# BIOINORGANIC CHEMISTRY

## ROLE OF METALS IN BIOLOGICAL SYSTEM

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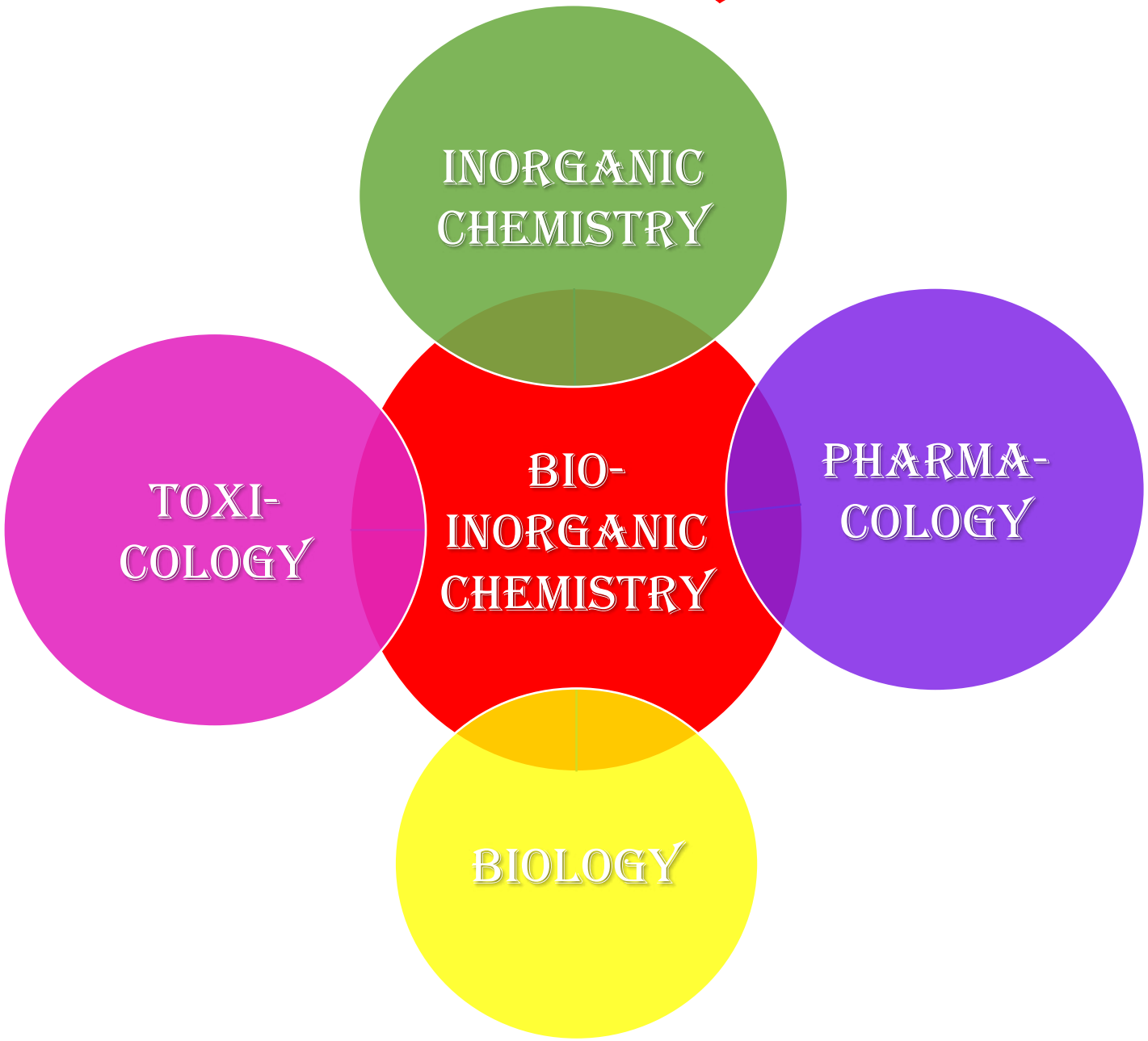
# BIO-INORGANIC CHEMISTRY

