Remedial biology

Unit – 4th

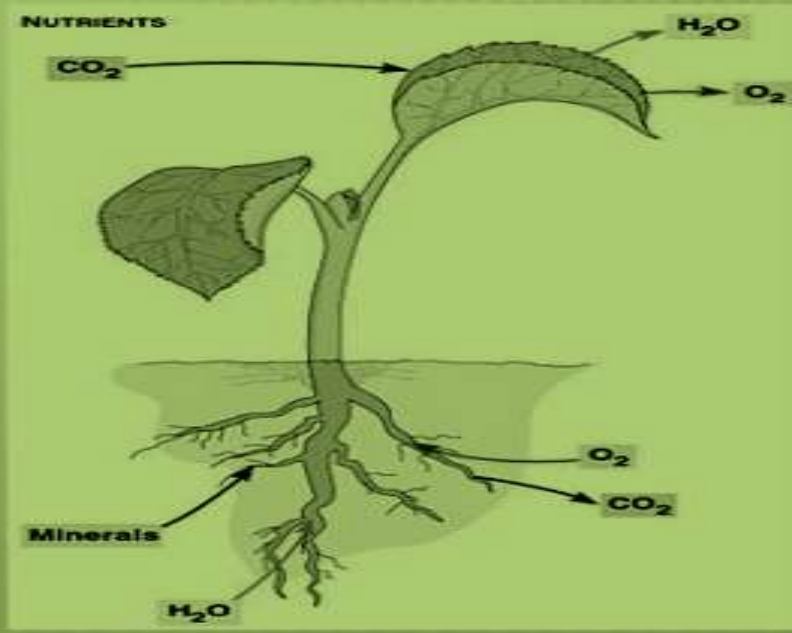
(plant & mineral nutrition)

Presented by : Ms. Preeti katiyar

MINERAL NUTRITION

Why Is Mineral Nutrition Important?

- In most natural soils, the availability of mineral nutrients limits plant growth and primary productivity.
- Nutrient limitation is an important selective pressure and plants face many special changes related to the need to acquire and use mineral nutrients efficiently.
- "Plant nutrition" specifically does not refer to photosynthesis.



Classification Of Minerals:

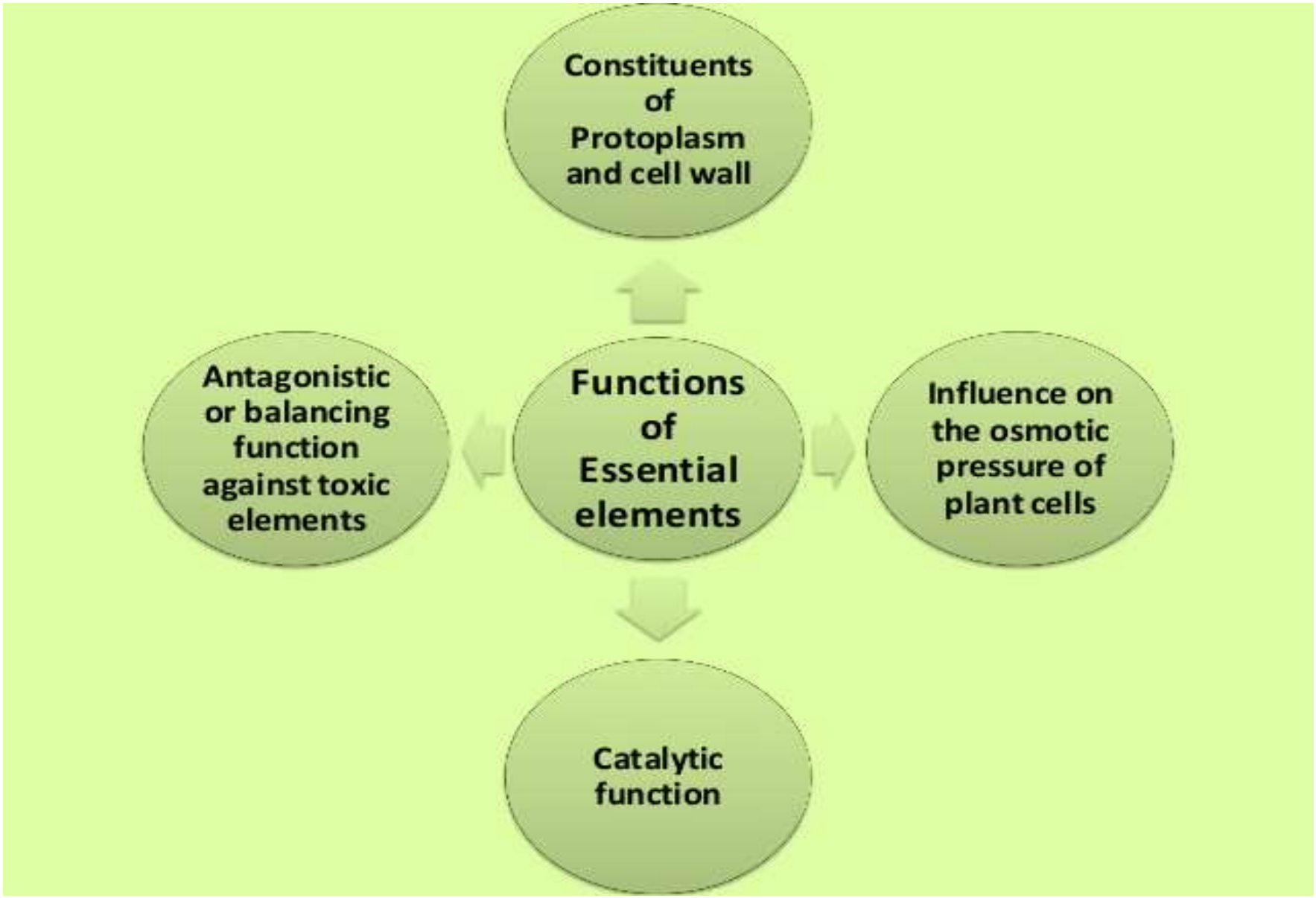
- On the basis of the amounts found in plants:
- Macronutrients: N, K, Ca, Mg, P, S, Na, (Si)
- Micronutrients: Cl, Fe, B, Mn, Zn, Cu, Mo, Ni

Essential Elements :

What defines an "essential" element?

1. In its absence the plant **cannot complete a normal life cycle**
2. The element is **part of an essential molecule** (macromolecule, metabolite) inside the plant

- Most elements fall into both categories above (e.g., structural vs. enzyme cofactor)
- These 17 elements are classified as
  - **9 macronutrients** (present at > 10 mmol / kg dry wt.)
  - **8 micronutrients** (< 10 mmol / kg dry wt.)

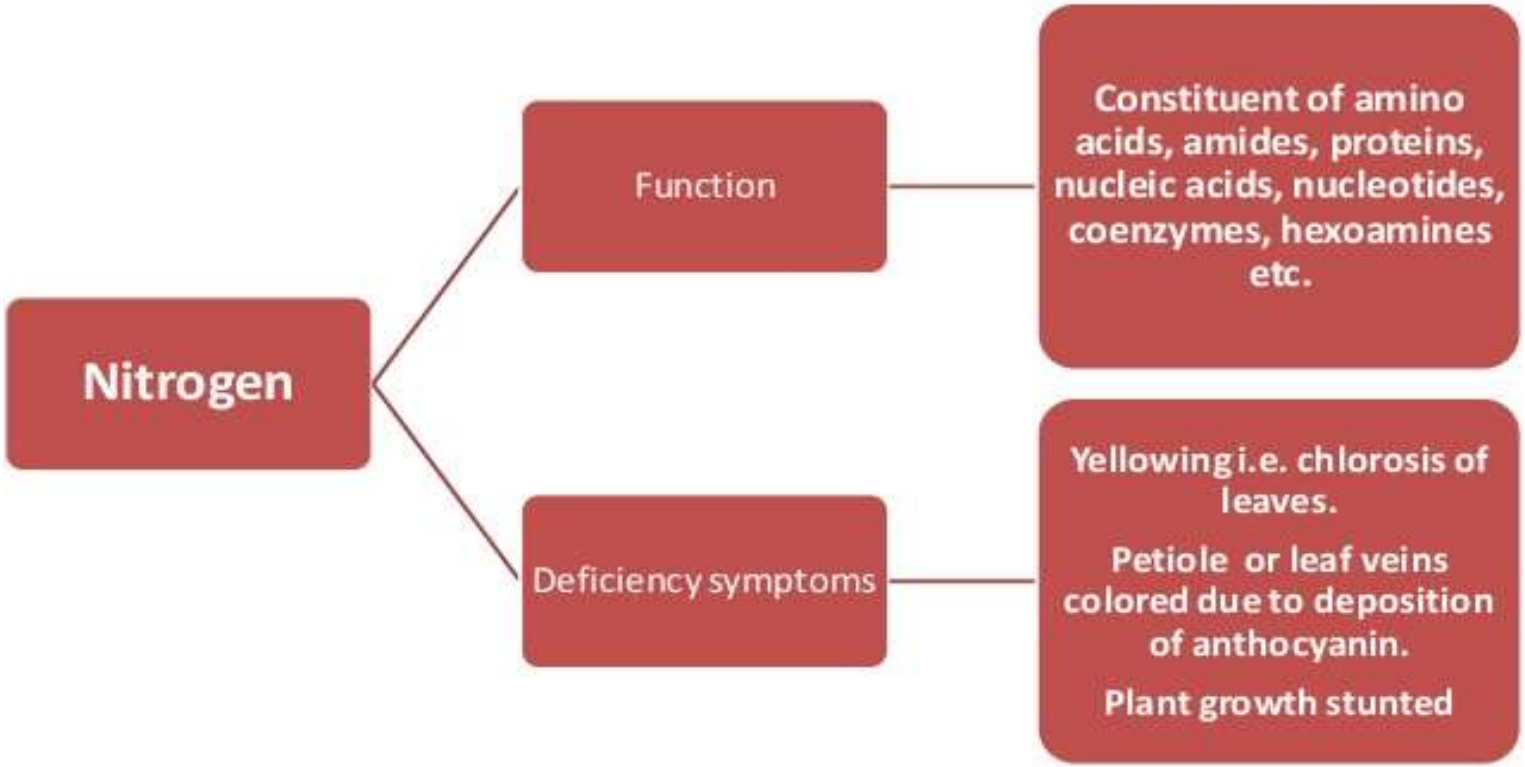

Constituents of Protoplasm and cell wall
Antagonistic or balancing function against toxic elements
Functions of Essential elements
Influence on the osmotic pressure of plant cells
Catalytic function

