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CBSE

CLASS-11th

THE CENTRAL BOARD OF SECONDARY EDUCATION

BIOLOGY-II

SIERRA INNOVATIONS

CONTENT

CHAPTER 11—TRANSPORT IN PLANTS

Contents

MEANS OF TRANSPORT:

DIFFUSION

- Diffusion is passive, and may be from one part of the cell to the other, or from cell to cell, or over short distances, i.e., from the intercellular spaces of the leaf to the outside.
- No energy expenditure takes place
- .Diffusion is very important to plants since it is the only means for gaseous movement within the plant body.

FACILITATED DIFFUSION

- A concentration gradient must already be present for molecules to diffuse even if facilitated by the proteins. This process is called facilitated diffusion
- It is very specific:
- it allows cell to select substances for uptake.
- In a symport, both molecules cross the membrane in the same direction;
- in an antiport, they move in opposite directions.
- The transport proteins allow the passage of selected ions &other polar molecules. Transport proteins are of two types – **carrier proteins &channel proteins**.

- **Carrier proteins** bind to the particular solute to be transported &deliver it to the other side of the membrane.
- A molecule when moves across the membrane through carrier protein independently of other molecules, the process are called **uniport**.

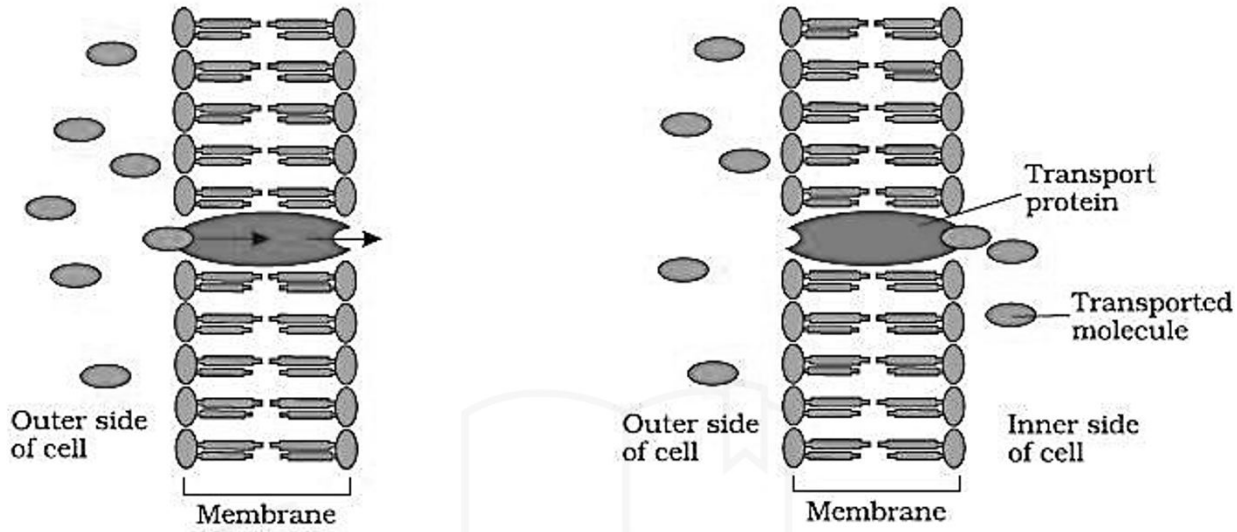


Fig 11.1 Facilitated diffusion

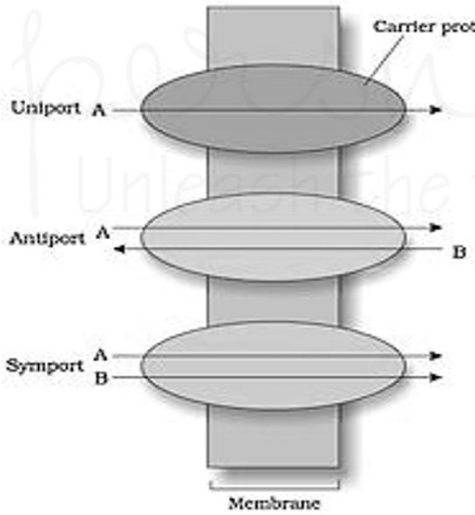


Fig 11.2 Facilitated diffusion

ACTIVE TRANSPORT

- Active transport uses energy to pump molecules against a concentration gradient.
- Active transport is carried out by membrane-proteins. Hence different proteins in the membrane play a major role in both active as well as passive transport.

