Chapter-2 Mineral Nutrition

Very Short Answers Questions:

1. **Define hydroponics?**

A: The technique of growing plants in a specified nutrient solution is known as hydroponics. It is a soil free culture.

2. **How do you categorize a particular essential element as a macro or microelement?**

A: Micronutrients or trace elements are elements that are needed in very small amounts i.e. less than 10m mole /kg of dry matter.

Essential elements which require more than 10 m mole/kg of dry matter are classified as macroelemnets.

3. **Give two examples of essential elements that act as activators for enzymes?**

A: **Magnesium** –for RUBISCO

Molybdenum—for Nitrogenase.

4. **Name the essential mineral elements that play an important role in photolysis of water?**

A: Calcium, Chlorine and Manganese.

5. **Out of the 17 essential elements which elements are called non-mineral essential elements?**

A: Carbon, Hydrogen and Oxygen

6. **Name two amino acids in which sulphur is present?**

A: Cystein and Methionine

7. **When is an essential element said to be deficient?**

A: The concentration of the essential element below which plant growth is retarded is termed as critical concentration. The element is said to be deficient when present below this critical concentration.

8. Name two elements whose symptoms of deficiency first appear in younger leaves?

A: Calcium and Sulphur

9. Explain the role of pink colour pigment in the root nodules of legume plants. What is it called?

A: The pink colour pigment is Leg-haemoglobin. It protects nitrogenase enzyme from oxidation. It is an oxygen scavenger.

10. Which element is regarded as 17^{th} essential element? Name a disease caused by its deficiency?

A: Nickel. It causes 'mouse ear disease' in pecans.(*Juglans sps*)

11. Name the essential elements present in nitrogenase enzyme. What type of essential elements are they?

A: Molybdenum and Iron. These are essential micronutrients.

12. Write the balanced equation of nitrogen fixation?

A: $N_2 + 8H^+ + 8e^- + 16ATP \rightarrow 2NH_3 + H_2 + 16ADP + 16Pi$

13. Name any two essential elements and the deficiency diseases caused by them?

A: Mottled leaf disease in Citrus is caused by the deficiency of Zinc.

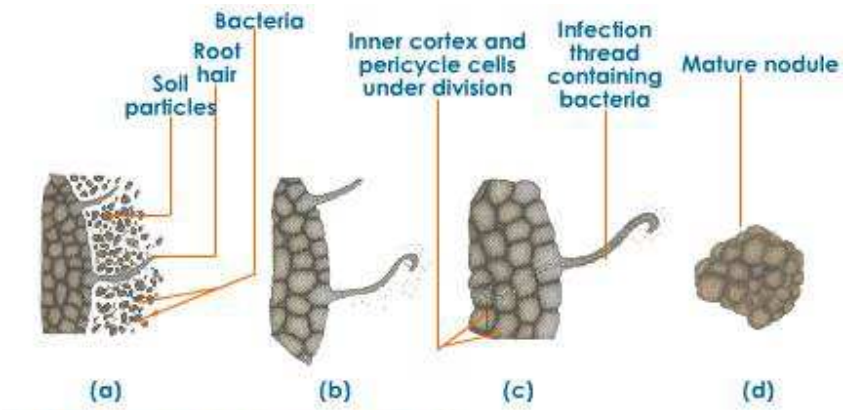
Die back disease is caused by the deficiency of Copper.

Heart-rot in beets is caused by the deficiency of Boron.

Short Answers Questions:

1. Explain the steps involved in the formation of root nodule?

Ans: The nodule formation involves a sequence of multiple interactions between *Rhizobium* and roots of the host plant. Principal stages in the nodule formation are:



(a) Development of root nodules in soyabean
(b) Rhizobium bacteria contact a susceptible root hair
(c) Infection thread carrying bacteria
(d) A mature nodule complete with vascular tissues continuous with those of root

- Rhizobia multiply and colonise the surroundings of roots and get attached to epidermal and root hair cells.
- The root-hairs curl and the bacteria invade the root-hair.
- An infection thread is produced carrying the bacteria into the cortex of the root, where they initiate the nodule formation in the cortex of the root.
- Then the bacteria are released from the thread into the cells which leads to the differentiation of specialised nitrogen fixing cells.
- The nodule thus formed, establishes a direct vascular connection with the host for exchange of nutrients.
- The nodule contains all the necessary biochemical components, such as the enzyme nitrogenase and leghaemoglobin.

- The enzyme nitrogenase is a Mo-Fe protein and catalyses the conversion of atmospheric nitrogen to ammonia, the first stable product of nitrogen fixation.

2. Write in brief how plants synthesize amino acids?

Ans: The most important element apart from Carbon, Hydrogen and Oxygen is Nitrogen. Plants absorb nitrogen from the soil in the form of nitates or ammonical form. Nitrates is the major form absorbed by the plants. Some plants in association with symbiotic microbes can utilize atmospheric dinitrogen form.