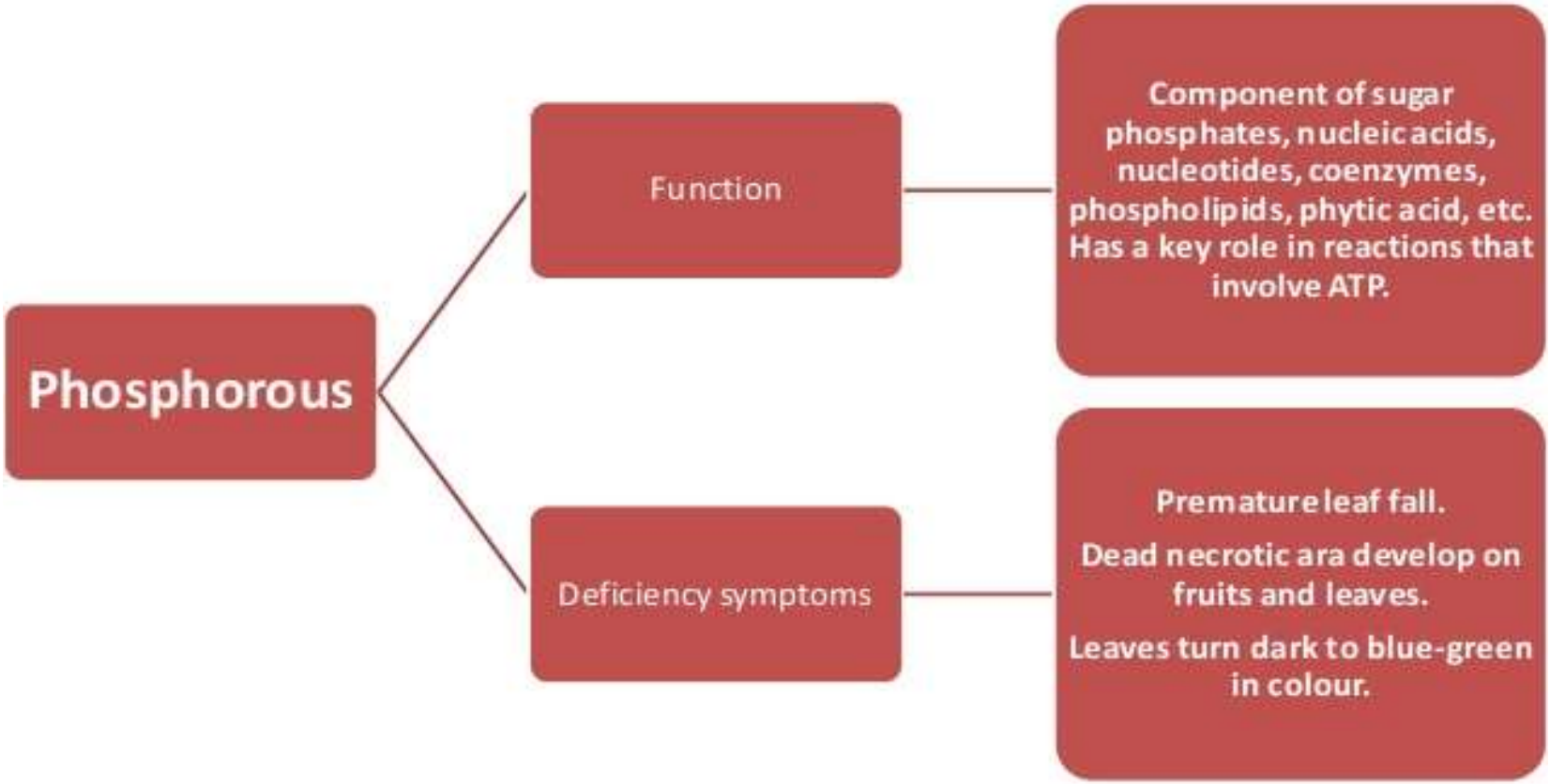
Classification of minerals:

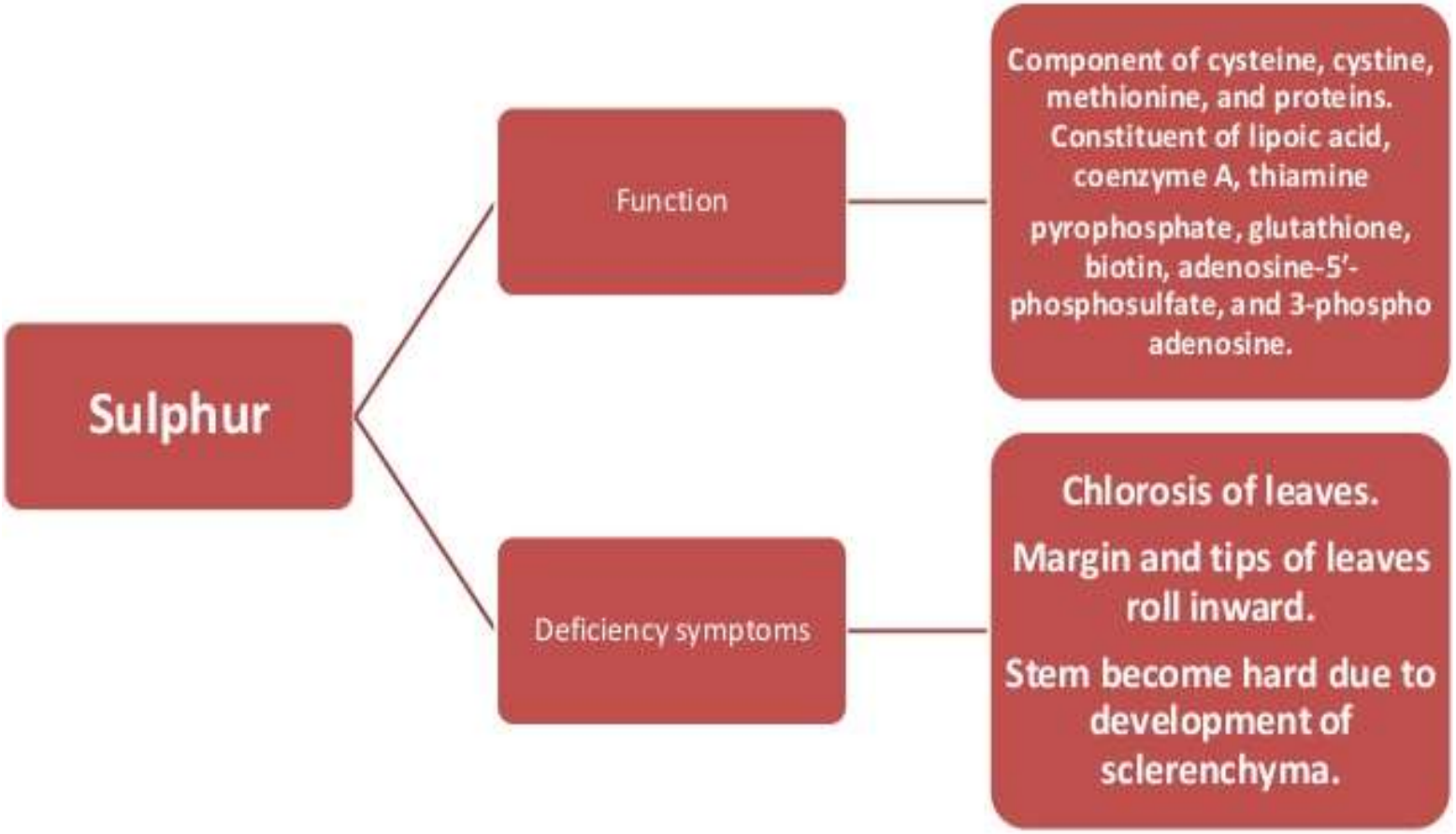
- **Macronutrients** are elements required by plants in relatively large quantities (9 total).
  - Organic compounds: Carbon, oxygen, hydrogen, nitrogen, sulfur, and phosphorus.
  - The other three are potassium, calcium, and magnesium.

