

Class –M. Sc. Sem. –III

Subject –Bio-Inorganic Chemistry

Paper – CC XI

Unit --I

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METAL IONS IN BIOLOGICAL SYSTEM: --

The chemistry of life involves many of the chemical elements including metals. The main constituent of the body is C, H, O and N. It comprises of about 90% of the solid organic material remaining 10% being the inorganic material. Although the inorganic constituents are relatively small quantity of the total body, but it is not less important than organic constituents for maintaining the vital activity of a living being. It is known that life processes in the plant and animal involves about forty elements out of which twenty- five are essential for plants and animals

The biologically important metals are divided into three headings: -

- i) Essential elements
 - ii) Beneficial elements
 - iii) Toxic elements
- 1) Essential elements—They are those elements whose absence will prevent some particular organism to complete its life cycles. They are Na, K, Mg, Ca, V, Cr, Mn, Fe, Co, Cu, Zn, Mo and W. The essential

metals can be divided into two parts according amount of each which are required to maintain a metabolic balance

A) Macro molecule,

B) Micro molecule

A) Macro molecule— Na^+ , K^+ , Mg^{2+} and Ca^{2+} present in bulk. For an adult of 70 Kg weight, the quantity of macro molecules are: $\text{Na}^+ = 70$ gm, $\text{K}^+ = 250$ gm, $\text{Mg}^{2+} = 42$ and $\text{Ca}^{2+} = 1700$ gm. regulatory action is

exercised by these metals ion. The flux of these ions through cell membrane, and other boundary layers sends signals that turns metabolic reaction on and off

B) Micro molecules— V, Cr, Mn, Co, Fe, Cu, Zn, Ni and Mo are micro- molecules. They are present in small quantity but they are very important for vital activities.

ii) BENEFICIAL ELEMENT – The beneficial elements are those whose absence produces ill effect. They are widely distributed in living material and which seems to aid growth and reproduction. They are lithium, rubidium, boron, silicon, arsenic, nickel, aluminium, lead, tin, vanadium and titanium.

iii) TOXIC ELEMENT– Toxic elements are those elements which are neither essential nor beneficial but a positively catastrophic effects on normal metabolic processes even when present in small amount. For example—arsenic, mercury, cadmium etc.

One of the major roles played by metallic elements in bioinorganic chemistry is in metalloenzyme.

Metalloenzyme is applied in enzymes that not only require the participation of a metal ion at an active site to function but bind that metal ion strongly even in resting state.

The biologically important elements have a variety of roles, some are given below: --

- i) Regulatory action is exercised by Na^+ , K^+ , Mg^{2+} , and Ca^{2+} . THE flux of these ions through cell membrane and boundary layer sends signals that turns metabolic reaction on and off.
- ii) The structural role of calcium in bone and teeth is well known, but many proteins their structural integrity due to presence of metal ions and lie together make rigid.
- iii) An enormous amount of electron transfer in the biological system depends on metal containing electron transfer agent. They are cytochromes (Fe), ferredoxin (Fe) and a number of copper containing blue proteins such as azurin plastocyanin stellacyanin.
- iv) Metalloenzyme or metalo - coenzyme are involved in a great deal of enzymatic activity, which depends on the presence of metal ions at the active site of the enzyme or key enzymes. The best -known key enzyme is vitamin B_{12} , which contains cobalt. Important metalloenzyme includes carboxypeptidase (Zn), alcohol dehydrogenase (Zn) superoxide di mutase (Cu Zn) urease (Ni) and cytochrome p-450 (Fe)
- v) All aerobic forms of life depend on oxygen carrier molecules that carry oxygen from the point to intake to tissues where O_2 is used in oxidative processes that generate energy. For example –Haemoglobin (Fe) found in all mammals.

Hemocyanin (Cu) founds in orthopods and Mollusca,

Hemerythrin (Fe) found in marine invertebrates.