Introduction to Bioinorganic Chemistry

DR. SHERIN BAKHASHAB

BIOC 301

What is biological inorganic chemistry (bioinorganic chemistry)?

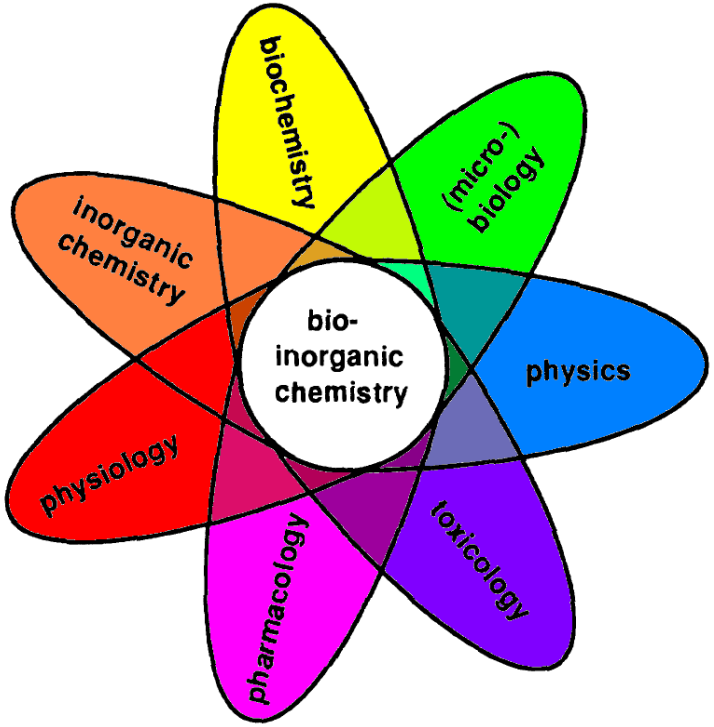
- An interdisciplinary research field at the interface of the more classical areas of inorganic chemistry and biology/biochemistry.
- Understanding the roles that metallic and non-metallic elements play in biological systems is the goal of biological inorganic (bioinorganic) chemistry.

What is biological inorganic chemistry (bioinorganic chemistry)?

There are two main fields of bioinorganic chemistry:

- 1. Investigations of inorganic elements in processes e.g. nutrition, the toxicity of inorganic species, including the ways in which such toxicities are overcome both by natural systems and by human intervention, and of metal-ion transport and storage in biology.
- 2. The introduction of metals (metal complexes) into biological systems as probes and drugs

An Interdisciplinary Research Field



Kaim, W.; Schwederski, B. *Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life*, Wiley, New York, **2013**.

Occurrence and availability of inorganic elements in organisms

- The familiar elements **C, H, N, O, P and S**, the big six, which are well covered in biochemistry texts provide the major building blocks for cellular components including proteins, nucleic acids, lipids-membranes, polysaccharides and metabolites.
- Despite this organic diversity, **life cannot survive** with only these principle elements.

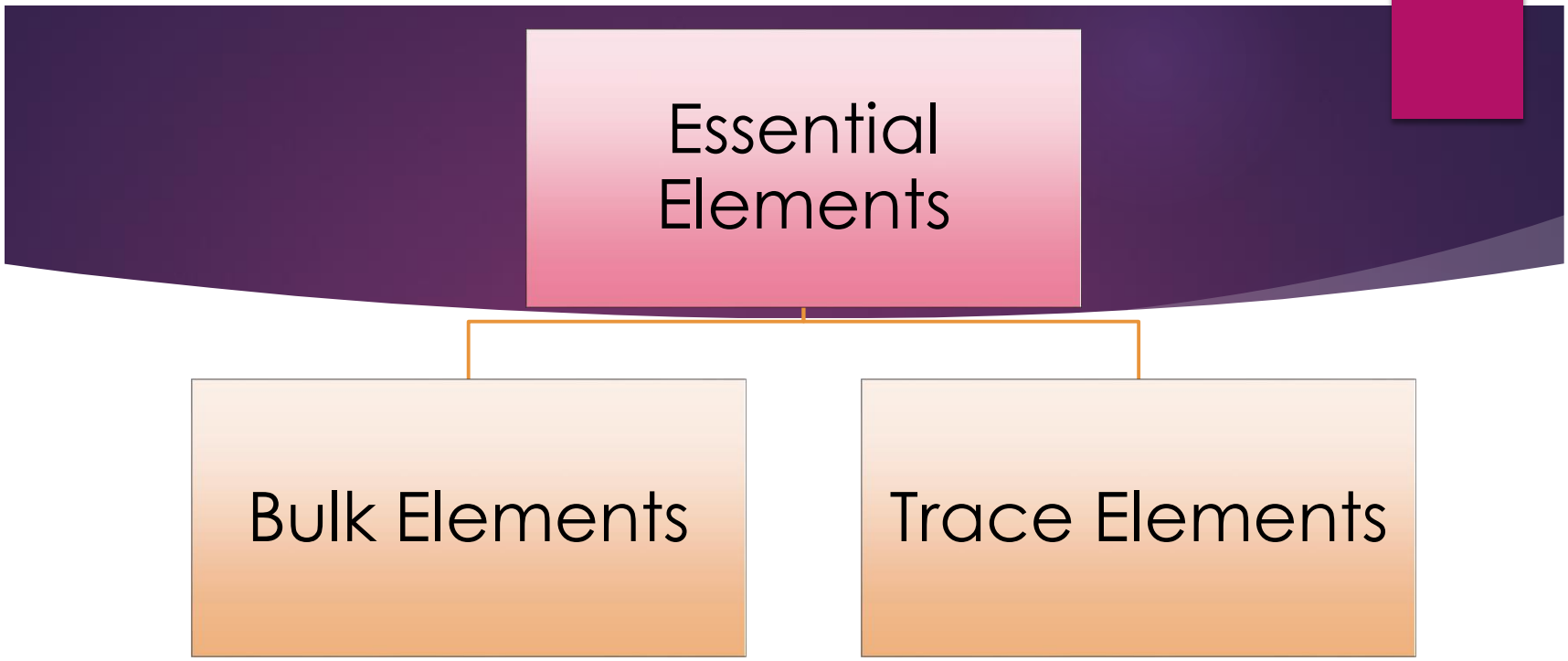
Occurrence and availability of inorganic elements in organisms