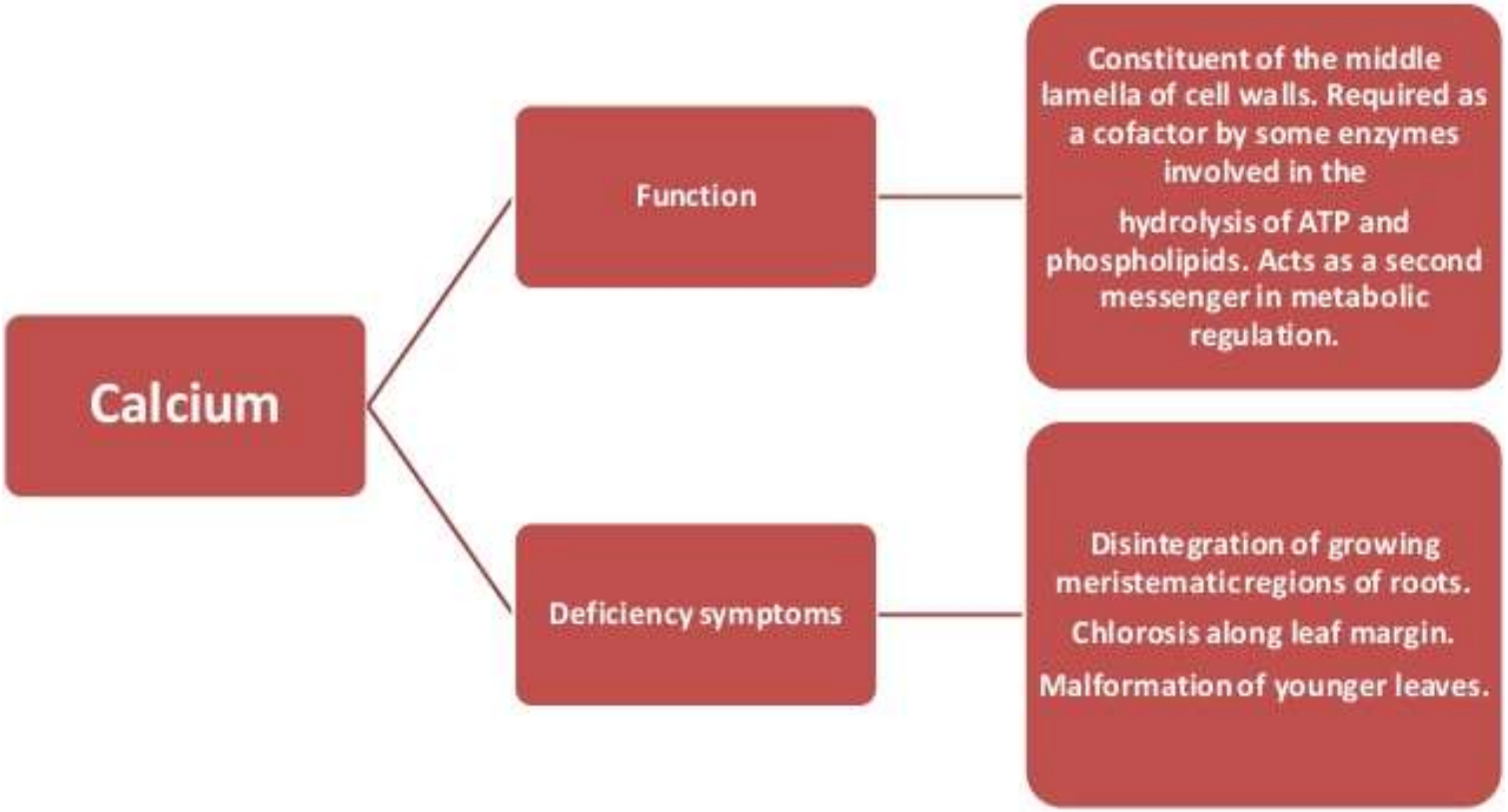
Name	Chemical symbol	Relative % in plant to N	Function in plant
Primary macronutrients			
Nitrogen	N	100	Proteins, amino acids
Phosphorus	P	6	Nucleic acids, ATP
Potassium	K	25	Catalyst, ion transport
Secondary macronutrients			
Calcium	Ca	12.5	Cell wall component
Magnesium	Mg	8	Part of chlorophyll
Sulfur	S	3	Amino acids
Iron	Fe	0.2	Chlorophyll synthesis
Micronutrients			
Copper	Cu	0.01	Component of enzymes
Manganese	Mn	0.1	Activates enzymes
Zinc	Zn	0.03	Activates enzymes
Boron	B	0.2	Cell wall component
Molybdenum	Mo	0.0001	Involved in N fixation
Chlorine	Cl	0.3	Photosynthesis reactions