PLANT-WATER RELATIONS

- Water is essential for all physiological activities of the plant and plays a very important role in all living organisms.
- It provides the medium in which most substances are dissolved.
- The protoplasm of the cells is nothing but water in which different molecules are dissolved and (several particles) suspended.

WATER POTENTIAL

- Water potential (Ψw) is a concept fundamental to understanding water movement.
- Solute potential (Ψs) and pressure potential (Ψ p) are the two main components that determine water potential.
- Water potential of a cell is affected by both solute and pressure potential. The relationship between them is as follows: Ψw = Ψs + Ψp.Ψ_{w} = water potential, Ψ_{m} = matric potential, Ψ_{S} = solute potential &Ψ_{P} = pressure potential
- At atmospheric pressure, pure water has zero water potential;
- , in solution the value of water potential is always negative or less than zero as the presence of solute reduces the free energy of water &thus decreases the water potential (negative value).
- Water always moves from the area of high water potential or low free energy
- .**Solute potential (osmotic potential**) is the amount by which the water potential is reduced as a result of the presence of solute. It always has negative value. The more the solute molecules, the lower is Ψ_{w}.
- **Hydrostatic pressure (pressure potential)** is the pressure which develops in an osmotic system due to osmotic entry or exit of water from it. A positive pressure develops in a plant cell or system due to entry of water into it, which is called **turgor pressure (TP).**

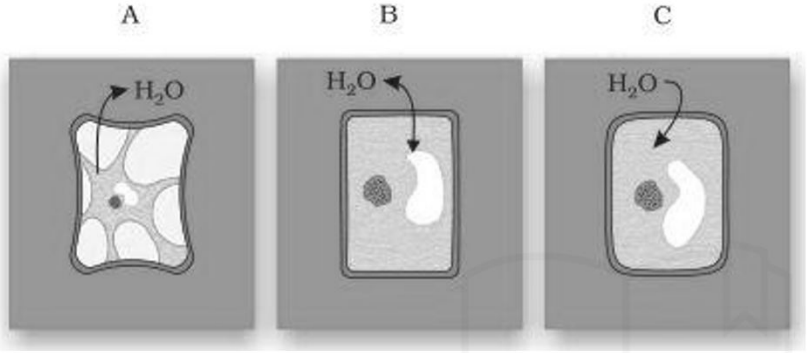
OSMOSIS

- Osmosis is a process by which molecules of a solvent pass through a semipermeable membrane from a region of higher concentration to the region of lower concentration.
- The osmotic entry of water into a cell is termed as endosmosis whereas the osmotic potential withdrawal of water from a cell is called as exosmosis.
- **Osmotic pressure (OP)**is the pressure which needs to be applied to a solution to prevent the inward flow of water across a semipermeable membrane.
- Osmotic pressure is numerically equal to the osmotic potential or solute potential, but the osmotic potential has a negative a value, while osmotic pressure has appositive value.

- **Diffusion pressure deficit (DPD)**is the reduction in the diffusion pressure of water in a solution over its pure state. It is also known as **suction pressure**. DPD = OP – WP (=TP).

PLASMOLYSIS

- Plasmolysis occurs when water moves out of the cell and the cell membrane of a plant cell shrinks away from its cell wall.
- Cells swell in hypotonic solutions and shrink in hypertonic ones.



A= PLASMOLYSED
B= FLACCID
C= TURGID

Figure 11.5 Plant cell plasmolysis

IMBIBITION

- Imbibition is a special type of diffusion when water is absorbed by solids – colloids – causing them to enormously increase in volume. The classical examples of imbibition are absorption of water by seeds and dry wood.