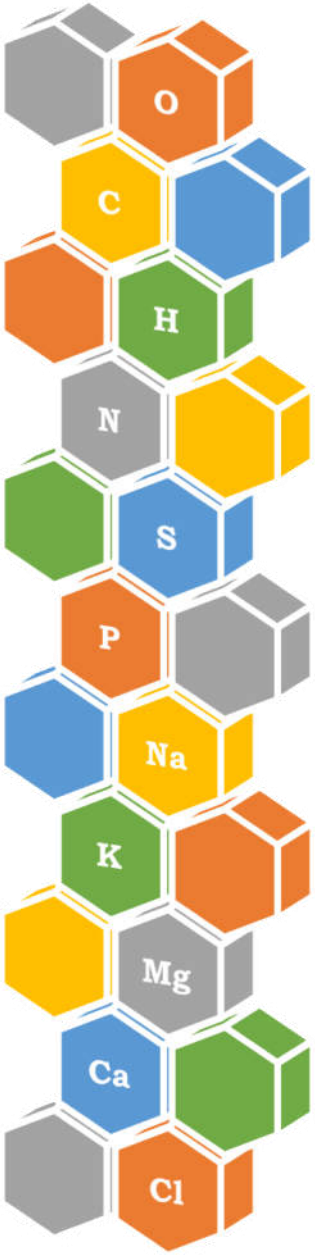
- Bio-Inorganic Chemistry is an interdisciplinary scientific branch that examines the chemistry of inorganic entities within biological and biochemical system.

- It is the inorganic chemistry of living organisms. It is concerned with the functions of all metallic and non-metallic elements in biology.

- These metal ions play in a vast number of widely differing biological process.