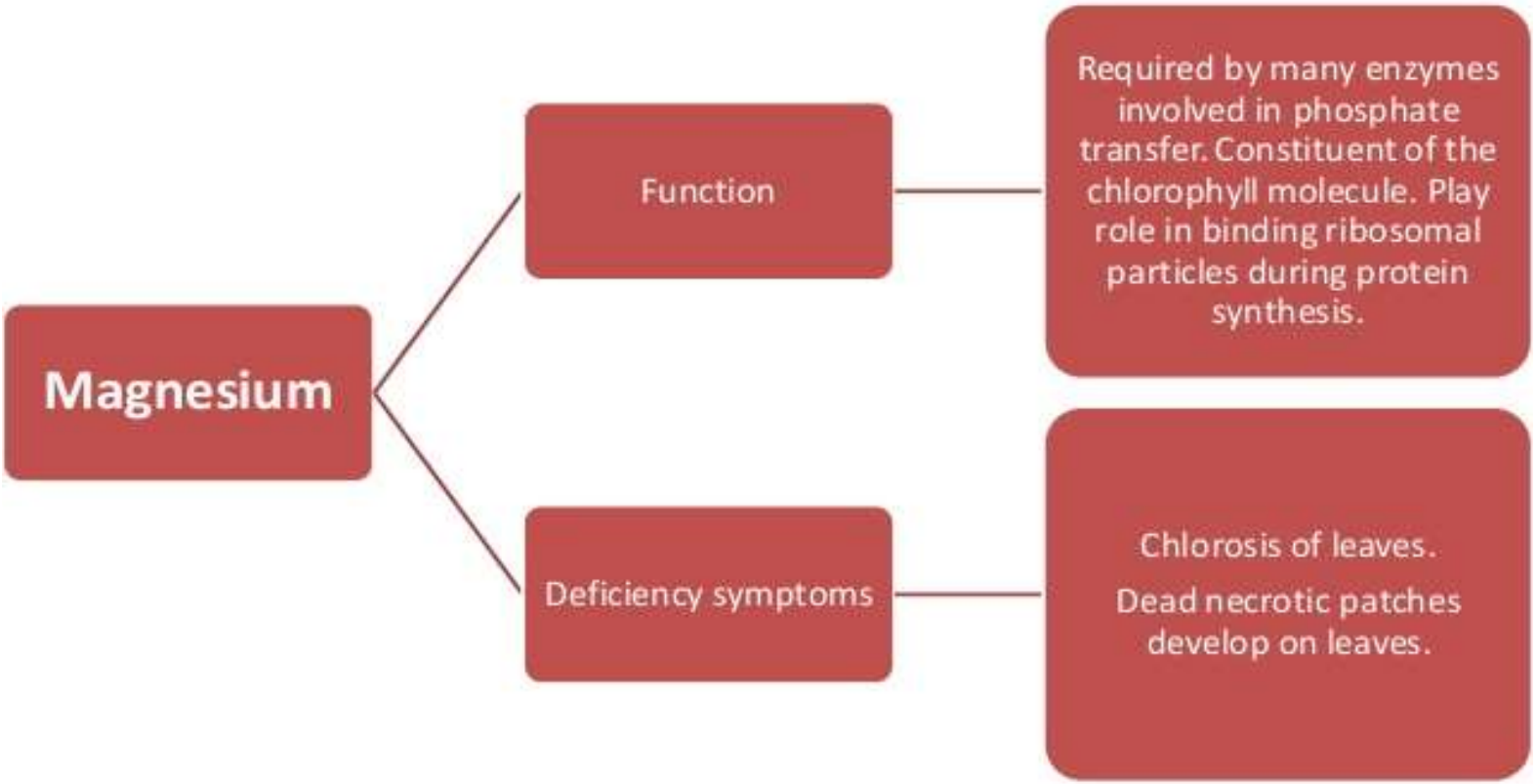
Functions and deficiency symptoms

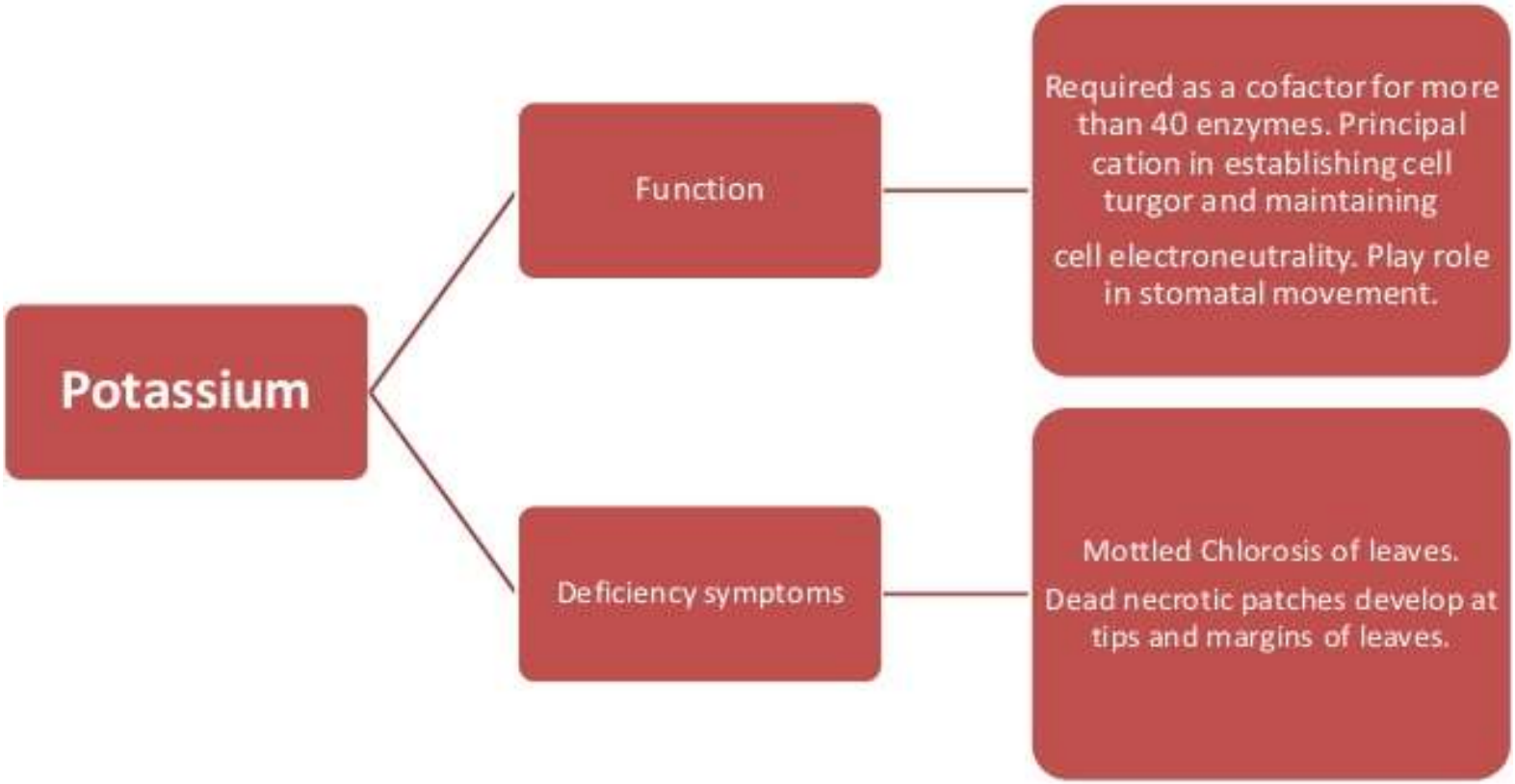


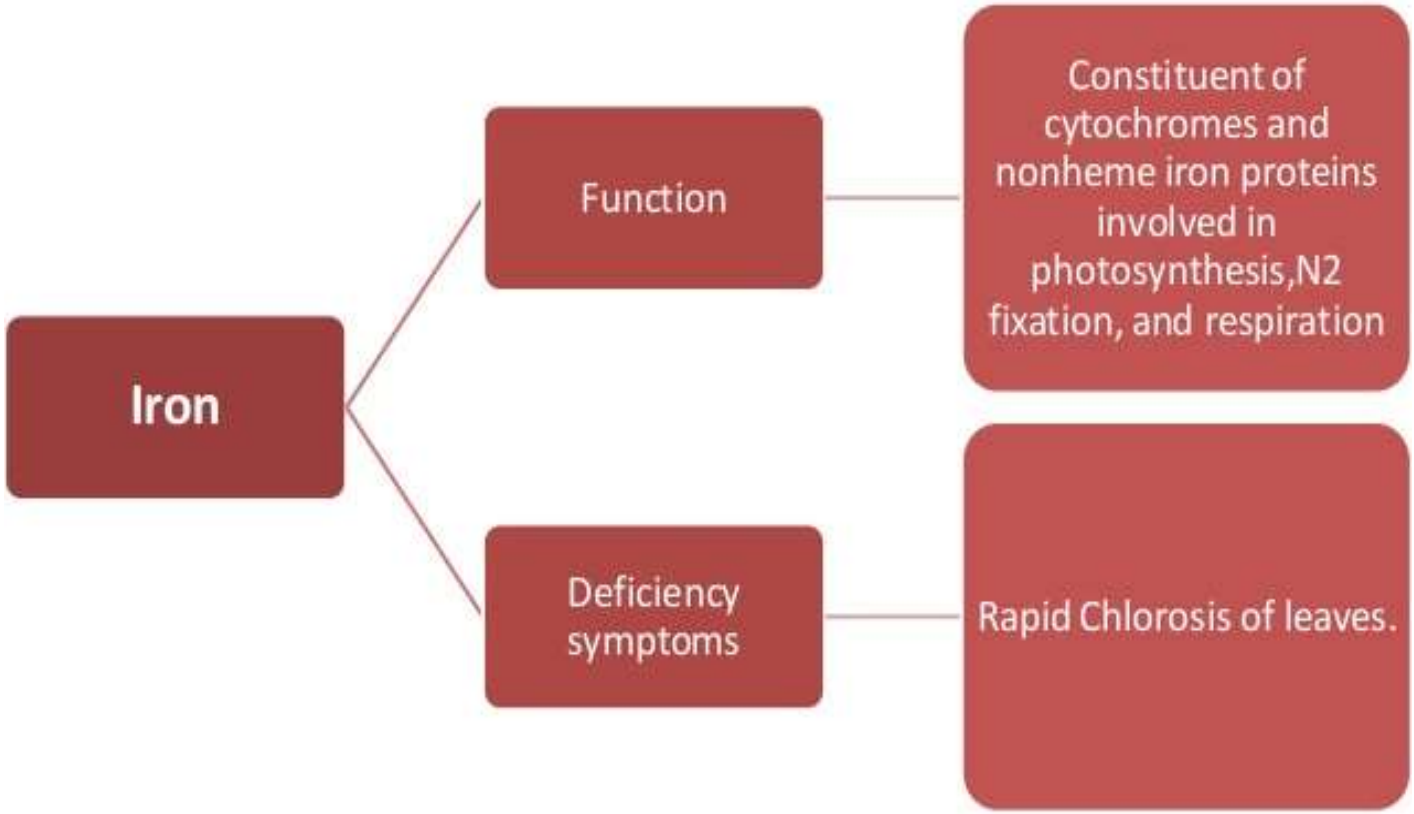

Phosphorous
Function
Component of sugar phosphates, nucleic acids, nucleotides, coenzymes, phospholipids, phytic acid, etc. Has a key role in reactions that involve ATP.
Deficiency symptoms
Premature leaf fall.
Dead necrotic ara develop on fruits and leaves.
Leaves turn dark to blue-green in colour.

