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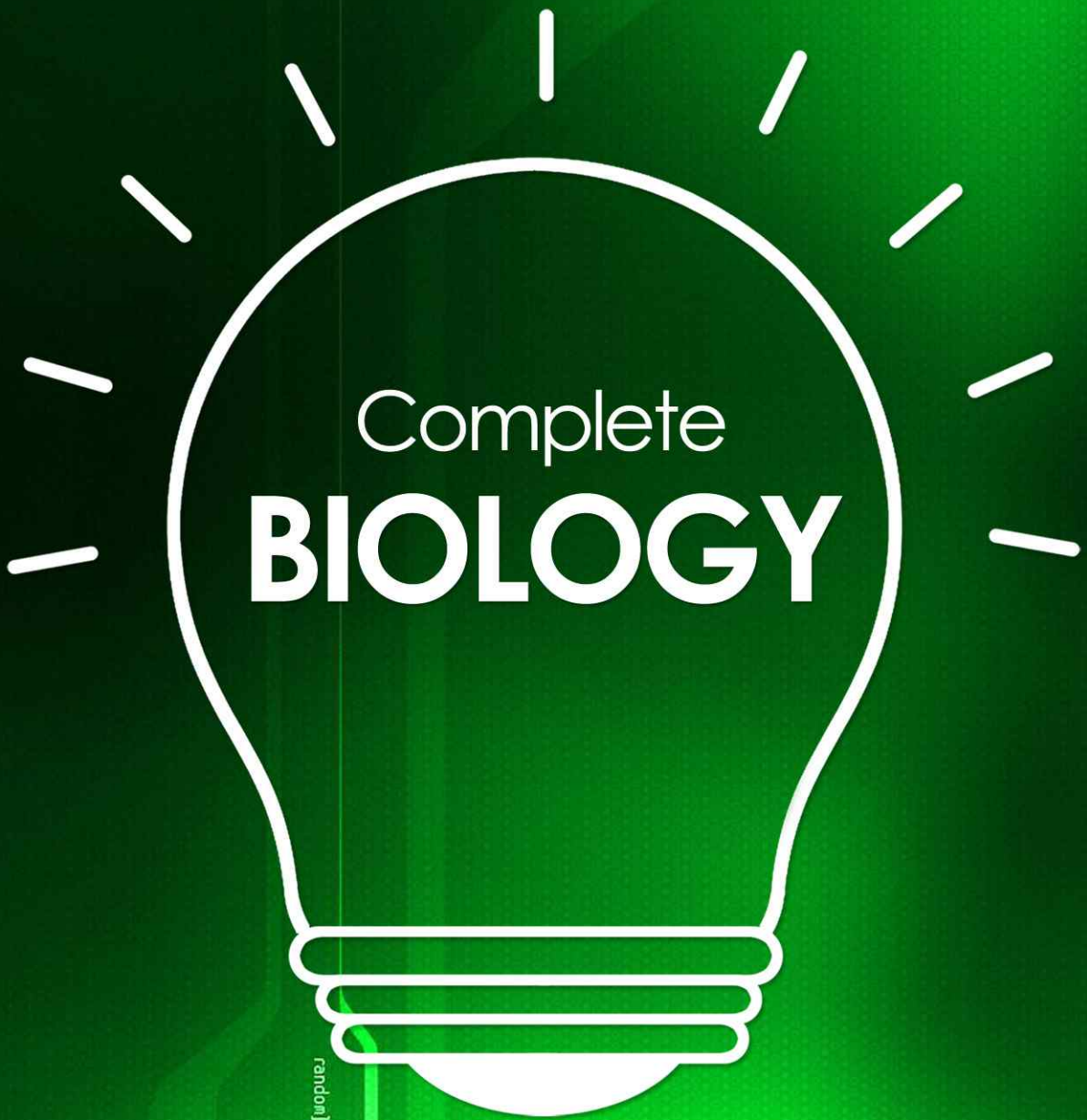

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Mineral Nutrition

01. Introduction

The total sum of process by which a living organism receives and utilises raw materials for it structure and maintaining body function is called **nutrition**. Plants absorb inorganic nutrients from soil which act as the reservoir of mineral elements. The study of absorption and metabolism of inorganic nutrient is called **mineral nutrition**. It also deals with the source of these inorganic nutrients. Various aspects of mineral nutrition are studied through culture experiments, hydroponics and aeroponics, etc.

02. Hydroponics

It is a technique of growing plants in a soil-free medium. The minerals are provided to the plant by a nutrient solution. Culture medium is kept in large tanks and covered with wire mesh. Tanks are provided with aerating and circulating techniques. Plantlets are suspended in solution. It is done with the help of threads.

