B.Sc 5th SEM MAJOR, INORGANIC CHEMISTRY

Unit 4: Bioinorganic Chemistry

Bioinorganic chemistry covers all aspects of inorganic elements as being vital for the growth and metabolism of living systems.

Geochemical effects on the distribution of metals:

All the most essential elements, except Mo are fairly abundant in the earth's crust. Al (8.2%), Si (28.2%), Ti (0.57%) and Zr (0.02%) are although abundant but these are not essential elements.

No common element is toxic at levels normally encountered though almost anything can be harmful at too high levels.

Classification of elements according to their action in the biological system

Elements

Essential	Trace	Non-essential	Toxic
O, C, H, N, P, Na, K, Mg, Cl	I, Fe, Cu, Zn, Mn, Co, Mo, Ca, S etc	Al, Sr, Ba, Sn etc	Cd, Pb, Hg

- Essential elements are absolutely essential for necessary for life processes
- Trace elements are also necessary for life processes
- Non-essential elements are not essential
- Toxic elements disturb the natural functions of the biological system.

Role of Alkali and Alkaline Earth Metal ions in Biological systems

Role of Na^+ and K^+ ions

Na^+ is a major cation of extracellular fluids of animals including human beings which is known to activate certain enzymes in the animal body. Na^+ are relatively harmless except when present in excess amounts in which case they may cause hypertension.

The K^+ ion is essential to all organisms with the possible exception of blue green algae. It is a major cation of intracellular fluids of animal cells.

Sodium-Potassium pump (Na/K pump)

The sodium-potassium pump is a ~~protein~~ mechanism in the cell membrane of animal cells that uses energy from ATP to move three sodium ions (Na^+) out of the cell for every ~~two~~ two potassium ions (K^+) it brings in.

How it works (Mechanism)

(i) ATP Binding and Na^+ uptake: The pump binds ATP and then three sodium ions from the cytoplasm.

(ii) Phosphorylation and Na^+ release: ATP is broken down, and its phosphate group binds to the pump, causing the pump to change shape and release the three sodium ions to the outside of the cell.

(iii) K^+ Binding: The pump then binds two potassium ions from the extracellular fluid.

(iv) ~~Dephosphyra~~ Dephosphorylation and K^+ Release: Another shape change occurs when the phosphate group is cleaved, releasing the potassium ions into the cytoplasm. The pump then returns to its original state, ready to start a new cycle.

Importance and Functions:

i) **Resting Membrane Potential:** By maintaining a high concentration of K^+ inside the cell and a low concentration of Na^+ ~~outside~~ outside, the pump creates the necessary ion gradients for cellular communication.

ii) **Electrical potential difference:** Since each operation of the pump pumps out larger number of sodium ions from the cell than the number of K^+ ions that it pumps into the cell, the interior of the cell acquires an excess negative charge and the exterior of the cell acquires an excess positive charge. This results in the development of ~~above~~ si of electrical potential gradient across the cell membrane which is responsible for the transmission of nerve signals in animals.

iii) **Cell volume regulation:** The Na^+-K^+ pump also maintains the volume of the cell. Without the existence of the Na^+-K^+ pump in the cell, the latter would have swelled in volume and ultimately bursted.