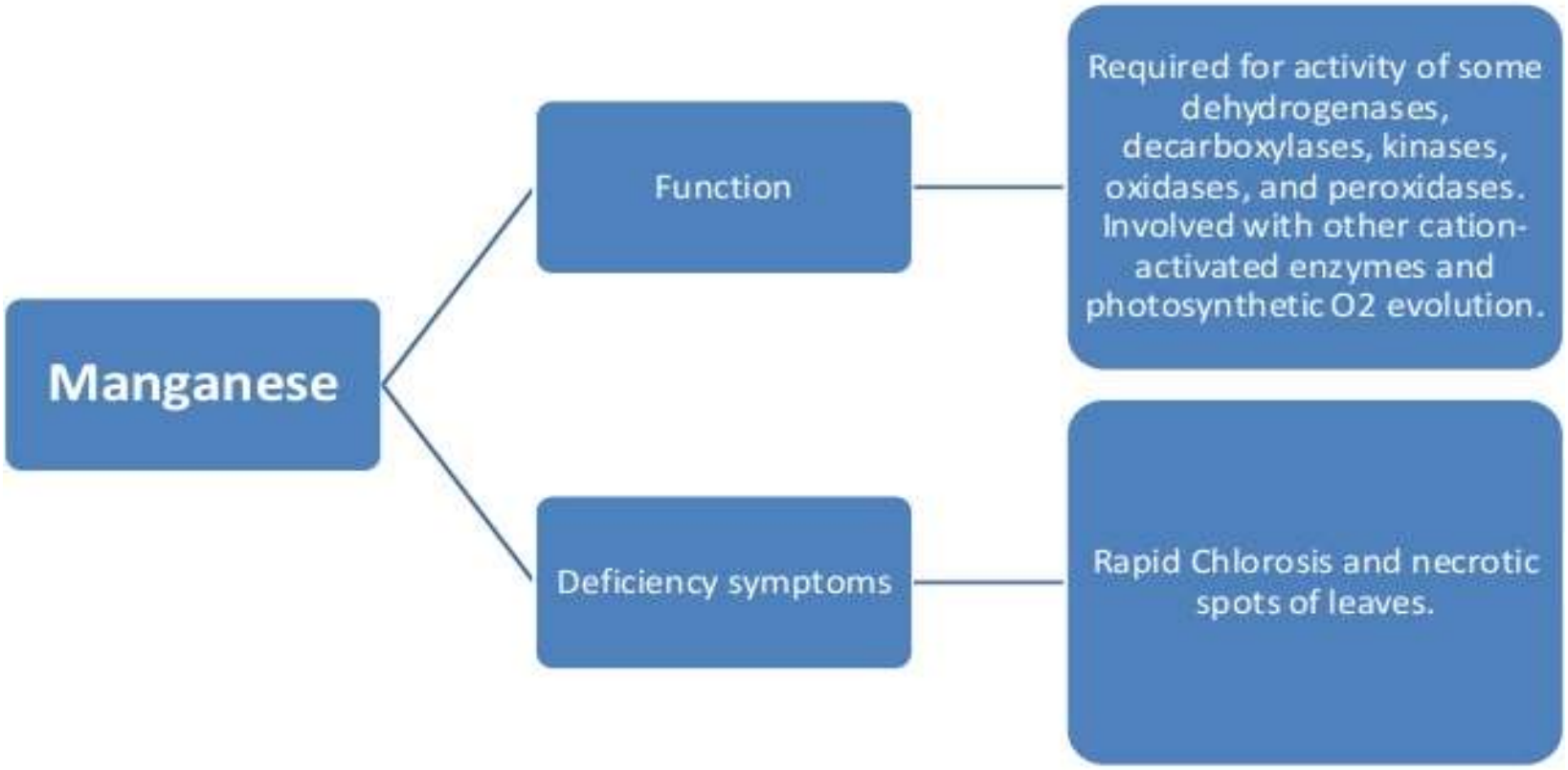

Sulphur
Function
Component of cysteine, cystine, methionine, and proteins. Constituent of lipoic acid, coenzyme A, thiamine pyrophosphate, glutathione, biotin, adenosine-5'-phosphosulfate, and 3-phospho adenosine.
Deficiency symptoms
Chlorosis of leaves.
Margin and tips of leaves roll inward.
Stem become hard due to development of sclerenchyma.

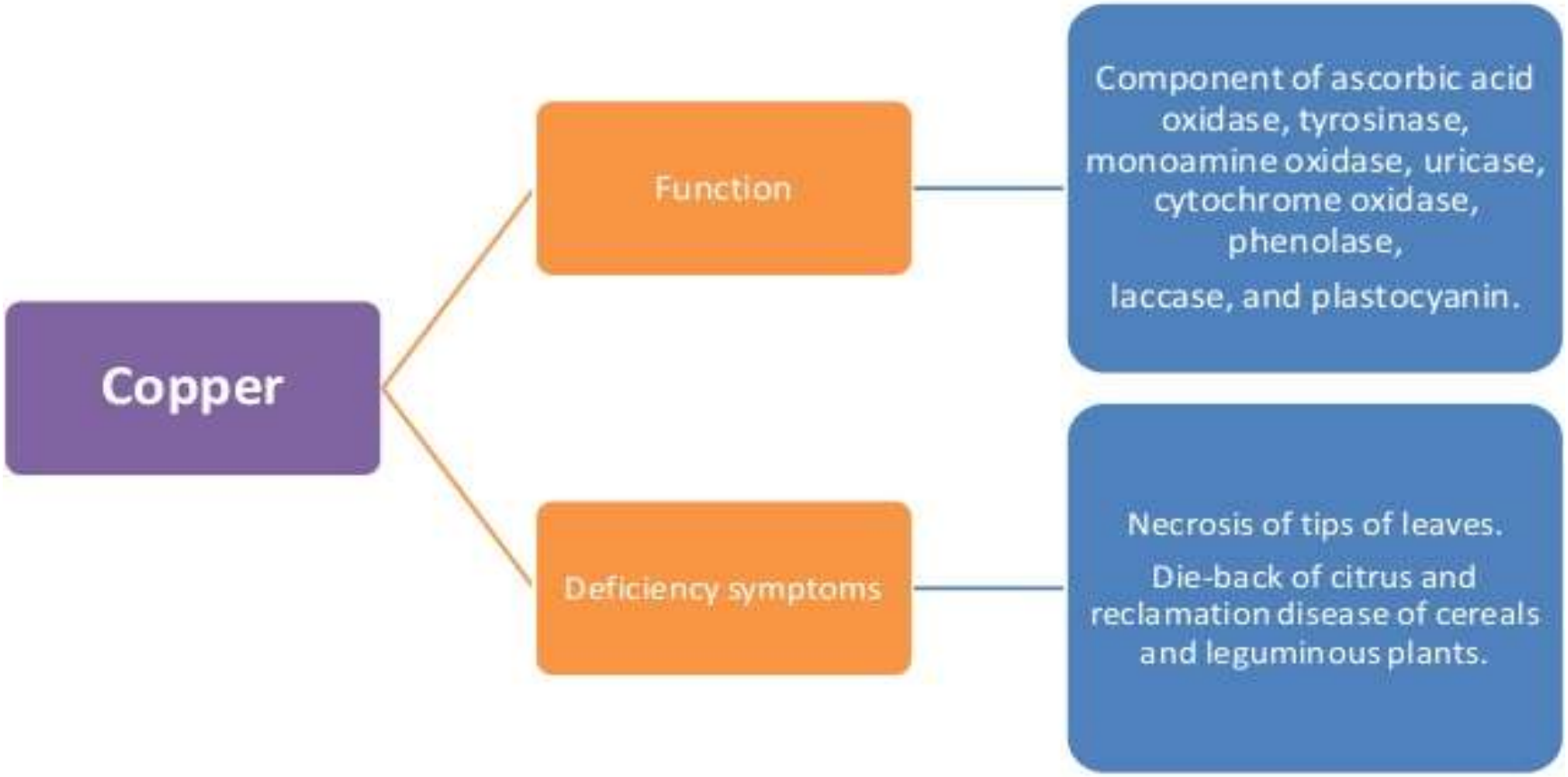

Calcium
Function
Constituent of the middle lamella of cell walls. Required as a cofactor by some enzymes involved in the
hydrolysis of ATP and phospholipids. Acts as a second messenger in metabolic regulation.
Deficiency symptoms
Disintegration of growing meristematic regions of roots.
Chlorosis along leaf margin.
Malformation of younger leaves.