LONG DISTANCE TRANSPORT OF WATER

- The bulk movement of substances through the conducting or vascular tissues of plants is called translocation.
- Water and minerals, and food are generally moved by a mass or bulk flow system.
- Mass flow is the movement of substances in bulk or en masse from one point to another as a result of pressure differences between the two points.
- Bulk flow can be achieved either through a positive hydrostatic pressure gradient.

How do Plants Absorb Water?

- Water is absorbed along with mineral solutes, by the root hairs, purely by diffusion.
- Once water is absorbed by the root hairs, it can move deeper into root layers by two distinct pathways:
- **• apoplast pathway • symplast pathway**
- **The apoplast** is the system of adjacent cell walls that is continuous throughout the plant, except at the casparian strips of the endodermis in the roots.
- **The symplast system** is the system of interconnected protoplasts. Neighbouring cells are connected through cytoplasmic strands that extend through plasmodesmata. During symplastic movement, the water travels through the cells – their cytoplasm; intercellular movement is through the plasmodesmata.

TRANSPIRATION

- Transpiration is the evaporative loss of water by plants.
- It occurs mainly through the stomata in the leaves.
- Besides the loss of water vapour in transpiration, exchange of oxygen and carbon dioxide in the leaf also occurs through pores called stomata.
- Normally stomata are open in the day time and close during the night. The immediate cause of the opening or closing of the stomata is a change in the turgidity of the guard cells.
- The inner wall of each guard cell, towards the pore or stomatal aperture, is thick and elastic.
- Usually the lower surface of a dorsiventral (often dicotyledonous) leaf has a greater number of stomata while in an isobilateral (often monocotyledonous) leaf they are about equal on both surfaces
- **. Transpiration is affected by several external factors**: temperature, light, humidity, wind speed.
- Plant factors that affect transpiration include number and distribution of stomata, per cent of open stomata, water status of the plant, canopy structure etc.
- **The transpiration driven ascent of xylem sap depends mainly on the following physical properties of water: • Cohesion – mutual attraction between water molecules. • Adhesion – attraction of water molecules to polar surfaces (such as the surface of tracheary elements). • Surface Tension – water molecules are attracted to each other in the liquid phase more than to water in the gas phase.**

- These properties give water high tensile strength, i.e., an ability to resist a pulling force, and high capillarity, i.e., the ability to rise in thin tubes.
- In plants capillarity is aided by the small diameter of the tracheary elements – the tracheids and vessel elements. The process of photosynthesis requires water.

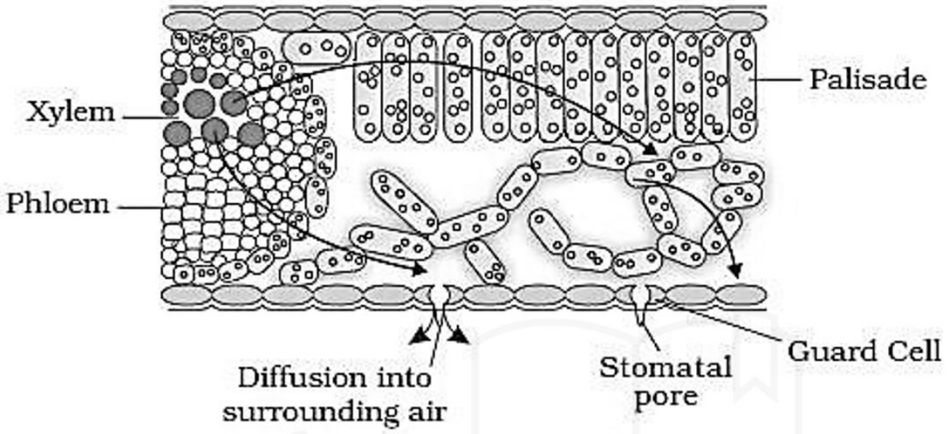


Figure11.9 Water movement in the leaf. Evaporation from the leaf sets up a pressure gradient between the outside air and the air spaces of the leaf. The gradient is transmitted into the photosynthetic cells and on the water-filled xylem in the leaf vein.