- Inorganic elements are also essential to life processes - eleven elements of the periodic table are required for all forms of life and an additional seven or eight elements are used by organisms on our planet.
- Blood known to contain iron since the 17th century.
- Need for Zinc, 1896.

Essential and Non-Essential Elements

- Essential elements are those elements which are required for the maintenance of life
- Absence of these elements results in death or a severe malfunction of the organism
- Example: oxygen, hydrogen, nitrogen, calcium, phosphorous

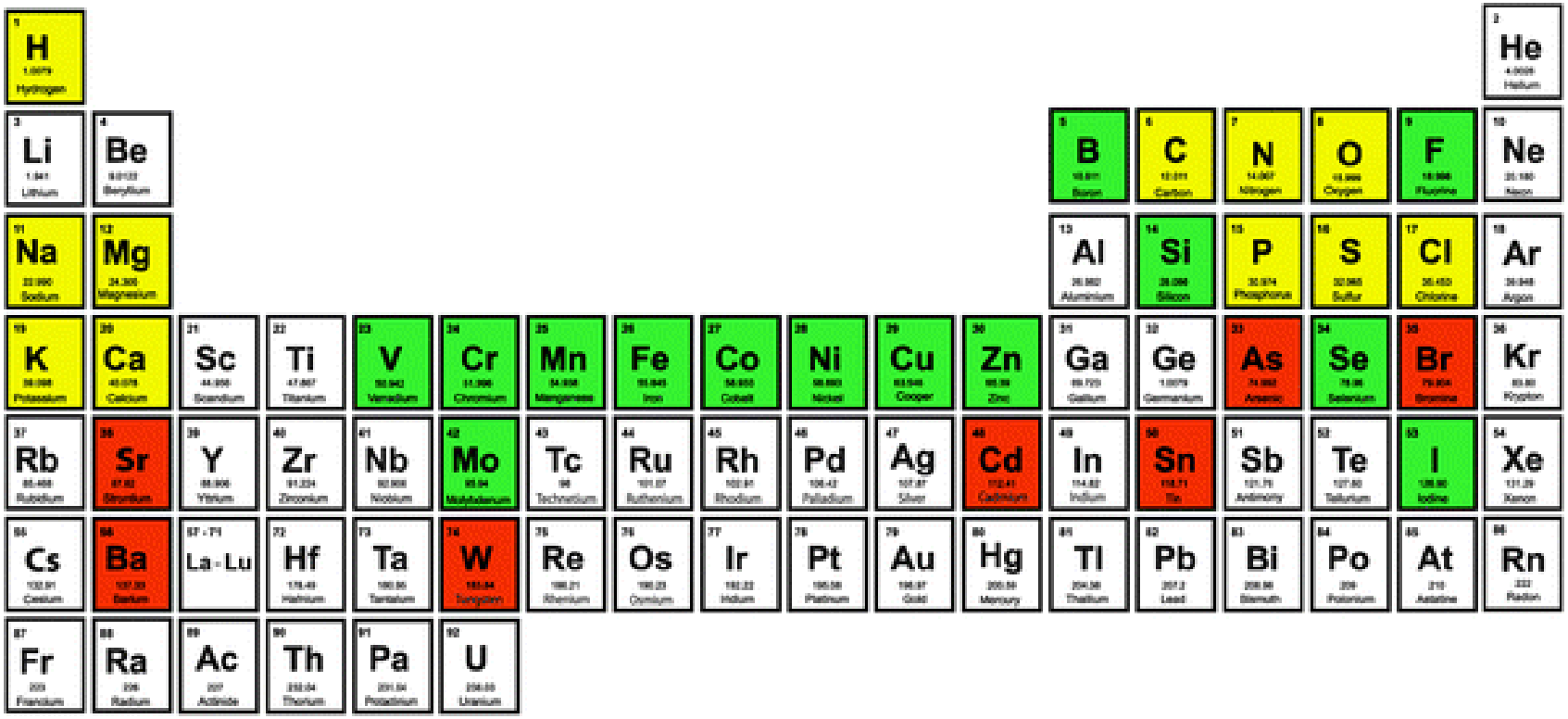
- Non-essential elements are those elements which don't play any positive role in biological systems
- Absence of these elements does not affect the body of an organism
- Example: Aluminium (Al), Strontium (Sr), Barium (Ba), Tin (Sn) etc