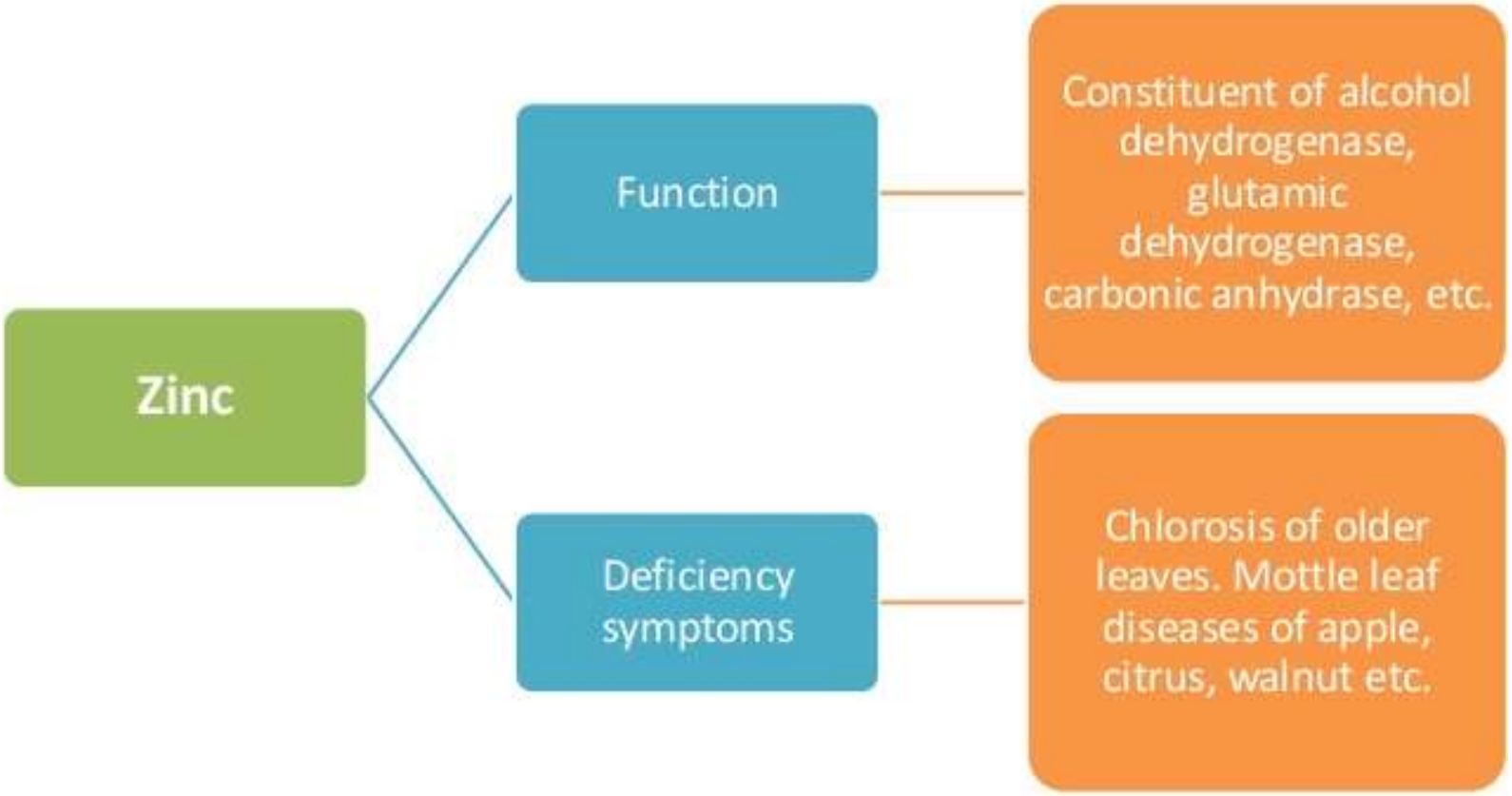

Magnesium
Function
Required by many enzymes involved in phosphate transfer. Constituent of the chlorophyll molecule. Play role in binding ribosomal particles during protein synthesis.
Deficiency symptoms
Chlorosis of leaves.
Dead necrotic patches develop on leaves.

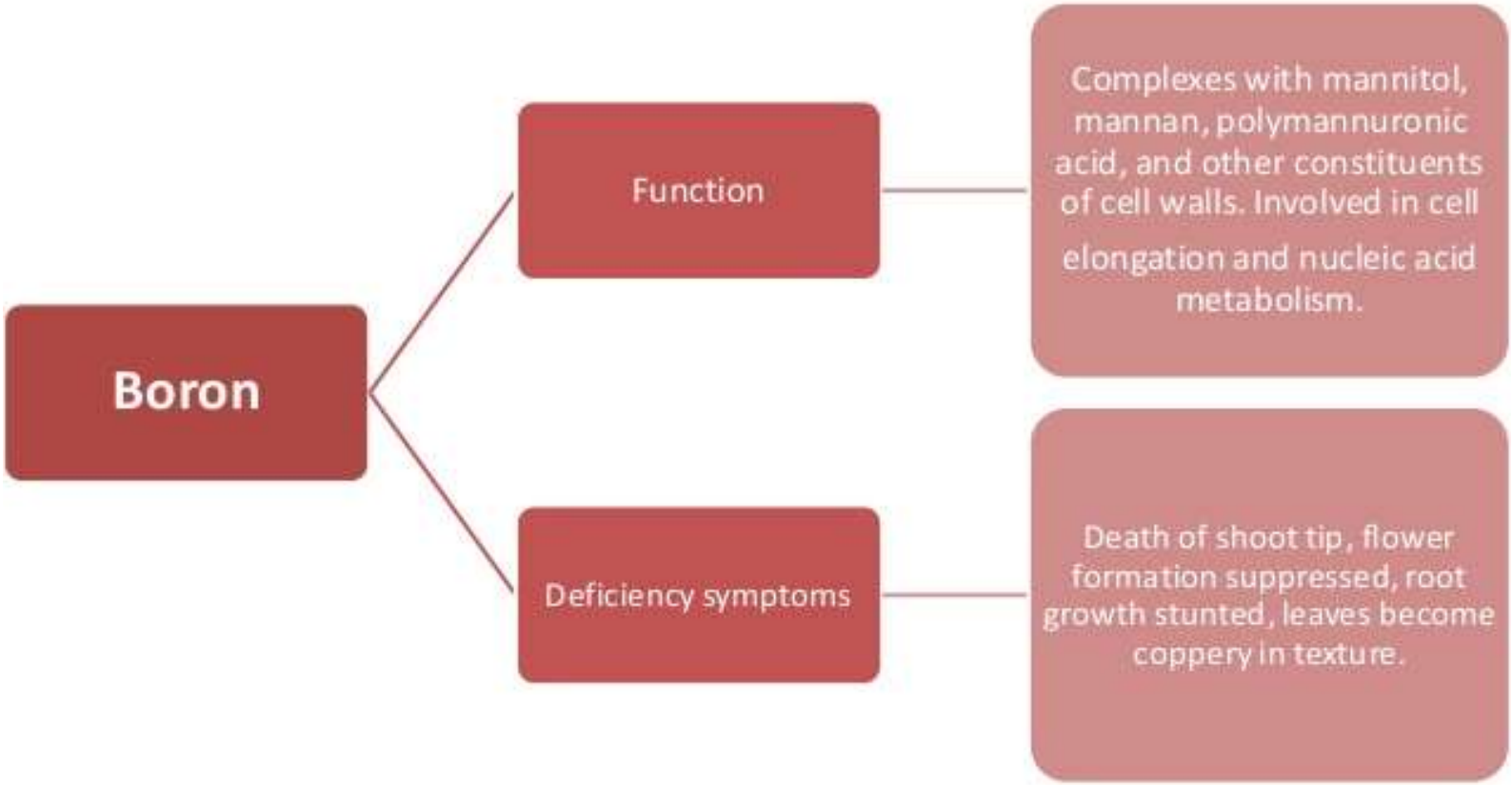

Potassium
Function
Required as a cofactor for more than 40 enzymes. Principal cation in establishing cell turgor and maintaining
cell electroneutrality. Play role in stomatal movement.
Deficiency symptoms
Mottled Chlorosis of leaves.
Dead necrotic patches develop at tips and margins of leaves.

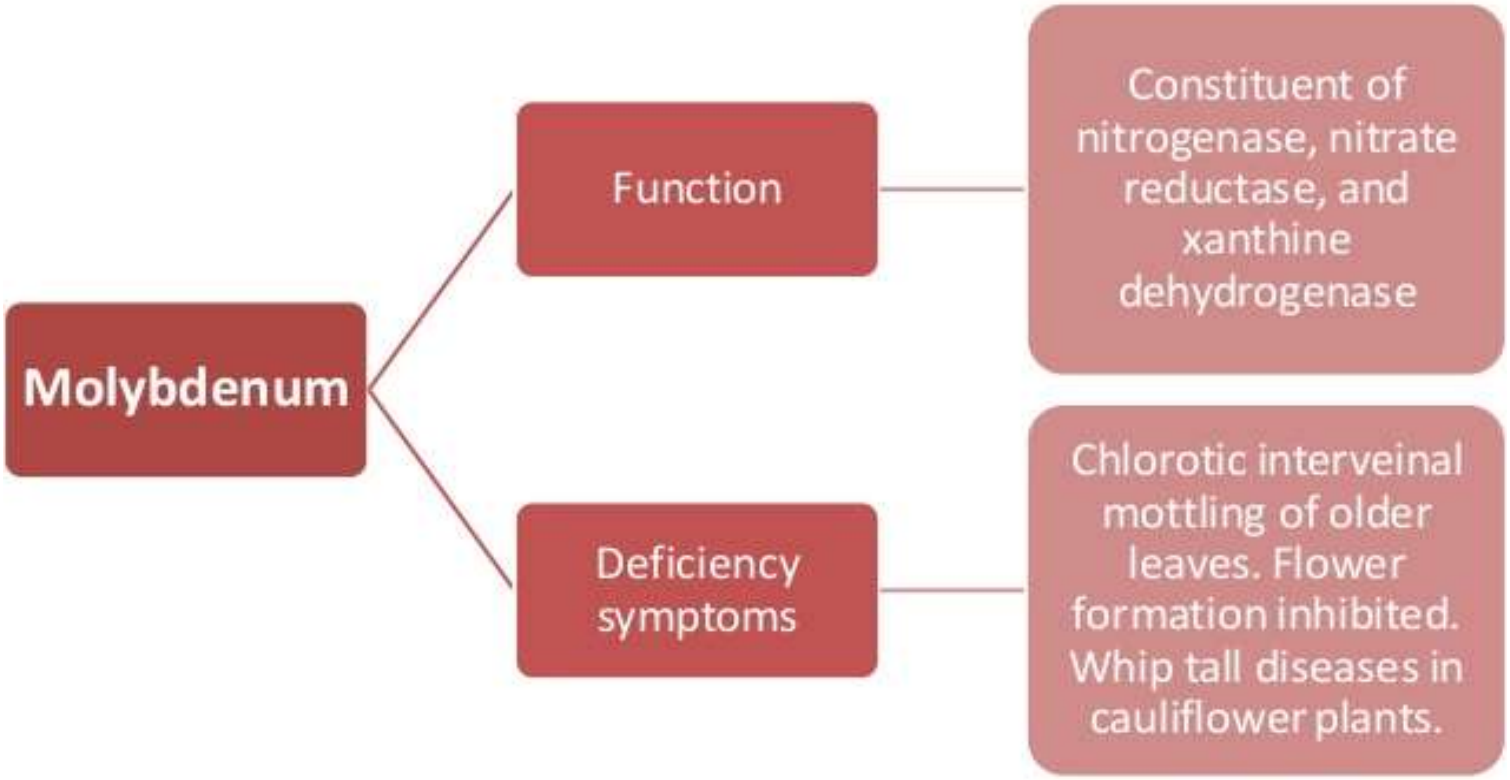

Iron
Function
Constituent of cytochromes and nonheme iron proteins involved in photosynthesis,N2 fixation, and respiration
Deficiency symptoms
Rapid Chlorosis of leaves.