Nitrates after absorption from the soil is reduced to ammonia by two different enzymes present in the roots or leaf cells. These enzymes are nitrate reductase and nitrite reductase. The resulting ammonia is toxic to the plants. At physiological pH ammonia is protonated to form ammonium ion(NH_4^+). Ammonium will be immediately incorporated into amino acids. This process is called Nitrogen assimilation.

There are two ways in which this can take place.

1. Reductive aminase: In this process ammonia reacts with α- keto glutaric acid and forms glutamic acid in the presence of Glutamate Dehydrogenase.

α -ketoglutaric acid + NH_4^+ + NADPH → Glutamate +H_2O + NADP

2. Transamination: It involves teansfer of amino group from an amino acid to a keto group of a keto acid in the presence of Transaminase enzyme.

Oxaloacitic acid + Glutamic acid → Aspartic acid + α- keto glutaric acid

The energy needed by these reaction will be provided by photosynthesis or respiration.

3. Explain in brief how plants absorb essential elements?

Ans: The essential elements are 17 in number. Out of these, three are absorbed from the atmosphere. These are Carbon, Hydrogen and Oxygen which are absorbed in molecular form passively. The remaining essential elements are absorbed from the

soil by the roots as mineral elements. Mineral elements absorbed in ionic form along with water.

The absorption of minerals from the soil can be demarcated into two main phases.

In the first phase, there is an initial rapid uptake of ions into the ‘ free space’ or ‘ outer space’ of cells – the apoplast. It is a **passive process**. The passive movement of ions into apoplast from cell along concentration gradient usually occurs through ion-channels.The membrane proteins function as selective pores.

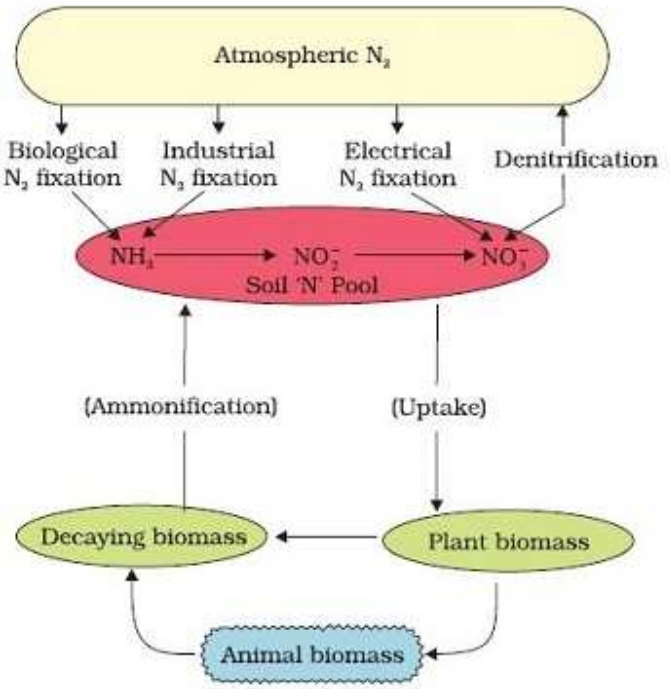
In the second phase of uptake, the ions move slowly into ‘inner space’ –the symplast of the cells.The entry or exit of ions to and from the symplast against concentration gradient requires the expenditure of energy which is an **active process**.

4. Explain the nitrogen cycle, giving relevant examples?

Ans: Atmosphere consisting of nearly 79% of nitrogen. The movement of nitrogen in nature in cyclic form atmosphere to soil and from soil to atmosphere through plants animals and microbes is called nitrogen cycle.

Nitrogen in the atmosphere exists as two nitrogen atoms joined by a very strong triple covalent bond (N≡ N).

The process of conversion of nitrogen (N_2) to ammonia is termed as **nitrogenfixation.**



In nature, lightning and ultraviolet radiation provide enough energy to convert nitrogen to nitrogen oxides (NO, NO_2, N_2O).

Industrial combustions, forest fires, automobile exhausts and power –generating stations are also sources of atmospheric nitrogen oxides.

Decomposition of organic nitrogen of dead plants and animals into ammonia is called ammonification.

Some of this ammonia volatilises and re-enters the atmosphere but most of it is converted into nitrate by soil bacteria in the following steps:

$$2NH_3 + 3O_2 \rightarrow 2NO^-_2 + 2H+ + 2H_2O$$

$$2NO^-_2 + O_2 \rightarrow 2NO^-_3$$

Ammonia is first oxidised to nitrite by the bacteria *Nitrosomonas* and/or *Nitrococcus*.

The nitrite is further oxidised to nitrate with the help of the bacterium *Nitrobacter*. These steps are called **nitrification.**

These nitrifying bacteria are **chemoautotrophs**. The nitrate thus formed is absorbed by plants and is transported to the leaves.

In leaves, it is reduced to form ammonia that finally forms the amine group of amino acids.

Nitrate present in the soil is also reduced to nitrogen by the process of denitrification. Denitrification is carried by bacteria *Pseudomonas* and *Thiobacillus*.