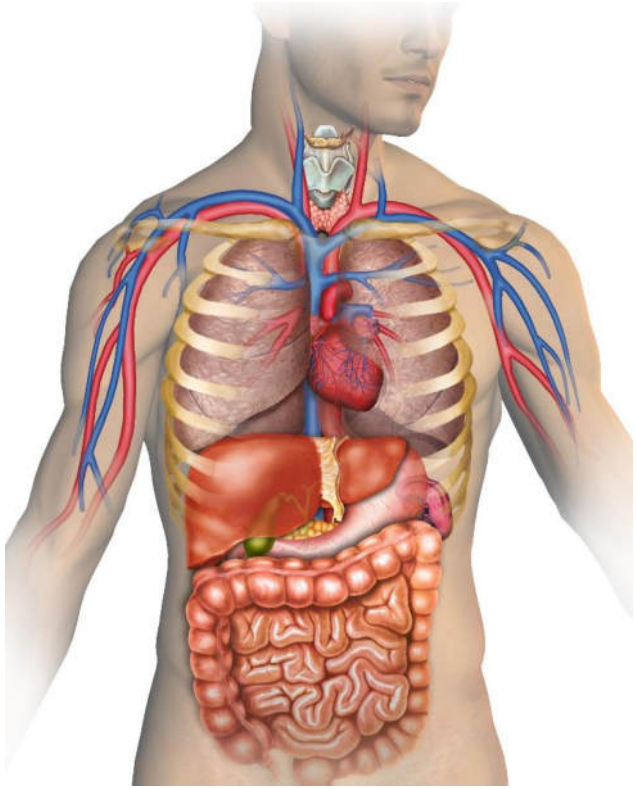
# CLASSIFICATION OF ESSENTIAL ELEMENTS IN BIOLOGICAL SYSTEM




## ESSENTIAL ELEMENTS

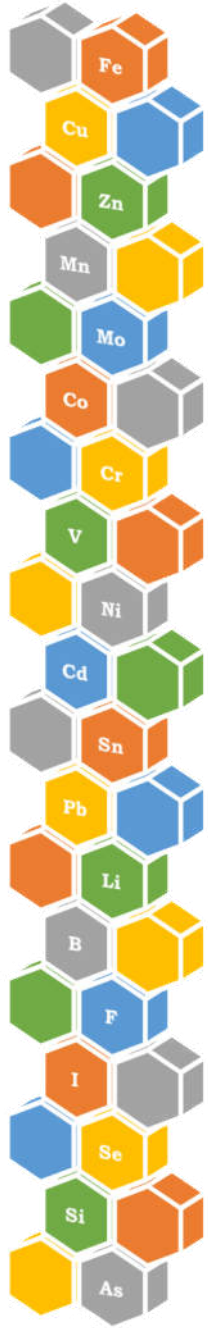
### BULK ELEMENTS

Required by living organism in large quantities



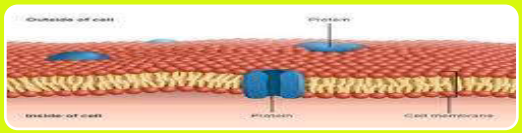
### TRACE ELEMENTS

Required by living organism in very minute quantities

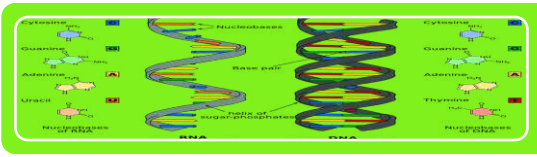


# FUNCTIONS OF METALS IN MAMMALS

Structure hard materials - bone and teeth

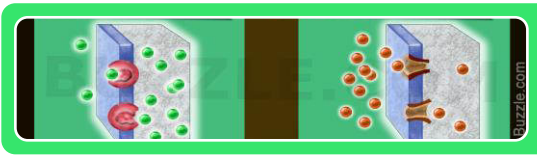


Cell membranes

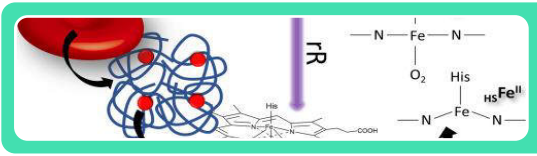


DNA and RNA structure

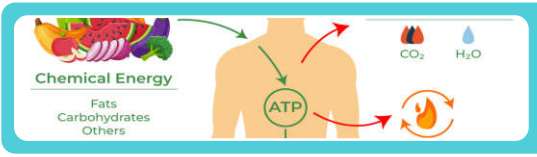

Protein including Enzyme



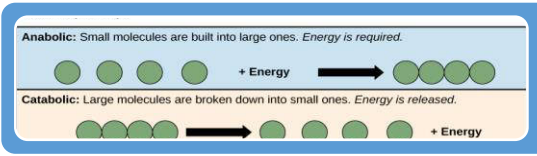
Charge carriers ($Na^{+}$, $K^{+}$, $Ca^{2+}$)




Redox reaction ($Fe^{2+}$, $Cu^{+}$, $Mn^{2+}$, $Ni^{2+}$, $Co^{2+/3+}$)




Metabolism (Degradation of organic molecules)




Activation of small molecules ($O_2$, $CO_2$)