Manganese
Function
Required for activity of some dehydrogenases, decarboxylases, kinases, oxidases, and peroxidases. Involved with other cation-activated enzymes and photosynthetic O2 evolution.
Deficiency symptoms
Rapid Chlorosis and necrotic spots of leaves.


Copper
Function
Component of ascorbic acid oxidase, tyrosinase, monoamine oxidase, uricase, cytochrome oxidase, phenolase,
laccase, and plastocyanin.
Deficiency symptoms
Necrosis of tips of leaves.
Die-back of citrus and reclamation disease of cereals and leguminous plants.

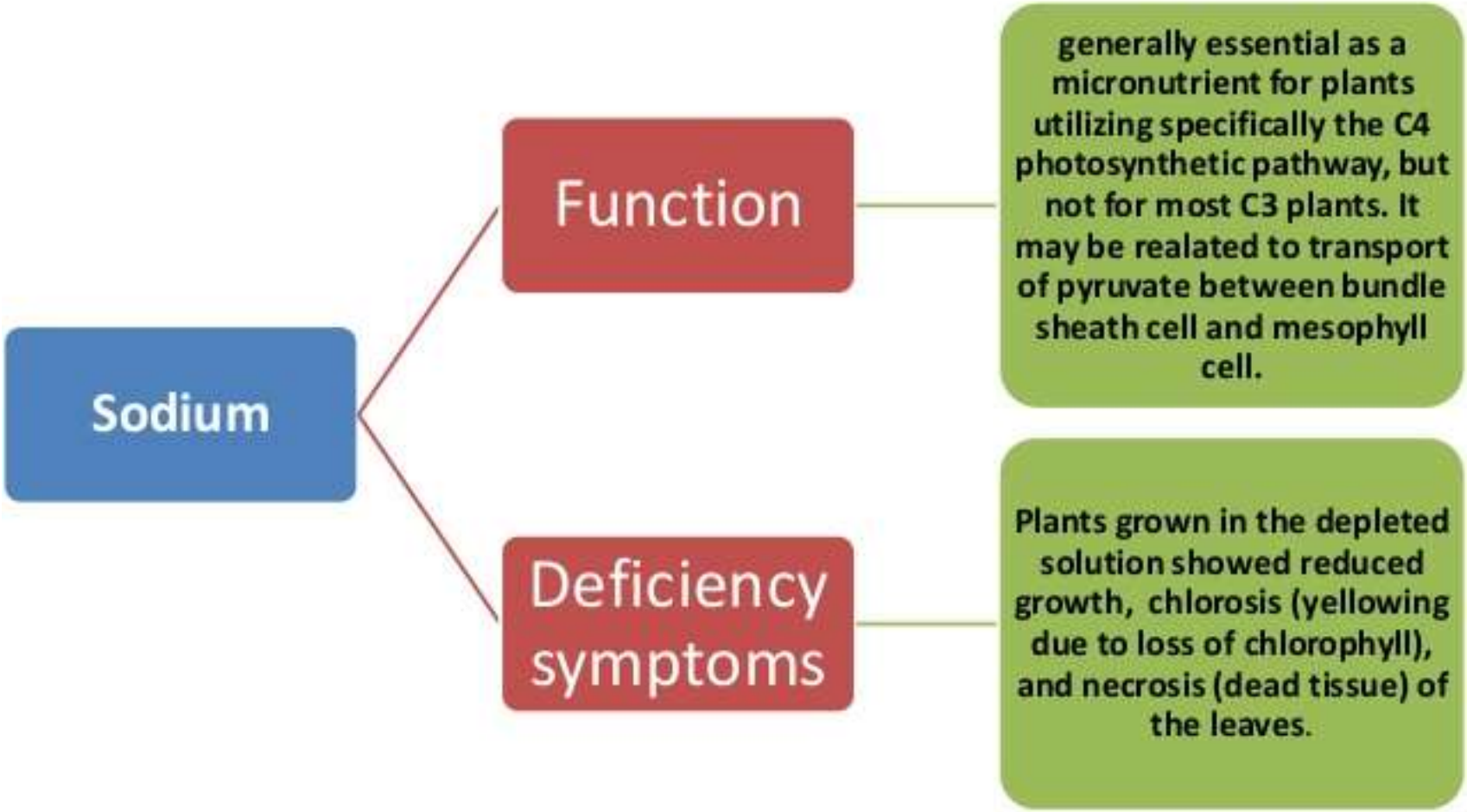

Zinc
Function
Constituent of alcohol dehydrogenase, glutamic dehydrogenase, carbonic anhydrase, etc.
Deficiency symptoms
Chlorosis of older leaves. Mottle leaf diseases of apple, citrus, walnut etc.

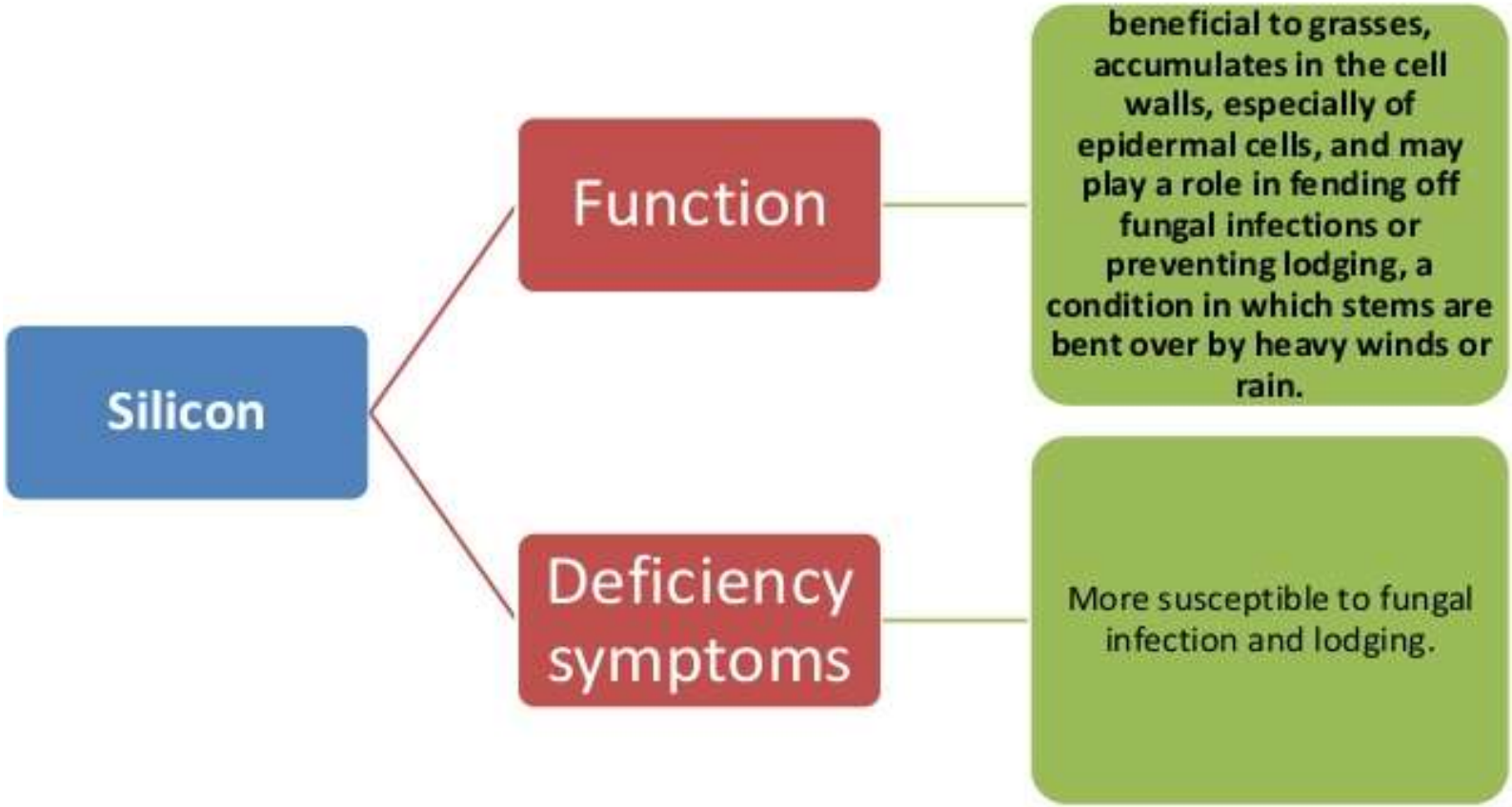

Boron
Function
Complexes with mannitol, mannan, polymannuronic acid, and other constituents of cell walls. Involved in cell elongation and nucleic acid metabolism.
Deficiency symptoms
Death of shoot tip, flower formation suppressed, root growth stunted, leaves become coppery in texture.

