Buffer-pH and Acid-Base Balance

Introduction

In normal water (non-buffered solution) if you add a small amount of a strong acid or base, it will cause the pH of the water to change significantly. Two drops of 1 mol dm^{-3} HCl added to water will change the pH from 7 to 4. water $[OH]= [OH]= 10^{-7}$

Most chemical reactions occurring in our bodies work best in a specific pH range. Blood, for example, works at pH 7.4 and any variation of 0.2 units either way would render the person seriously ill.

A buffer solution can be described as a solution, which will resist changes in pH when a small amount of a strong acid or base is added.

$CH_3COOH+CH_3COONa$

NH_4OH+NH_4Cl

1- Protein buffers

Proteins are the most abundant materials in the body. Proteins have long chains of carbon compounds, as many as 1000 or more, and have amino acid side chains sticking out of them. One protein of general formula could be $^{+}NH_3(CH_2)_n COOH$:



2- Haemoglobin (a compound of iron and proteins) buffers the blood system using the proteins present. This is essential for controlling the pH of the blood, which is necessary due to the uptake of acidic CO2 gas formed when cells use carbohydrates, glucose, to give energy.

3-Phosphate Buffer

- Any acid reacts with HPO_4^{-2} according to the following equation:

$$HPO_4^{-2} + H_3O^+ \leftrightarrow H_2PO_4^- + H_2O$$

- While any base will react with $H_2PO_4^-$ as depicted below:

$$H_2PO_4^- + OH^- \leftrightarrow HPO_4^{-2} + H_2O$$

Henderson-Hasselbalch Equation For Buffer Solutions

The pH of buffer solution could be calculated as the following:

$$pH = pK_a + \log \frac{[Salt]}{[weak\ acid]}$$

$$pH = pK_b + \log \frac{[Salt]}{[weak\ Base]}$$

The Importance of Hydrogen Ion Concentration

- Hydrogen ion concentration has a widespread effect on the function of the body's enzyme systems. The hydrogen ion is highly reactive and will combine with bases or negatively charged ions at very low concentrations.

Acid-Base Balance

Blood is normally slightly basic, alkaline, with a pH range of 7.35 to 7.45. To function properly, the body maintains the pH of blood close to 7.40.

Acidosis and Alkalosis

- There are two abnormalities of acid-base balance.
- **Acidosis**: The blood has too much acid (or too little base), resulting in a decrease in blood pH.
- **Alkalosis:** The blood has too much base (or too little acid), resulting in an increase in blood pH.

Death occur if blood pH < 6.8 or pH > 7.8

Two Factors That Contribute to Blood pH Imbalance

- The first is our intake, oxygen-carbon dioxide, and dietary habits.
- The second is our production, elimination, and stress.

Role of the Lungs

The blood carries carbon dioxide to the lungs, where it is exhaled. As carbon dioxide accumulates in the blood, the pH of the blood decreases (acidity increases). The brain regulates the amount of carbon dioxide that is exhaled by controlling the speed and depth of breathing.

Role of the Kidneys

The kidneys are also able to affect blood pH by excreting excess acids or bases. The kidneys have some ability to alter the amount of acid or base that is excreted, but because the kidneys make these adjustments more slowly than the lungs do, this compensation generally takes several days.

Good acid-base balance and blood pH levels promote:

- Healthy cholesterol levels.
- Healthy blood sugar balance.
- Proper fat metabolism.
- Normal energy balance.
- Disease resistance.
- The body's ability to flush toxins.