Bio-inorganic Chemistry

Subject: Chemistry (CH 1101)
B.Tech (Group V)

The presence of nearly 40 different elements has been established in living bodies.

Among them some are most abundant elements e.g. H, O, C, N, Na, K etc.

Some are essential, some are beneficiary, some are trace and some are ultra-trace elements.

Bulk and trace elements

– bulk elements: **C, H, O, N, S, P**

– maintaining the osmotic pressure body fluids

Na, K, Ca, Mg, Cl

– essential trace elements:

F, I, Se, Si, Sn (main group elements)

Fe, Zn, Cu, Mn, Mo, Co, V, Ni (transition metals)

– potential trace elements**: B, Ti, As, Pb, Cd, W, ...**

– toxic elements

Average abundance of Bulk elements (70 kg individual)

	element	weight (g)	%
Organic elements	O	45550	65.1
	C	12590	18.0
	H	6780	9.7
	N	1815	2.6
	P	680	1.0
	S	100	0.15
Bulk elements	Ca	1700	2.42
	K	250	0.36
	Cl	115	0.16
	Na	70	0.10
	Mg	42	0.06

Average amount of trace elements (70 kg individual)

	Elements	Weight (gm)	Percentage %
Trace elements (<100 mg/body kg)	Fe	4.2-4.6	0.007
	Zn	2-4	0.004
	Cu	80-120 mg	0.00014
	Mn	12-20 mg	0.00003
	Mo	4 mg	0.00001

Trace elements

1. The abundance of elements in different living organisms is in a given concentration range

2. The decreasing of abundance of elements causes physiological changes (diseases)

3. Administration of missing trace elements improve the physiological condition

They take part in the metabolism.

4. The elements have defined biochemical functions

Roles of trace elements

1. **Transport of biological small molecules**

O_2-transport: hemoglobin (Fe), hemocianin (Cu) O_2-storage: myoglobin (Fe)

2. **Activation of molecules:** metalloenzymes, enzymes activated by metal ions

a) catalysing of redox processes (Fe, Cu, Mn, Co, Mo, Ni) biological oxidation, reduction of substrate

b) catalysing of acid-base processes (Zn)

3. **Secunder conformation of macromolecules**

– determination of conformation of enzymes

– determination of conformation of proteins, nucleic acids

4. **Metabolism of microelements**

– uptaking, transport, storage of trace elements

At biological pH (~ 7), all these biometals cannot exist as free ions. They should form insoluble hydroxides and phosphates.

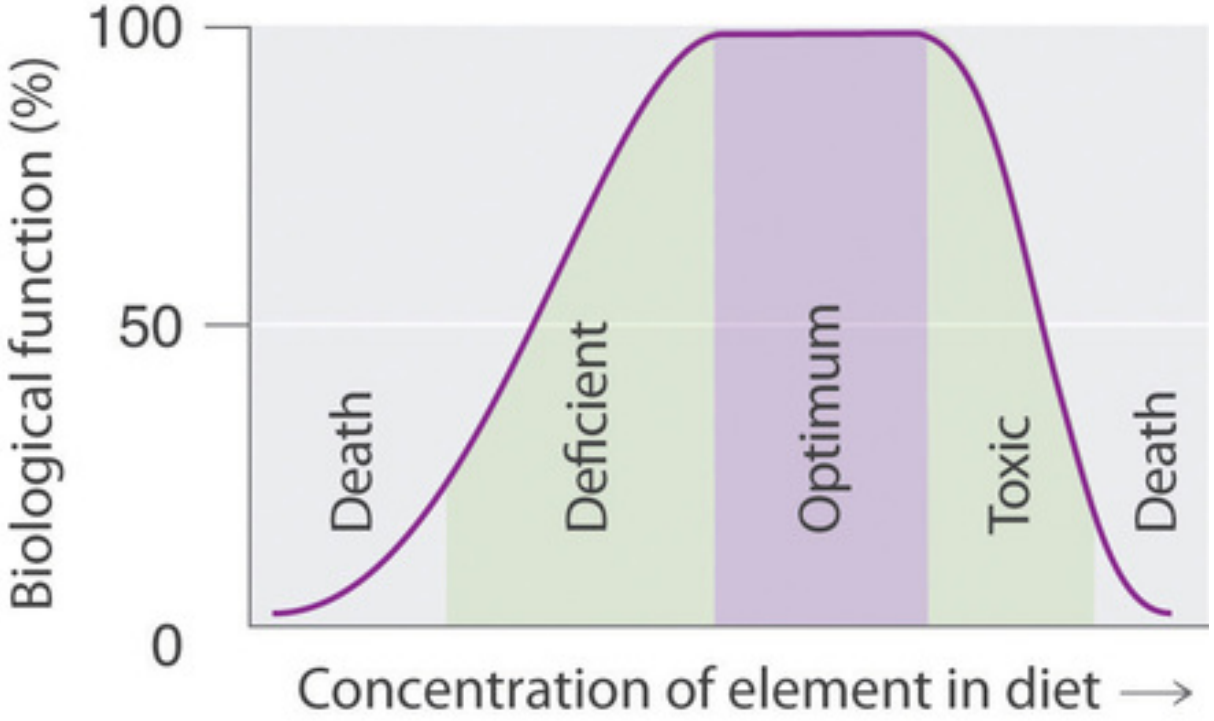
By using the bioligands, these biometals form soluble complexes and they function accordingly.

The important bioligands are proteins , amino acids, peptides having mostly N and O donor ligands with high molecular weight.

So, the biological growth depends on the concentration of these elements in the body.

If the elements present at an amount more than the required amount, they will function as toxic elements.

Dependence of biological growth on the conc. of essential and toxic elements



The above figure illustrates the effect of both essential elements on growth.

The essential elements can show toxicity if there uptake is very high.

If the concn. is less than B , the system experiences their deficiency but if their concn. exceed C, their beneficial role decreases.

Thus, the deficient concn. range A-B is responsible for retardation of growth; the optimal concn. range (B-C) stands for optimal growth; the excess conc. range (C-D) again exerts growth retardation and the condition exceeding the limiting value D induces toxic effects.

For the different essential elements, the conc. values denoted by A, B, C and D are different.

For the toxic elements like Cd, As, Hg, Pu, etc. the effect is represented by the curve shown below.