Transpiration has more than one purpose;

- creates transpiration pull for absorption and transport of plants
- supplies water for photosynthesis
- transports minerals from the soil to all parts of the plant
- cools leaf surfaces, sometimes 10 to 15 degrees, by evaporative cooling
- maintains the shape and structure of the plants by keeping cells turgid

UPTAKE AND TRANSPORT OF MINERAL NUTRIENTS

- Two factors account for this: (i) minerals are present in the soil as charged particles (ions) which cannot move across cell membranes and (ii) the concentration of minerals in the soil is usually lower than the concentration of minerals in the root.
- Some ions also move into the epidermal cells passively. Ions are absorbed from the soil by both passive and active transport.

- Specific proteins in the membranes of root hair cells actively pump ions from the soil into the cytoplasms of the epidermal cells
- Transport proteins of endodermal cells are control points, where a plant adjusts the quantity and types of solutes that reach the xylem.

PHLOEM TRANSPORT: FLOW FROM SOURCE TO SINK

- Food, primarily sucrose, is transported by the vascular tissue phloem from a source to a sink.
- Usually the source is understood to be that part of the plant which synthesises the food, i.e., the leaf, and sink, the part that needs or stores the food. But, the source and sink may be reversed depending on the season, or the plant needs.
- Sugar stored in roots may be mobilised to become a source of food in the early spring when the buds of trees, act as sink; they need energy for growth and development of the photosynthetic apparatus.
- Since the source-sink relationship is variable, the direction of movement in the phloem can be upwards or downwards, i.e., bi-directional.
- This contrasts with that of the xylem where the movement is always unidirectional, i.e., upwards. Hence, unlike one-way flow of water in transpiration, food in phloem sap can be transported in any required direction so long as there is a source of sugar and a sink able to use, store or remove the sugar.
- Phloem sap is mainly water and sucrose, but other sugars, hormones and amino acids are also transported or translocated through phloem.

THE PRESSURE FLOW OR MASS FLOW HYPOTHESIS

- the movement of sugars in the phloem begins at the source, where sugars are loaded (actively transported) into a sieve tube.
- Loading of the phloem sets up a water potential gradient that facilitates the mass movement in the phloem.
- Phloem tissue is composed of sieve tube cells, which form long columns with holes in their end walls called sieve plates.
- Cytoplasmic strands pass through the holes in the sieve plates, so forming continuous filaments. As hydrostatic pressure in the phloem sieve tube increases, pressure flow begins, and the sap moves through the phloem. Meanwhile, at the sink, incoming sugars are actively transported out of the phloem