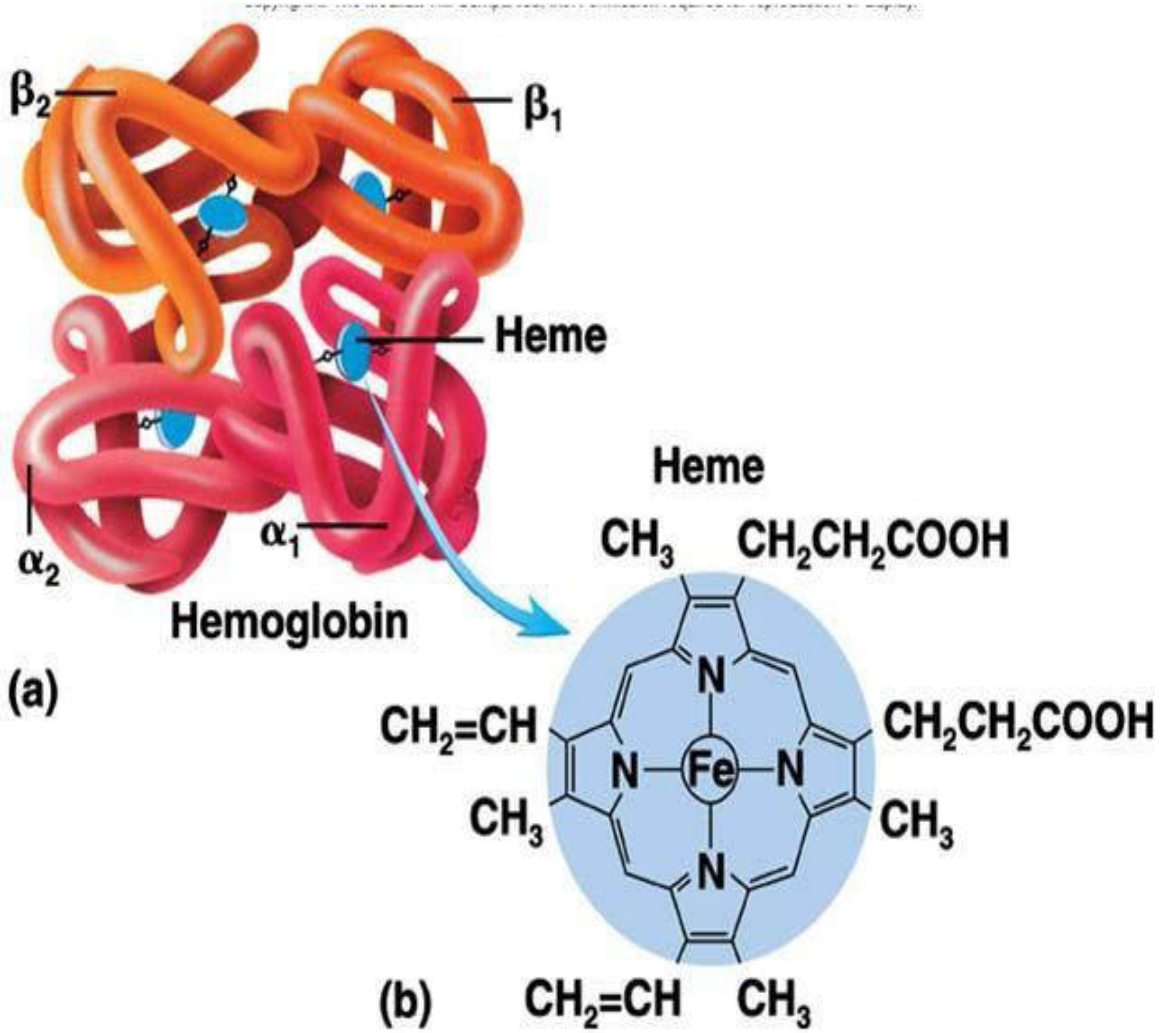
# HAEMOGLOBIN AND MYOGLOBIN

- **Both haemoglobin and myoglobin are metal porphyrins which contains heme group in their structure.**

- **Heme group – Iron atom coordinated with four nitrogen in porphyrin ring.**

- **Porphyrin is a derivative of porphine which contains four pyrrole unit and it was linked by methyl group.**

