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Acid-base equilibrium in biological systems

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Electrolytes

are the substances which solutions conduct electric current.

In 1884 S. Arrhenius founded a comprehensive theory which is known as theory of electrolytic dissociation or ionic theory.

Classification of electrolytes:

weak	medium	strong
$\alpha<3\%$	$3\%<\alpha<30\%$	$\alpha>30\%$

Strong electrolytes are the majority of salts, some acids (HCl, HBr, HNO_3, H_2SO_4) and alkalis (LiOH, NaOH, KOH, $Ca(OH)_2$, $Ba(OH)_2$). They are completely ionized in a solution.

Weak are the majority of acids and bases (H_2S, H_2CO_3, NH_4OH etc.). They are feebly ionized in a solution and their dissociation is a reversible process.

Protolytic equilibrium in water

The ionization of water is accompanied by the transfer of a proton from one water molecule to another and is called autoprotolysis.

Water is a weak amphoteric electrolyte.

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

Autoprotolysis of water is described by the equilibrium constant called water autoprotolysis constant or ion product of water:

$$K_w = [H^+] \cdot [OH^-] = 10^{-14}$$

Hydrogen ion exponent

In pure liquid water (neutral medium) concentrations of hydrogen and hydroxyl ions are the same:

$$[H^+] = [OH^-] = 10^{-7}$$

$$pH = -\lg[H^+] = 7$$

$$pOH = -\lg[OH^-] = 7$$

$$pKw = pH + pOH = 14$$

pH is hydrogen ion exponent – a value that is equal to negative decimal logarithm of hydrogen ions concentration (mole/litre).

- Hydrogen ions have catalytic effect in many biochemical processes.
- Enzymes and hormones exhibit their biological activity only at specific ranges of pH values.
- Small changes of pH in blood and intercellular fluid affect the osmotic pressure in this fluids.

BUFFER SOLUTIONS

are the solutions which pH values do not practically change when moderate amounts of either a strong acid or a strong base are added and also as a result of dilution.

Buffer solutions consist of weak acids and their salts (conjugate bases) or of weak bases and their salts (conjugate acids).

Buffer systems of blood

are the most important among the buffer systems of all biological fluids.

- Hydrocarbonate and phosphate buffers are present in blood plasma and in erythrocytes.
- Proteins buffer system is in plasma.
- Hemoglobin buffer system is in erythrocytes.

ACIDOSIS and ALKALOSIS

- **Gaseous (respiratory)**
- **Non-gaseous:** metabolic,

  excretory,

  exogenous.