BUFFER

A buffer system is a solution that resists a change in pH when acids or bases are added. Acidic solution contains high concentrations of hydrogen ions (H^+) and has pH values less than seven.

Maintenance of blood pH

I. **Blood buffers**
II. **Respiratory mechanism**
III. **Renal mechanism**

I. BLOOD BUFFERS

a. Weak acid and its salts
b. Weak base and its salts

The blood contains 3 buffer systems.

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

1. Bicarbonate buffer system :

- The bicarbonate buffer system consists of carbonic acid and bicarbonate ions.
- The pKa of the bicarbonate buffer system is 6.1. It is the most important buffer system of blood plasma.

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

- Carbonic acid is a weak acid that partially dissociates into bicarbonate ion [HCO^-_3] and H+ ion.
- As base is added and H+ removed, carbonic acid dissociates into hydrogen ion and bicarbonate ions, and dissolved CO_2 reacts with water to replenish the carbonic acid levels.

- When CO_2 levels are increased, it forms more amount of carbonic acid which in turn dissociates into hydrogen ion and bicarbonate ions.
- Thus bicarbonate buffer functions as buffer system in blood.

2. Phosphate buffer system:

- The dihydrogen phosphate [$H_2PO_4^-$] ions and monohydrogen phosphate [HPO_4^{2-}] ions contribute to the phosphate buffer system.
- The pKa of a phosphate buffer system is 6.8.
- Phosphoric acid dissociates into H+ ions and dihydrogen phosphate [H2PO4–] ions with pKa of 2.15.
- Dihydrogen phosphate [H_2PO_4–] ion dissociates into H+ ions and monohydrogen phosphate [HPO_4^{2-}] ions with pKa of 7.2
- Whereas monohydrogen phosphate ions dissociates into hydrogen ion and phosphate PO43– anions with pKa of 12.4.

From the dissociation constant values, it is clearly understood that phosphate acts as

$$H_3PO_4 \rightleftharpoons H^+ + H_2PO_4^- \rightleftharpoons H^+ + HPO_4^{2-} \rightleftharpoons H^+ + PO_4^{3-}$$

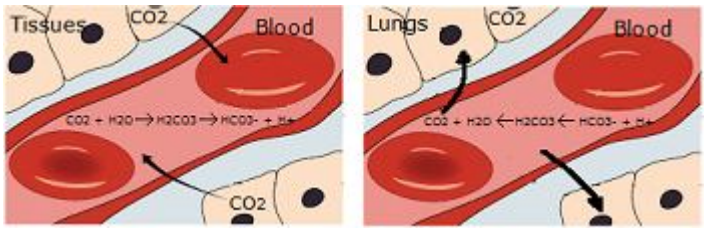
3. Protein buffer system:

The plasma proteins and hemoglobin together constitute the protein buffer system of the blood.
pK=6.7

II. RESPIRATORY MECHANISM FOR pH REGULATION

- In every molecule of O_2 utilized, one molecule of CO_2 is liberated.
- Hemoglobin actively participates in the transport of CO_2 from the tissues to the lungs.
- About 15% of CO_2 carried in blood directly binds with Hb.
- The rest of the tissue CO_2 is transported as bicarbonate (HCO_3^-)
- Carbon di oxide enters into the tissue; combine with water, the formation of carbonic acid occour
- Carbonic acid dissociated into bicarbonate and proton (H^+)

- Hemoglobin acts as buffer and immediately binds with protons.
- It is estimated that for every 2 protons bound to Hb, 4 oxygen molecules are released to the tissues.
- In the lungs, binding oxygen to Hb results in the release of protons.
- The bicarbonate and protons combine to form carbonic acid.
- The latter is release as carbon di oxide, which is exhaled.



III. RENAL MECHANISM FOR pH REGULATION

- The role of kidneys in the maintenance of acid-base balance of the body is highly significant.
- Bicarbonate (HCO_3^-) does not have a transporter, so its reabsorption involves a series of reactions in the tubule lumen and tubular epithelium.
- In response to acidosis, the tubular cells reabsorb more bicarbonate from the tubular fluid, and the collecting duct cells secrete more hydrogen and generate more bicarbonate.
- The H+ combines with non-carbohydrate base and is excreted in urine.