Bulk elements: They are the elements which are found in higher concentrations. Examples: O, C, H, N, P, Na, K, Mg, Cl, Ca, S etc.

Trace elements: They are those elements which are needed in very low concentrations. Examples: Fe, Cu, Zn, Mn, Co, Mo etc.

Elements Essential for Life in the Periodic Table



Bulk biological elements

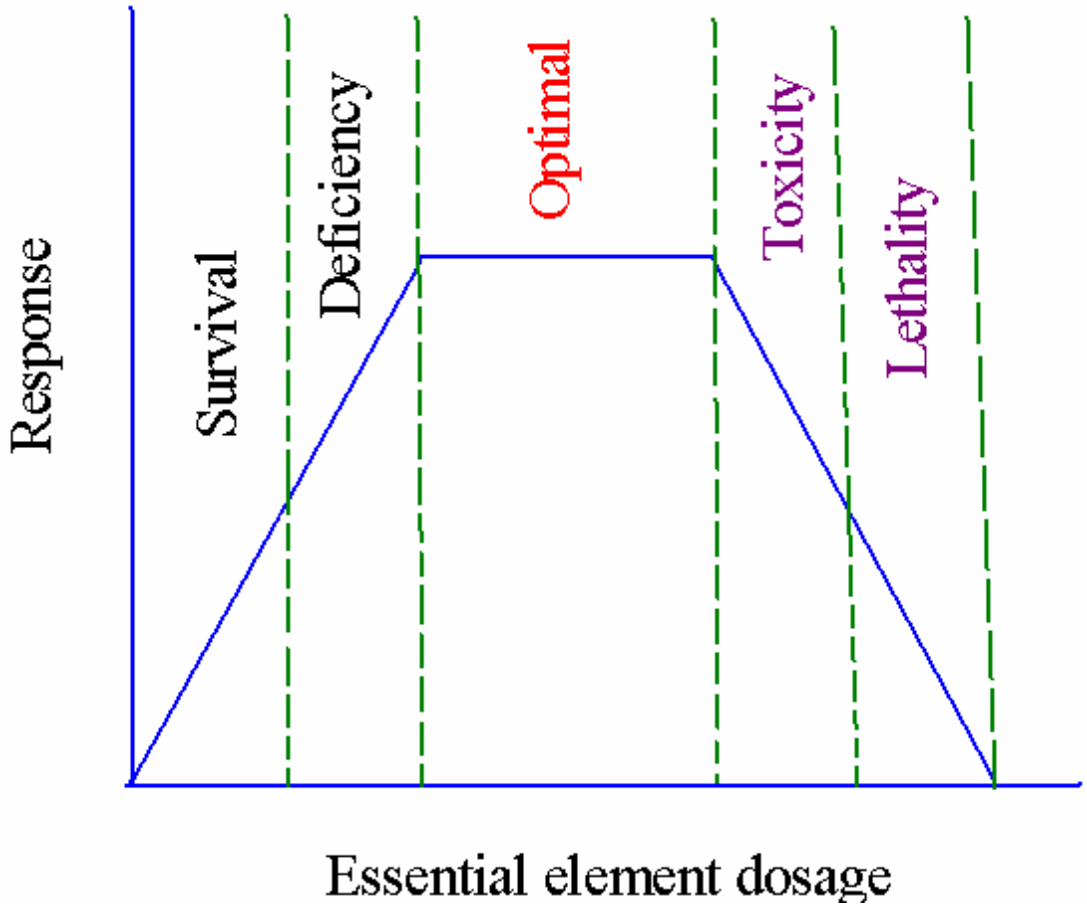
Trace elements believed to be essential for bacteria, plants or animals

Possibly essential trace elements for some species

Essentiality of elements is defined by

- A physiological deficiency appears when the element is removed from the diet
- The deficiency is relieved by the addition of that element to the diet
- A specific biological function is associated with the element

Every essential element follows a dose-response curve



Explanation of dose-response curve

- At lowest dosages organism does not survive
- In deficiency regions, the organism exists with less than optimal functions
- After optimal dosage (plateau region), higher dosage cause toxic effects in the organism eventually leading to lethality