

Role of Metal ions in Biological Systems

Essential and trace elements Present in our biological system.

The Principal (Macro) Mineral elements -

There are seven essential elements, such as Calcium, Magnesium, Sodium, Potassium, Phosphorous, Sulphur and Chlorine.

1. Sodium, Potassium and Chlorine are involved mainly in the maintenance of acid-base balance and osmotic control of water metabolism.
2. Calcium, Phosphorous and Magnesium act as constituents of bones and teeth.
3. Phosphorous forms a constituent of body cells of soft tissues, such as muscles, liver etc.
4. Sulphur forms a constituent in Cysteine and methionine, thiamine, biotin, Lipic acid and CoA.

Trace Elements

These elements are found in living tissues in small amounts.

They are subdivided into three groups i.e. Essential, Possibly essential & non-essential.

1. Essential trace elements: (Micro nutrients): Iron, Iodine, Copper, Zinc, Manganese, Cobalt, Molybdenum, Selenium, Chromium, and fluorine.
2. Possibly essential trace elements: Nickel, Tin, Vanadium & Silicon.
3. Non essential trace elements: Aluminium, boron, Germanium, Cadmium, Arsenic, Lead and Mercury.

Physiological Importance:-

- (a) Iodine is needed for thyroxine formation.
- (b) Iron and Copper are needed for hemoglobin formation.
- (c) Zinc is a constituent of Carbonic anhydrase & insulin.
- (d) Cobalt is a constituent of Vitamin B₁₂.

The ratio of one element to the other in the tissues is of physiological importance.

Once again we can classify essential and trace elements as follows.

i.e. There are thirty (Maximum) elements that have been accepted as essential and indispensable to our life.

The elements which are required in large quantity for our life are called Macro nutrients.

and the less amount required elements for our life is called Micro nutrients or those elements which are required in small quantities are refer as micro nutrients.

Now the essential elements can be classified in two groups
i.e. (A) Bulk elements (B) Trace elements.

(A) Bulk elements :- Elements found in our living body with higher concentration or those essential elements which are found in maximum amount in our body is called Bulk elements (Living).

(B) Elements present in low concentration (i.e. minimum) are called trace elements.

The above facts may be tabulated as follows.

(i) Bulk (Max^m found) elements with its Symbols.

(a) Hydrogen (H) (b) Carbon (C) (c) Nitrogen (N) (d) Oxygen (O)
(e) Phosphorus (P) (f) Sulphur (S)

(ii) Mineral elements :-

(a) Sodium (Na) (b) Potassium (K) (c) Magnesium (Mg)
(d) Calcium (Ca) (e) Chlorine (Cl)

(iii) Trace elements :- Trace mineral elements are as

(a) Iron (Fe) (b) Copper (Cu) (c) Zinc (Zn) (d) Vanadium (V)
(e) Nickel (Ni) (f) Cadmium (Cd) (g) Lithium (Li) (h) Lead (Pb) (i) Tin (Sn)

(iv) Ultra trace elements (Metal) :-

(a) Manganese (Mn) (b) Molybdenum (Mo) (c) Chromium (Cr) (d) Arsenic (As)

(v) Ultra trace (Non-Metal) Elements :-

(a) Fluorine (F) (b) Iodine (I) (c) Boron (B) (d) Silicon (Si) (e) Selenium (Se)

Role of Metallic elements in our biological system :-

The followings are the important role i.e. a variety of important role of metallic elements in our biological system.

(a) Biological regulatory action is exercised by ions i.e. Na^+ , K^+ , $\text{H}_2\text{PO}_4^{2-}$, and Ca^{2+} .

Now The flux of these ions through cell membranes and other boundaries layer send a signals which turns metabolic reactions on and off.

The Role of Calcium is well defined for bones and teeth but many proteins owe their structural integrity to the presence of metal ions that tie together and make rigid certain portions of these large molecular portions.

The metal ions particularly Ca^{2+} and Zn^{2+} ions are known to do this act.

Here enormous amount of electron transfers chemi goes on in biological systems and nearly all of these critically depend on metal containing electron transfer agents. These include Cytochromes (Fe), Ferredoxin (Fe) and a number of Copper containing "Blue" proteins such as Azurin, Plastocyanin and Stellacyanin.

Metalloenzymes or metallocoenzymes are involved in a great deal of enzymatic activity. This enzymatic activity depends on the presence of

metal ions at the activity site of the enzyme, ~~coenzyme~~

The best known Key Coenzyme is Vitamin B₁₂.

Vitamin B₁₂ contains Co, important metalloenzymes include Carboxypeptidase (Zn), Alcohol dehydrogenase (Zn), Superoxide dismutase (Cu, Zn); Urease (Ni) and Cytochrome P-450 (Fe)

All aerobic forms of life depend on oxygen carrier molecules that carry oxygen from the point of intake, such as lungs, to tissues where O₂ is used in oxidative processes that generate energy carriers and all of them contain metal ions that provide the actual binding sites for the O₂ molecules. These are mentioned as, Hemoglobins (Fe) found in all mammals, Hemerythrins (Fe) found in various marine invertebrates & Hemocyanins (Cu) found in arthropods and molluscs.