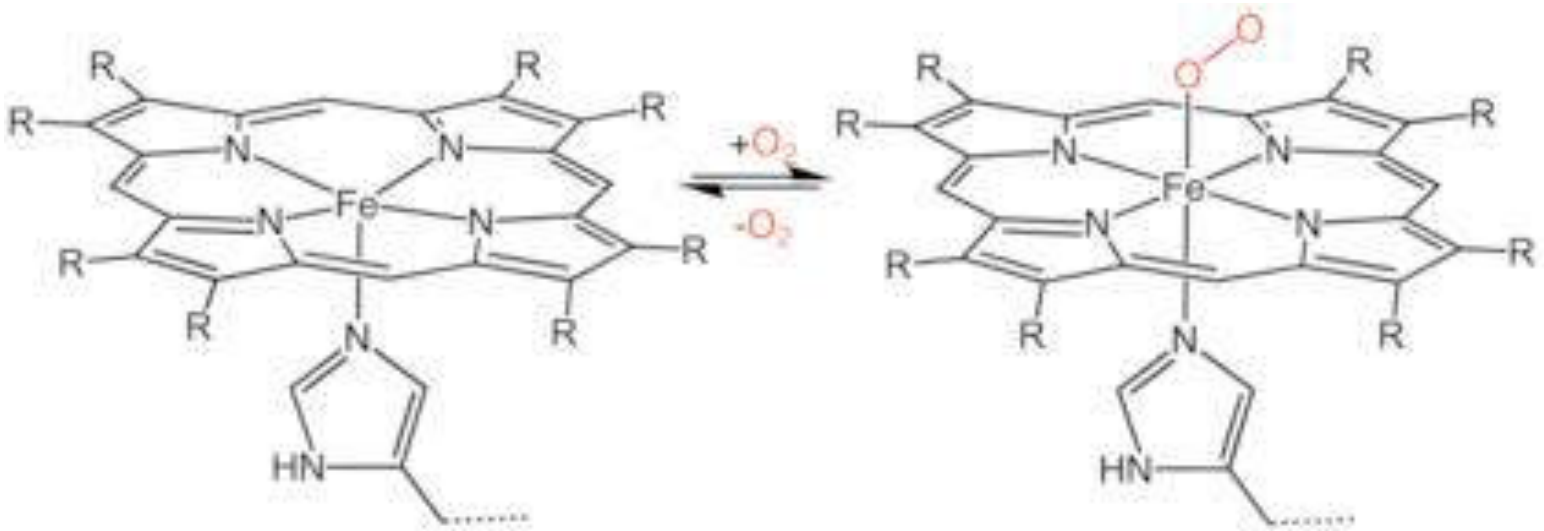
- **Both haemoglobin and myoglobin is an respiratory pigment.**




**(a) Haemoglobin**
**(b) Heme unit**

# FUNCTIONS OF HAEMOGLOBIN AND MYOGLOBIN

- **Both haemoglobin and myoglobin contains heme unit for transfer oxygen to tissues.**
- **If the heme unit does not having oxygen is named as deoxyhaemoglobin/ deoxymyogobin.**
- **If the heme unit having oxygen is named as oxyhaemoglobin/oxymy ogobin.**




**Deoxyhaemoglobin (Blue)** **Oxyhaemoglobin (Red)**

**Scheme. Oxygen transfer reaction in haemoglobin.**

# OTHER ESSENTIAL ELEMENTS AND ITS BIOLOGICAL ACTIVITIES.

| Essential elements | Biological activity |
|---|---|
| **Hydrogen** | ➢ Life supporting property.<br>➢ It is a major element in water.<br>➢ It Plays a role in operation of several enzymes.<br>➢ It Controls protein folding & opening.<br>➢ It act as a encapsulation of active sites in hydrophilic and hydrophobic environment. |
| **Oxygen** | ➢ It plays a important role in various biochemical and physiological process.<br>➢ It involves mainly in respiration, immune function and photosynthesis. |
| **Carbon** | ➢ It is the key important element in any form of life.<br>➢ It is a part of all the organic molecule present in living organisms.<br>➢ E.g: Carbohydrates, proteins, lipids, fats, enzymes & hormones. |
| **Sulphur** | ➢ It is an important constituent of many aminoacids (cysteine,cystine,methionine etc).<br>➢ It controls many metabolism. |