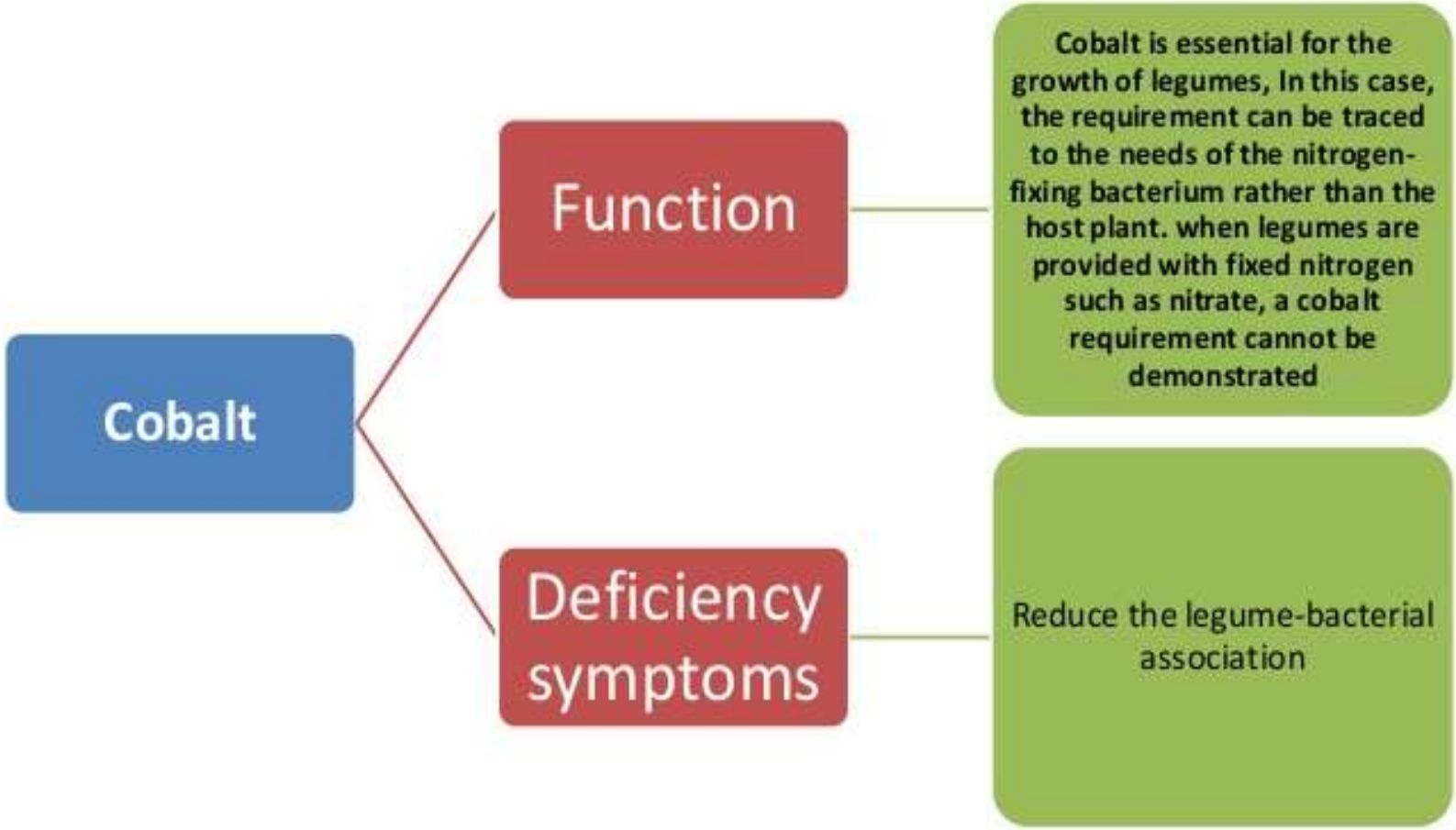

Molybdenum
Function
Constituent of nitrogenase, nitrate reductase, and xanthine dehydrogenase
Deficiency symptoms
Chlorotic interveinal mottling of older leaves. Flower formation inhibited. Whip tall diseases in cauliflower plants.

BENEFICIAL ELEMENTS

In addition to the 17 essential elements, some plants appear to have additional requirements. However, because these have not been shown to be requirements of higher plants generally, they are excluded from the list of essential elements. They are referred to instead as **beneficial elements.** The definition of *beneficial currently applies primarily* to **sodium, silicon, selenium, and cobalt**.


Sodium
Function
generally essential as a micronutrient for plants utilizing specifically the C4 photosynthetic pathway, but not for most C3 plants. It may be realated to transport of pyruvate between bundle sheath cell and mesophyll cell.
Deficiency symptoms
Plants grown in the depleted solution showed reduced growth, chlorosis (yellowing due to loss of chlorophyll), and necrosis (dead tissue) of the leaves.


Silicon
Function
beneficial to grasses, accumulates in the cell walls, especially of epidermal cells, and may play a role in fending off fungal infections or preventing lodging, a condition in which stems are bent over by heavy winds or rain.
Deficiency symptoms
More susceptible to fungal infection and lodging.


Cobalt
Function
Cobalt is essential for the growth of legumes, In this case, the requirement can be traced to the needs of the nitrogen-fixing bacterium rather than the host plant. when legumes are provided with fixed nitrogen such as nitrate, a cobalt requirement cannot be demonstrated
Deficiency symptoms
Reduce the legume-bacterial association

Nitrogen Cycle

The **nitrogen cycle** is the process by which **nitrogen** is converted between its various chemical forms. This transformation can be carried out through both biological and physical processes.

Nitrogen Cycle

Forms of Nitrogen :

a) organic nitrogen as-

- ammonium (NH_4^+),
- nitrite (NO_2^-),
- nitrate (NO_3^-),
- nitrous oxide (N_2O),
- nitric oxide (NO) or

b) inorganic nitrogen as nitrogen gas (N_2).

Nitrogen Cycle

Nitrogen cycle consists of the following steps-

1. Nitrogen Fixation
2. Nitrogen assimilation
3. Ammonification
4. Nitrification and
5. Denitrification
6. Sedimentation

Nitrogen Cycle

1. Nitrogen fixation :

The conversion of free nitrogen of atmosphere into the biologically acceptable form or nitrogenous compounds.

There are following ways to convert N_2 into more chemically reactive forms:

a) Biological Nitrogen fixation
b) Physiocochemical nitrogen fixation
c) Industrial nitrogen fixation

Nitrogen Cycle

a) **Biological Nitrogen fixation :**

some symbiotic bacteria , blue-green algae and some free-living bacteria are able to fix nitrogen as organic nitrogen.

e.g-

symbiotic bacteria	:	*Rhizobium*
symbiotic blue-green algae	:	species of ***Nostoc***, ***Anabaena*** , etc
free-living bacteria	:	***Azotobacter***, *Clostridium*, ***Derxia***, ***Rhodospirillium***, *etc*

Nitrogen Cycle

b) **Physiocochemical *or Non-biological nitrogen fixation :***

In this process, atmospheric nitrogen combines with oxygen (as ozone) during lightning or electrical discharges in the clouds and produces different nitrogen oxides :

$$N_2 + 2(O) \xrightarrow{Electric} 2NO$$

$$2NO + 2(O) \xrightarrow{Discharge} 2NO_2$$

$$2NO_2 + (O) \rightarrow N_2O_5$$

Nitrogen Cycle

c) Industrial nitrogen fixation :

Under great pressure, at a temperature of $600^{\circ} C$ and with the use of an iron catalyst, hydrogen and atmospheric nitrogen can be combined to form ammonia ($\mathbf{NH_3}$) in the **Haber-Bosch** process.

Nitrogen Cycle

2. Nitrogen assimilation :

In this process , Inorganic nitrogen in the form of nitrates , nitrites , and ammonia is absorbed by the green plants via their roots and then it is converted into nitrogenous organic compounds.

Nitrates are first converted into ammonia which combines with organic acids to form aminoacids . Aminoacids are used in the systhesis of proteins, enzymes, chlorophylls, nucleic acids, etc.

Nitrogen Cycle

3. **Ammonification :**

It is the process of releasing ammonia by certain microorganisms utilizing organic compounds derived from the dead organic remains of plants and animals and excreata of animals .

The microorganisms especially involved are-

actinomycetes, and
bacilli
(Bacillus ramosus , B. vulgaris, B. mesenterilus)

Nitrogen Cycle

4. **Nitrification :**

Nitrification is a process of enzymatic oxidation of ammonia to nitrate by certain microorganisms in soil and ocean.

Nitrosomonas ammonia to nitrites (NO_2^-

Nitrobacter oxidation of the nitrites into nitrates (NO_3^-).

Nitrogen Cycle

5. **Denitrification :**

Denitrification is the reduction of nitrates back into the largely inert nitrogen gas (N_2).

Some denitrifying bacteria are-

Thiobacillus denitrificants

Micrococcus denitrificants

Pseudomonas aeruginosa

$$2NO_3^- \rightarrow 2NO_2^- \rightarrow 2NO \rightarrow N_2O \rightarrow N_2$$

Nitrogen Cycle

6. **Sedimentation :**

Sometimes , nitrates of soil are locked up in the rocks while they are washed down to the sea or leached deeply into the earth along with percolating water.This phenomena is known as **sedimentation**.