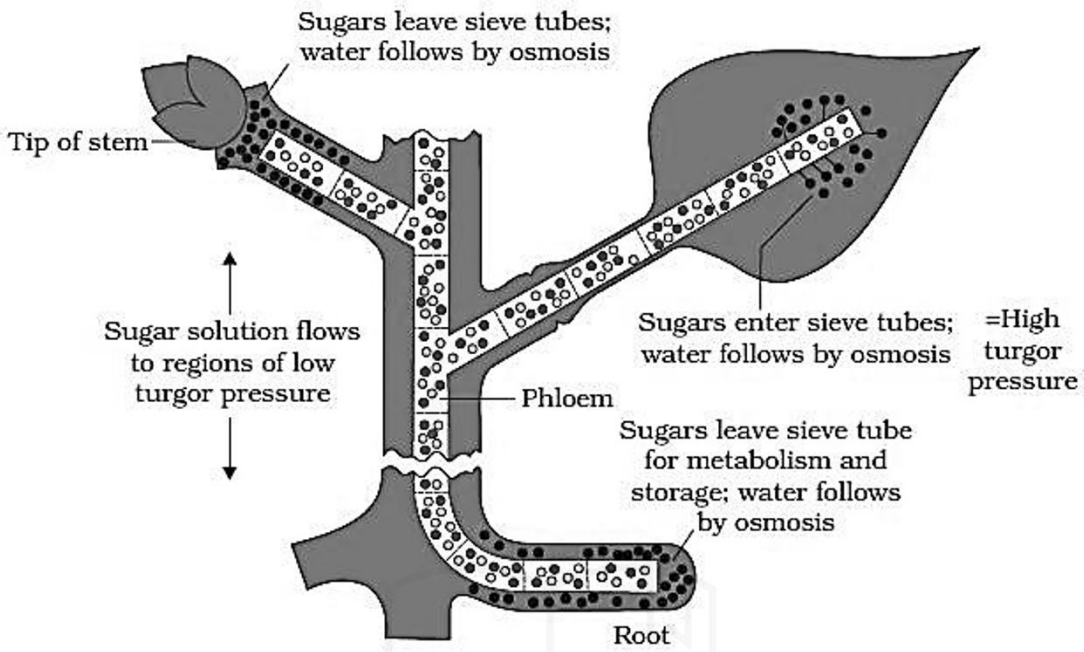


Figure11.10 Diagrammatic presentation of mechanism of translocation

Points to remember

- Plants do not have a regular circulatory system but they need to move or transport various types of substances over short i.e., within the cell, across the membrane &cell to cell or long distances i.e., from root to leaves.
- The long distance transport that occurs through vascular tissues i.e., xylem &phloem is called translocation. It occurs through mass flow
- The porins are the proteins that form the huge pores in the outer membrane of the plastids ,mitochondria and allow molecules of protein size to pass through it. Water channel ate made up of 8 types of **aquaporins** .
- The behavior of plant cells with regard to water movement depends on the surrounding solution that may be of three types:-

1. **Hypotonic solution** has lower osmotic concentration &hence lower osmotic pressure as compared to another solution.
2. **Hypertonic solution** has higher osmotic concentration &hence higher osmotic pressure as compared to another solution.
3. The two solutions with same osmotic concentration or osmotic pressure are termed as **isotonic solution**.

- When water moves in and out of the cell and are in equilibrium the cell are known as **flaccid**

- Plasmolysis process is reversible process
- **A mycorrhiza is a symbiotic association of fungus with a root system** The fungal filament form a netwrok aroumd young route the hyphae have a large surface area that absorb water and mineral from the soil and the fungus provide minerals and water to the roots and root provides sugars and n containing compound to mycorrhiza
- Most of the water flow through the apoplast as the cortical cells are loosely packed and offer no resistance to water movement

- Loss or excretion of water in the form of liquid droplets from the tips &margins of leaves is called guttation. It was first studied by **Bergerstein** in 1887.

IMPORTANT QUESTIONS

1 Marks Questions

Q1 What is the water potential of pure water?

Ans. Zero bars.

Q2 Which part of the root is related with the absorption of water?

Ans. Root hairs.

Q3 What makes the raisins to swell up when kept in water?

Ans. Endosmosis.

Q4 What will happen to water potential when a solute is added to water ?

Ans. Water potential will decrease.

Q5 Mention two ways of absorption of water by root hair in plants.

Ans. Apoplast and symplast pathway.

Q6 What is responsible for transport of food (primarily) sucrose from the source to the sink?

Ans. phloem

Q7 The translocation in phloem is?

Ans. bi-directional

Q8 Name the hypothesis by which translocation in phloem is explained?

Ans. pressure flow hypothesis.

Q9 what are the factors that effect the rate of transpiration?

Ans. Temperature, light, humidity, wind speed and number of stomata affect the rate of transpiration

2 Mark Questions

Q1 What are porins? What role do they play in the diffusion?

Ans. Porins are the kind of proteins that forms the pore of lage sizes in the outer membranes of chloroplast, mithochondria and also in some bacteria, allowing passive transport of small sized protein molecules. Thus porins help in diffusion.

Q2 Explain mycorrhiza is a symbiotic association of fungus with a root system?

Ans. The fungal filament form a network around young route the hyphae have a large surface area that absorb water and mineral from the soil and the fungus provide minerals and water to the roots and root provides sugars and n containing compound to mycorrhiza.

Q3 what is guttation? Who coined this term and in which year ?

Ans. Loss or excretion of water in the form of liquid droplets from the tips &margins of leaves is called guttation. It was first studied by **Bergerstein**in 1887

Q4 explain the two types of pathway system in plants ?

