Water :-

The product of Concentration of H and OH ions in water at a particular temperature is known as Ionic product of Waters

$$pK_w = pH + pOH$$

$$pK_w - pH = pOH$$

$$pK_w - pH = pK_b + \log \frac{\text{Conjugate acid}}{\text{base}}$$

$$pK_w - pH = -\log \frac{\text{Conjugate acid}}{\text{base}} = pH$$

measurement of tonicity :-

tonicity : measurement of osmotic pressure

(1) Haemolytic method :

The effect of various solutions of the drug is observed on the appearence of RBC suspended in the solutions. This is Quantitative method based on fact that Hypotonic solutions liberates oxyhemoglobin

in direction proption to

By such means the Vant hoff factor (i) can be determined and the value obtained and is compared with ~~the~~ from Cryoscopic, osmotic co-efficient, activity co-efficient

Vant hoff factor I is the Ratio between actual Concentration of particles produced when the Substance is dissolved and the Concentration Calculation from its mass -

(2) The second approach to measure tonicity is based on any method the determine Colligative property

Eg: freezing point of blood and lacrimal fluids (0.52°C)

The temperature corresponds to freezing point of 0.9% NaCl which is considered to be isotonic with blood and lacrimal fluids.

Calculation tonicity using liso values

The solution of Electrolyte, the freezing point

K_f = freezing point depression constant

A new factor $L = iKf$ is introduced to overcome the difficulty

The "L" value obtained from the freezing point depression of a solution of a given ionic solution

The Liso value for 0.9% NaCl (0.154 M) which has freezing point 0.59°C and isotonic with body fluid

Type	Liso	Example
non Electrolytes	1.9	Sucrose, urea
Weak Electrolyte		boric acid, phenobarbital
uni-univalent Electrolytes		Nac, coccaine, HCl
uni-diralent Electrolytes		Sodium Sulphate, Na_2SO_4
		$ZnCl_2$