| Essential elements | Biological activity |
| --- | --- |
| Nitrogen | ➢ Nitrogen is an essential element of all the amino acids in plant structures which are the building blocks of proteins.<br>➢ Nitrogen is a component of nucleic acid that forms DNA a genetic material. |
| Sodium | ➢ Sodium is used for the generation of nerves impulses and for maintenance of electrolyte balance and fluid balance.<br>➢ Sodium ions are necessary for heart activities and certain metabolic functions. Health is affected when the body has too much and too little sodium.<br>➢ They are needed for the transport of sugars and amino acids into the cells. |
| Pottasium | ➢ It is the key important element in any form of life.<br>➢ It is a part of all the organic molecule present in living organisms.<br>➢ E.g: Carbohydrates, proteins, lipids, fats, enzymes & hormones. |
| Phosphorous | ➢ Phosphorous is an integral component of ATP – adenosine triphosphate, the major energy-generating molecule in the system.<br>➢ Assisting in the contraction of muscles.<br>➢ Ridding the system of toxins, food wastes via the kidneys.<br>➢ Transmission of nerve signals between cells, tissues and organs.<br>➢ Improving muscle recovery and strength post intense physical workouts.<br>➢ Producing the main genetic components of all cells and tissues – DNA and RNA.<br>➢ Preserving normal heartbeat. |

| Essential elements | Biological activity |
| --- | --- |
| Pottasium | ➢ Potassium ions are primarily found inside the cell.<br>➢ Potassium ions maintain the osmolarity (the concentration of a solution expressed as the total number of solute particles per liter) of the cell. They also regulate the opening and the closing of the stomata.<br>➢ Potassium ions act as cofactors for certain enzymes such as pyruvate kinase.<br>➢ Potassium is important in heart function and in skeleton and muscle contraction.<br>➢ Diets with low potassium lead to hypertension.<br>➢ It maintains the electrolyte balance in the body. |
| Magnesium | ➢ Activity of enzymes.<br>➢ Acts as a fuel source.<br>➢ Protecting the human DNA.<br>➢ To maintain electrolyte balance. |
| Calcium | ➢ Calcium is mainly found in the bones and teeth of the living beings.<br>➢ Blood is a large tank of this mineral.<br>➢ It helps in blood clotting. Deficiency of calcium increases the blood clotting time.<br>➢ Calcium supports muscle contraction.<br>➢ The deficiency of this metal leads to disorder of nerves.<br>➢ It plays a significant role in the metabolism of nitrogen in plants.<br>➢ Absence of this mineral in the plants affects the size and number of chloroplasts. |

| Essential elements | Biological activity |
| --- | --- |
| Iron | ➢ It helps in converting blood sugar into energy.<br>➢ Iron is essential for the growth and development of muscles. It is the chief component of myoglobin present in the muscles.<br>➢ Iron acts as an immune booster.<br>➢ Iron is essential for providing strength to nails, hairs and skin.<br>➢ Iron also plays an essential role in the enzyme system of our body.<br>➢ It also helps in the production of blood. |
| Zinc | ➢ involved in many aspects of cellular metabolism.<br>➢ It is required for the catalytic activity of hundreds of enzymes.<br>➢ It plays a role in enhancing immune function.<br>➢ It plays a role in protein and DNA synthesis, wound healing, and cell signalling and division. |
| Molybdenum | ➢ It act as biological catalyst for reactions in which proton and electron transfer.<br>➢ It plays a role in oxygen transfer.<br>➢ It is useful in nitrogen fixation. |

# REFERENCES


1.Hussain Reddy. K, Bioinorganic Chemistry, New Age International, 2003, New Delhi.

2. Asim K. Das & Mahua Das, Biophysical, Biorganic & Bioinorganic Chemistry, Books & Allied (P) Ltd, 2018,Kolkata.

# THANK YOU