Ans.

- **The apoplast** is the system of adjacent cell walls that is continuous throughout the plant, except at the casparian strips of the endodermis in the roots.
- **The symplast system** is the system of interconnected protoplasts. Neighbouring cells are connected through cytoplasmic strands that extend through plasmodesmata. During symplastic movement, the water travels through the cells – their cytoplasm; intercellular movement is through the plasmodesmata.

Q5 what do you mean by imbibition ?

Ans. Imbibition is a special type of diffusion when water is absorbed by solids – colloids – causing them to enormously increase in volume. The classical examples of imbibition are absorption of water by seeds and dry wood.

3 Mark Questions

Q1 Difference between guttation and transpiration?

Ans.

S. No.	Guttation	Transpiration
1. 2. 3.	Involves in loss of water from leaves in the form of liquid droplets. Occurs in the vein endings of leaves. Occurs usually at night.	Involves in loss of water from leaves in the form of of water vapour. Occurs on surface, stomata, lenticels. Occurs during the day.

Q2 Explain three types of solution?

Ans.

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Q3 What is the role of transpiration?

Ans.

- Creates transpiration pull for absorption and transport of plants.
- Supplies water for photosynthesis.
- Transports minerals from the soil to all parts of the plant.
- Cools leaf surfaces, sometimes 10 to 15 degrees, by evaporative cooling.
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Ans. Osmosis is a process by which molecules of a solvent pass through a semipermeable membrane from a region of higher concentration to the region of lower concentration. The osmotic entry of water into a cell is termed as endosmosis whereas the osmotic potential withdrawal of water from a cell is called as exosmosis. **Osmotic pressure (OP)**is the pressure which needs to be applied to a solution to prevent the inward flow of water across a semipermeable membrane. Osmotic pressure is numerically equal to the osmotic potential or solute potential, but the osmotic potential has a negative a value, while osmotic pressure has appositive value. **Diffusion pressure deficit (DPD)**is the reduction in the diffusion pressure of water in a solution over its pure state. It is also known as **suction pressure**. DPD = OP – WP (=TP).

Q5 Explain facilitated diffusion?

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5 Marks Questions

Q1 Explain why xylem transport is unidirectional and phloem transport is bi-directional?

Ans. Xylem tissues mainly transport water and minerals roots to other plant parts. These water and minerals are utilized by leaves in the process of photosynthesis. Also most of the most of the water is lost through transpiration. Again supplied through the same channel. Hence xylem transport is unidirectional.

Phloem tissues transport the food in plants from source to sink. During the growth its leaves acts a source of food as they carry out the photosynthesis process. The phloem transports the food from leaves to sink. But during early spring when new buds emerge out, the storage organ becomes source. In such a case, a revers food flow is necessary. Thus the movement of food in phloem is bidirectional.

Q2 Elaborate water potential ,solute potential ,turgor pressure,pressure potential ?

Ans. Water potential (Ψw) is a concept fundamental to understanding water movement. Solute potential (Ψs) and pressure potential (Ψ p) are the two main components that determine water potential.Water potential of a cell is affected by both solute and pressure potential. The relationship between them is as follows: Ψw = Ψs + Ψp.$\Psi_{w=}$ water potential, Ψ_m = matric potential, Ψ_S = solute potential &Ψ_P = pressure potentialAt atmospheric pressure, pure water has zero water potential;, in solution the value of water potential is always negative or less than zero as the presence of solute reduces the free energy of water &thus decreases the water potential (negative value).Water always moves from the area of high water potential or low free energy **Solute potential (osmotic potential**) is the amount by which the water potential is reduced as a result of the presence of solute. It always has negative value. The more the solute molecules, the lower is Ψ_w **Hydrostatic pressure (pressure potential)** is the pressure which develops in an osmotic system due to osmotic entry or exit of water from it. A positive pressure develops in a plant cell or system due to entry of water into it, which is called **turgor pressure (TP)**

Q3 Explain the process of transpiration?