In hydroponics following two types of systems are used

(i) **Tank System**

(ii) **Film System**

03. Aeroponics

It is also a method of growing plants in a soil-free media. It utilises air or mist environment. It is considered to be a type of hydroponic system. But, it is slightly different from hydroponics. In aeroponics large tanks are taken. In one such tank liquid nutrient solution is kept. The roots of plants are suspended in air. A motor driven rotor is used to aid in generating mist (moisture cloud). Thus, plants take nutrients in the form of mist.

04. Inorganic Nutrients

These are defined as, the nutrients, which are taken up in their elemental or ionic form. In general, water and mineral ions are inorganic nutrients.

05. Classification

The mineral elements are grouped under two broad categories, i.e. essential and non-essential elements. At present 17 essential elements are known. They are C, H, O, N, P, K, Ca Mg, S, Fe, B, Mn, Cu, Zn, Mo, Cl and Ni. Apart form these Al, Si, Na and Ga (Gallium) may be essential for some plants.

06. Essential Elements

The term 'Essential element' was proposed by Arnon and Stout (1939). *The criteria for an element to be considered as essential are as follows*

(i) The element must be essential for the normal growth and reproduction. In the absence, plant cannot complete its life cycle.

(ii) The requirement of element must be specific. It should not be replaceable by any another element.

(iii) The element must be directly involved in metabolism.

(iv) In the absence of element a disorder or malformation in plants occur. This disorder can be corrected only in the presence of that element.

Essential elements are differentiated into two main categories. Based upon their quantitative requirement, i.e. macroelements and microelements.

07. Macroelements (Macronutrients or Major Elements)

Macroelements are required by the plants in large amount. Their quantity in plants is easily detectable. It is around 1-10 mg/g of dry matter. These are usually involved in the synthesis of protoplasm. They are also responsible for the development of osmotic potential inside cell.
Carbon, oxygen, hydrogen, nitrogen, phosphorus, potassium, calcium, sulphur and magnesium are called macronutrients. Macronutrients which commonly deficient in the soil are called **critical elements**, i.e. N, P and K. The fertilisers which contain critical elements are called as **complete fertilisers**. They are expressed in the ration 15 : 16 : 18 (N : P : K).

08. Microelements (Trace Elements or Micronutrients)

Microelements are required by the plant in trace amounts. Their amount in plants can be equal or less than 1 mg/g of dry weight of plant body.
They are mainly involved in functioning of enzymes.
These mainly act as cofactor or metal activator of enzymes.
Microelements are eight in number, i.e. zinc, manganese, boron, copper, iron, nickel, molybdenum and chlorine. Some microelements become toxic to the plant when present in high concentration.
Essential elements can also be grouped into four broad categories, based upon their diverse functions. These categories are

(i) Constituent of organic biomolecules,
e.g. C, H, O, N.

(ii) Component of energy related chemical compound,
e.g. Mg^{2+}, P.

(iii) Activators and inhibitors of enzymes,
e.g. Zn^{2+}, Mg^{2+}.

(iv) Regulators of osmotic potential of cell,
e.g. K^{+}, Na^{+} and Cl^{-}.

09. Functions and Deficiency Symptoms of macro and Micronutrients

The concentration of essential element below which plant growth is retarded is termed as **critical concentration**. sometimes, an element may be present in concentration below its critical concentration.

Then, the plant shows deficiency symptoms. The morphological changes that indicate deficiencies of an element are called deficiency symptoms. These symptoms differ from element to element. They disappears when the deficient mineral nutrient is provided to the plant.

Table. Essential elements their functions and deficiency symptoms

Element	Absorbed as	Function	Deficiency symptom	Required by
Macroelements				
Nitrogen (N)	NO^-_3 and sometimes as NO^-_2 and NH^+_4	Component of proteins, nucleic acids, porphyrins and coenzyme, nucleotides vitamins, hormones. They aid in cell division, growth and photosynthesis.	Chlorosis appears first in older leaves, dormancy of lateral buds, premature leaf fall, delaying of flowering. Interference in protein synthesis. Purple colouration of stem.	Required by whole plant mainly by meristematic tissue.
Phosphorus (P)	Absorbed from soil as $H_2PO^-_4$ or PO^{3-}_4	Component of nucleic acids, proteins, phospholipids, ATP and NADP. Involved in energy transfer and all membrane phosphorylation reactions (thus generate metabolic energy).	Reduced growth, promotes premature leaf fall and delay flowering, necrosis. Vascular tissues and poorly developed. Increased pith tissue, pigmented leaves due to anthocynin (purple and red spots)	Growing organ, i.e. meristerms and storage organ (seed and fruit).