Ans. Transpiration is the evaporative loss of water by plants. It occurs mainly through the stomata in the leaves. Besides the loss of water vapour in transpiration, exchange of oxygen and carbon dioxide in the leaf also occurs through pores called stomata. Normally stomata are open in the day time and close during the night. The immediate cause of the opening or closing of the stomata is a change in the turgidity of the guard cells. The inner wall of each

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These properties give water high tensile strength, i.e., an ability to resist a pulling force, and high capillarity, i.e., the ability to rise in thin tubes. In plants capillarity is aided by the small diameter of the tracheary elements – the tracheids and vessel elements. The process of photosynthesis requires water.

CHAPTER 12—MINERAL NUTRITION

Contents

Macronutrients

- Macronutrients are required in large quantities.
- They are present in excessive concentration in plants.
- They are also called as major elements.
- Macronutrients includes minerals and few non-mineral elements as well.
- These includes carbon(C), nitrogen (N), phosphorous (P), sulphur (S), potassium (K), calcium (Ca) and magnesium (Mg).
- They are usually not toxic for plants in case present in excess.

Micronutrients

- Micronutrients are required in less quantity.
- They are present in low concentration in plants.
- They are also called as trace elements.
- All micronutrients are minerals.
- These include iron, manganese (Mn), copper(Cu), molybdenum (Mo), zinc (Zn), boron (B), chlorine (Cl) and nickel (Ni).
- They can be toxic for plants if present in excess.
- Macronutrients and micronutrients are jointly divided into two major groups. Hence we can also say that nutrients are categorised into two parts again which is **essential** and **non essential elements**.

Essential elements

- Essential elements are a group of elements which cannot be synthesized by the body.
- Example: Oxygen (O), Hydrogen (H), Nitrogen (N)
- Absence of these elements leads to death or severe malfunction.

Non-Essential elements

- Nonessential elements are another group of elements that our body can synthesize.
- Example: bromine, boron, silicon, argon, nickel, aluminium.
- Absence of these elements does not affect much.

Mineral Nutrients and its Functions

Nitrogen

Important constituent of nucleic acid, protein, hormones and vitamins. It is absorbed mainly as NO_3^- though some are also taken up as NO_2^- or NH_4^+

Phosphorus

Promotes root growth and fruit ripening. Absorbed by the plants from soil in the form of phosphate ions (either as $H_2PO_4^-$ or HPO_4^{2-}).

Potassium

It acts as an activator for several enzymes. It is absorbed as potassium ion (K^+).

Calcium

Facilitates the formation of middle lamella of plants and acts as an enzyme activator. Plant absorbs calcium from the soil in the form of calcium ions (Ca^{2+}).

Magnesium

Plays a vital role in the metabolism of carbohydrates, lipids. It is absorbed by plants in the form of divalent (Mg^{2+}).

Sulphur

Major constituent of amino acids and vitamins. Plants obtain sulphur in the form of sulphate (SO_4^{2-}).

Iron

Plays an important role in the energy conversion reaction reactions of respiration and photosynthesis, activates nitrate reductase and aconitase. Plants obtain iron in the form of ferric ions (Fe3+).

Manganese

Essential for chlorophyll synthesis, initiate photolysis of water. It is absorbed in the form of manganous ions (Mn2+).

Zinc

It helps in various enzyme activation and also helps in auxin synthesis.Plants obtain zinc as Zn2+ ions.

Copper

Plays an important role in photophosphorylation. It is absorbed as cupric ions (Cu2+).

Boron It is essential for cell elongation, differentiation and carbohydrate relocation. It is absorbed as BO_3^{3-} or $B_4O_7^{2-}$

Molybdenum

It helps in the synthesis of ascorbic acid. Plants obtain it in the form of molybdate ions (MoO_2^{2+}).

Chlorine

Helps in the photolysis of water in photosystem-II. It is absorbed in the form of chloride anion (Cl^-).

Deficiency of Mineral Nutrients

- The concentration of the essential element below which plant growth is retarded is termed as critical concentration. in the absence of any particular element, plants show certain morphological changes.
- These morphological changes are indicative of certain element deficiencies and are called deficiency symptoms .The deficiency of major mineral nutrients are given below: