

Unit 8: Plant Physiology

Short Questions

SHORT ANSWER QUESTIONS EXERCISE

Q1. Differentiate between macronutrients and micronutrients in plants?

Ans.

Macronutrients	Micronutrients
• Macronutrients are needed in relatively larger amounts in plants for growth and development. • There are nine macronutrients in plants i.e., carbon, hydrogen, oxygen, nitrogen, potassium, calcium, phosphorus, magnesium and sulphur.	• Micronutrients are needed in very smaller amounts in plants for growth and development. • There are seven micronutrients i.e., iron, manganese, zinc, molybdenum, copper, chlorine and boron.

Q2. What is water potential?

Ans. Water molecules possess kinetic energy which means that in liquid or gaseous form they move about rapidly and randomly from one place to another. So, greater the concentration of the water molecules in a system the greater is the total kinetic energy of water molecules. This is called water potential $\psi = \Psi_w$.

Factors: In plant cells, two factors determine water potential i.e., Solute potential (Ψ_s) and Pressure potential (Ψ_p).

Pure water has maximum water potential which by definition is zero. Water moves from a region of higher Ψ_w to lower Ψ_w .

Q3. What are the main three pathways for the movement of water between plant cells?

Ans. 1. The Apoplast Pathway

It is a continuous pathway that involves a system of adjacent cell walls in the plant roots. The apoplast pathway becomes

discontinuous in the endodermis in the roots due to the presence of Casparian segments.

2. The Symplast Pathway

In symplast pathway, water and minerals move through interconnected protoplasts of root cells. The protoplasts of neighbouring cells are interconnected through **plasmodesmata**, which are cytoplasmic strands that extend through pores in adjacent cell walls. The symplast

pathway is less important, except for minerals in the region of endodermis

3. The Vacuolar Pathway

In vacuolar pathway, water and minerals move through cell membranes, cytoplasm and tonoplast (membranes of vacuoles) and vacuoles. They move from vacuole to vacuole and bypass the symplast and apoplast pathways. Movement in vacuolar pathway is negligible.

Q4. Differentiate between hypertonic and hypotonic solution.

Ans.

Hypotonic Solution	Hypertonic Solution
- A solution having reduced solute concentration relative to the intracellular environment of a cell. - As a result, water enters the cell by osmosis resulting in the swelling.	- A solution having high solute concentration relative to the intracellular environment of a cell. - As a result, water moves out of the cell which causes the cell to shrink due to loss of water, a condition called plasmolysis.

Q5. What are halophytes?

Ans. Halophytes are the plants that inhabit in saline soil with high concentrations of salts like NaCl, MgCl₂, MgSO₄, or saline water. On such a substratum, only such plants can grow which can tolerate a relatively high concentration of these salts.

Succulent leaves: These plants have succulent leaves and sometimes the stem is also succulent. In certain cases, leaves are modified into spines.

Examples of halophytes are sea arrow grass and sea lavender.

Q6. Differentiate between long day plants and short day plants?

Ans.

Short-day plants	Long-day plants
The plants in which flowering induced by dark periods longer than a	The plants in which flowering induced by dark periods shorter than a

critical length, e.g., cocklebur 8.5h; tobacco 10-11h. Examples include cocklebur (<i>Xanthium</i>), chrysanthemum soyabean, tobacco, strawberry.	critical length, e.g., henbane 13h. Examples include henbane (<i>Hyoscyamus niger</i>) Snapdragon, cabbage, spring, wheat, spring barely.
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Q7. Write down the phases of plant growth?

Ans. 1. **Cell Division:** The cells of apical meristems undergo divisions and the number of cells is increased.

2. **Cell Elongation:** After the formation of new cells, their volume increases due to uptake of water.

3. **Cell Differentiation:** After the cells have got their final size and shape, elongation stops and cells are specialized to perform specific functions.

Q8. Differentiate between vernalin and florigen.

Ans.

Vernalin	Florigen
Vernalin is a hormone which induces vernalization which is a process in biennial and perennial plants to stimulate flowering by exposure to low temperature (4 days to 3 months).	Florigen is a hormone produced in leaves in response to different concentration of P_{730} ; it travels through phloem to floral buds initiating flowering.

Q9. Differentiate between Thigmotropism and Geotropism?

Ans.

Thigmotropism	Geotropism
- It is the movement in response to stimulus of touch. When they come in contact with some solid object, the growth on the opposite side of contact increases and the tendril coils around the support. - For example climbing vines.	- It is the movement of plant parts in response to gravity. - For example, roots display positive geotropism and shoots show negative geotropism.

Q10. How intercalary meristem is different from apical meristem?

Ans.

Apical Meristems	Intercalary Meristems
- Apical meristems are found at the tips of roots and shoots. - They are primarily responsible for the extension of the plant body. These are perpetual growth zones found and are responsible for the increase in the number of cells at the tips of roots and stems. They play an important role in primary growth.	- The type of meristem situated at the base of internodes. - They are actually the part of apical meristem, which are separated by permanent tissues. - Play an important role in the production of leaves and flower, and are of temporary nature.

SLO BASED SHORT QUESTION ANSWERS

Nutrition in Plants

Q11. Differentiate between nutrient and nutrition.

Ans.

Nutrient	Nutrition
- A nutrient is a substance that provides the body with essential ingredients required for metabolism. - Specific nutrients, such as carbohydrates, lipids, and proteins, serve as sources of energy.	- Nutrition refers to the collective processes involved in the intake and utilization of nutrients for growth, repair, and maintenance of activities in an organism. - It is of two types i.e. autotrophic and heterotrophic nutrition.

- Other nutrients, including water, electrolytes, minerals, and vitamins, are necessary for the metabolic process.

Q12. What are the roles of Nitrogen and Magnesium in plant? Also describe effects of their deficiencies.

Ans. Role of Nitrogen

- **Nitrogen** is necessary for plant growth as it plays an essential role in energy metabolism and the production of proteins.
- **Deficiency of nitrogen:** A deficiency of nitrogen results in leaf loss and stunted growth.

Role of Magnesium

- **Magnesium** constitutes the core of the chlorophyll molecule and is therefore essential for photosynthesis.
- It promotes the absorption and transportation of phosphorus and also contributes to the storage of sugars within the plant.
- **Magnesium deficiencies** result in weak stalks, loss of greenness in the oldest leaves, and the appearance of yellow and brown spots.

Q13. Describe the roles of phosphorous and potassium in plant growth.

Ans. Role of Phosphorus

- **Phosphorus** is a part of ATP. It also plays a role in promoting root growth and favours flowering in the aerial zone.
- **Deficiency of phosphorus:** A deficiency of phosphorus leads to delayed flowering, as well as the browning and wrinkling of the leaves.

Role of Potassium

- **Potassium** is involved in water regulation and the transportation of the plant's reserve substances.
- It enhances the ability of plants to carry out photosynthesis, reinforces

cellular tissue, and stimulates the uptake of nitrates.

- **Deficiency** results in dark patches on the leaves.

Q14. What are effects of deficiencies of calcium and sulphur?

Ans. Effect of Calcium Deficiency

- Calcium provides stability to the cell wall and promotes the development of the cell wall.
- It also plays a role in cellular proliferation and maturation, and aiding in the development of seeds.
- **Insufficient calcium** leads to the development of yellow and brown patches on the leaves.

Effect of Sulfur Deficiency

- Sulfur is a fundamental element in the metabolism of nitrogen.
- If there is a **shortage of sulfur**, the plant becomes lighter in colour.

Q15. How iron and manganese are important to plants?

Ans. Importance of Iron

Iron is essential for the synthesis of chlorophyll. It acts as a cofactor for several enzymes which are involved in energy transfer and nitrogen metabolism.

Deficiency: Its deficiency results in interveinal chlorosis.

Importance of Manganese

Manganese is involved in the process of photosynthesis, nitrogen metabolism, carbohydrate metabolism and activation of enzymes.

Deficiency: Its deficiency results in the premature falling of the leaf and delayed maturity.

Q16. How does zinc and molybdenum are critical in plant growth?

Ans. Zinc

- **Zinc** facilitates chlorophyll synthesis, root development and uptake of nutrients.
- **Deficiency** of zinc can lead to stunted growth.

Molybdenum

- **Molybdenum** is critical for nitrogen fixation, nitrogen reduction, sulfur metabolism, phosphorus metabolism and iron utilization.
- **Deficiency:** Its deficiency can result in chlorosis of older leaves and stunted growth.

Q17. How does zinc and chlorine deficiencies manifest in plants?

Ans. Zinc

- **Zinc** facilitates chlorophyll synthesis, root development and uptake of nutrients.
- **Deficiency** of zinc can lead to stunted growth.

Chlorine

- **Chlorine** is involved in stomatal regulation, osmotic adjustment and transport of nutrients.
- **Deficiency:** Its deficiency can affect the health and growth of plants.

Q18. All insectivorous plants are true autotrophs then why does they capture insects?

Ans. Insectivorous plants supplement organic molecules into their food in addition to inorganic nutrients, acquired through the process of capturing and breaking down insects and tiny animals.

- All insectivorous plants are true **autotrophs**. However, their development accelerates when they capture prey.
- Apparently, nitrogenous compounds of animal body are of benefit to these plants.

The captured insects are broken down by enzymes that are released by the leaves.

- Pitcher plant, venus fly trap and sundew are some of the known insectivorous plants.

Q19. How does pitcher plant kill insects?

Ans. Pitcher plant has leaves modified into a sac or a pitcher, partly filled with water.

- The leaf's terminal portion is altered to create a **hood**, which partially covers the exposed opening of the pitcher.
- It has numerous **stiff hairs** that prevent little insects from crawling out once they fall inside it.

Q20. How does venous fly trap is adapted to fulfil its nitrogen requirements?

Ans. Venus-fly trap has a "trap" consisting of two lobes that are hinged at the end of each leaf. The inner surfaces of the lobes contain **trichomes**, which are hair-like projections that trigger the lobes to close rapidly upon contact with prey.

- The hinged traps are lined with fine bristles that interlock upon closure, preventing the prey from escaping.
- The trapped insect is then digested by the enzymes secreted from the glands on the leaf surface and the products are then absorbed.

Q21. Which plants use/release odour to trap its prey?

Ans. Sundew catches its prey with shiny drops of "dew," where the plant's common name comes from. The leaves are covered with tiny hairs that look like tentacles.

- Each leaf has gland and has a single dew-like drop at the tip.
- The insects, attracted by plant's odour are trapped by tentacles.
- The trapped insects are digested by enzymes and products are absorbed.

Gas Exchange in Plants

Q22. Define stomata. Write their function.

Ans. Stomata are tiny opening or pores present within the plant tissues which are necessary for gaseous exchange.

- These are typically found in leaves but can even be present in some stems.
- The stomata are surrounded by specialized cells or the guard cells that facilitate the opening and closing of the stomatal pores.
- Guard cells are **bean-shaped** and contain chloroplasts.
- Guard cells can open and close depending on environmental conditions. The opening and closing of stomata control the transpiration rate in plants.

Q23. How are stomata involved in gaseous exchange?

Ans.

- **During daylight** stomata open to allow CO_2 to enter the plant for photosynthesis. The opening of stomata is primarily regulated by guard cells.
- **At night** when photosynthesis ceases due to lack of light, stomata typically close to conserve water. However, plants still respire, taking in O_2 and releasing CO_2 . The closure of stomata at night helps to minimize water loss by transpiration.

Q24. Guard cells function as multisensory hydraulic valves justify.

Ans. Guard cells functions as multisensory hydraulic valves as they open and close in response of certain environmental factors like light, CO_2 and humidity.

- They change shape due to water potential and release excess water through transpiration.

Q25. Brief about starch sugar hypothesis.

Ans. Starch Sugar Hypothesis

In 1856, German botanist H. Van Mohl proposed that guard cells in leaf epidermis are solely responsible for photosynthesis, producing sugars during the day. During day time as sugar concentration increases in guard cells, the water potential drops.

- Water moves into guard cells causing them to become turgid and open the stomata.
- At night, photosynthesis ceases, and sugars are converted to insoluble starch or used for respiration, leading to a decline in free sugars. Consequently, water moves out of guard cells and they lose turgor pressure. So, they become flaccid and close the stomata.

Q26. How does K^+ ions facilitate opening and closing of stomata? Also describe role of blue light in K^+ -influx.

Ans. The opening of stomata in plants is facilitated by the active transport of potassium ions (K^+) into guard cells, which reduces their osmotic potential. This influx of K^+ leads to water entering the guard cells through osmosis, causing them to become turgid and open the stomata.

- **Blue light enhances** this process by acidifying the surrounding environment, promoting K^+ uptake and subsequent water absorption.
- **At night**, K^+ passively diffuses out of the guard cells, resulting in water loss and causing the guard cells to become flaccid, thereby closing the stomata.

★Q27. How does abscisic acid overrides the effect of light and CO_2 in stomatal movements?

Ans. Hormones are involved in stomatal movement in plants during stress conditions. At high temperature when leaf cells start

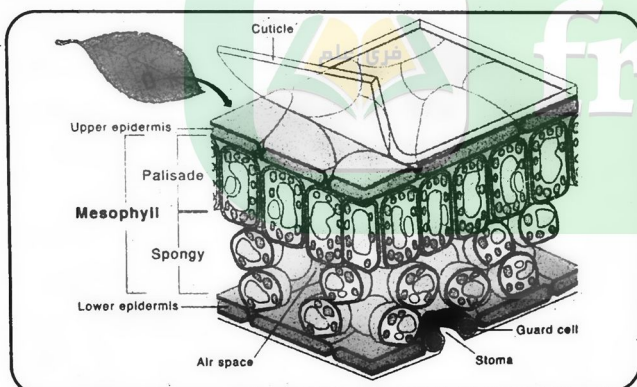
wilting, a hormone called abscisic acid, is released by mesophyll cells. This hormone stops the active transport of K^+ into guard cells, overriding the effect of light and CO_2 concentration. So, K^+ pumping stops and stomata close.

Q28. Describe the location of palisade tissue. How the arrangement of their cells maximize light absorption and gaseous exchange?

Ans. Palisade tissue is primarily located just beneath the upper epidermis of the leaf. It consists of elongated, tightly packed cells that are rich in chlorophyll. The arrangement of these cells is organized to maximize light absorption and allowing plants to efficiently convert light energy into chemical energy.

Q29. Draw the sketch of structure of leaf.

Ans.



Support in Plants

Q30. Define tonoplast. How does it maintain turgor pressure / rigidity of cells?

Ans. The membrane that surrounds the vacuole is called the **tonoplast**. It has many active transport mechanisms that move ions into the vacuole, even when the concentration within the vacuole is higher than that of the surrounding fluid.

- Due to the elevated ionic concentration, water is drawn into the vacuole, resulting in turgidity and providing mechanical support to the plant's soft tissues.

Q31. How does parenchyma provide support in plants?

Ans. The parenchyma tissue provides support to herbaceous plants and parts of larger plants.

- The parenchyma cells of the epidermis, cortex, and pith absorb water. This water creates an internal hydrostatic pressure known as **turgor pressure** that maintains the rigidity of cells.

Turgor pressure arises from the elevated osmotic pressure within the cell vacuole.

Q32. Describe the role of collenchyma tissue in context of support.

Ans. Collenchyma cells are specialized cells that are grouped in the form of strands or cylinders.

- They are found beneath the epidermis of young stems, leaf stalks and along the veins in leaves.
- Collenchyma cells lack secondary walls.
- Their primary walls are thickened at the corners, due to extra deposition of cellulose.
- They elongate when stem or leaf grows lengthwise. They provide support to the young parts of plant in which secondary growth has not taken place.

Q33. Sclerenchyma confer strength and rigidity to the cell walls of plants.

Ans. Sclerenchyma

This tissue also provides structural support to the plants. Typically, the cells of sclerenchyma tissue possess thick secondary cell walls.

- These walls are saturated with lignin, an organic compound that confers strength and rigidity to the walls.
- The majority of sclerenchyma cells are non-living.
- The main function of this tissue is to provide support to the various components of the plant.

Q34. Name the types of sclerenchyma cells and describe their roles.

Ans. There are three types of sclerenchyma cells which are fibres, sclereids and vessels.

1. Fibers (Tracheids) are elongated and cylindrical in shape. They can be found either as compact bundles inside the xylem or as bundle caps.

2. Sclereids are smaller in size as compared to fibers and are present in the seed coats and shells of nuts. Their function is to offer protection.

3. Vessels (Tracheae) are long tubular structures that are joined end to end to form a long water conducting pipe in xylem.

Water Potential

Q35. Differentiate between solute potential and pressure potential.

Ans.

Solute Potential	Pressure Potential
- The solute potential or osmotic potential is a measure of the change in water potential (Ψ_w) of a system due to the presence of solute molecules. Ψ_s is always a negative value, so if more solute molecules are present, lower (more negative) is the Ψ_s.	- It is the part of water potential which is due to the pressure exerted by water it is denoted by Ψ_p. If pressure greater than atmospheric pressure is applied to pure water or a solution, its water potential increases. - When water enters plant cells by osmosis, pressure may be built up inside the cell making the cell turgid and increasing the pressure potential

Transport of Water in Plants

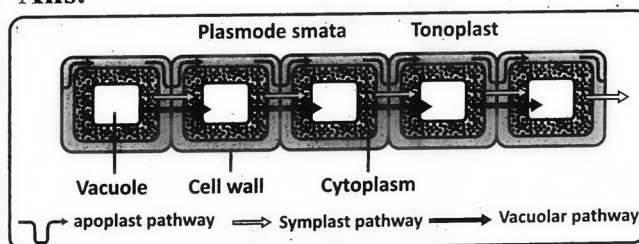
Q36. Describe the role of roots and root hairs for efficient transport of water from soil to xylem. Enroute water from soil to xylem.

Ans. Roots of plants provide large surface area for absorption by their extensive branching systems. Roots have tiny root hairs, which are actually extensions of epidermal cells of roots. Most of the uptake of water and minerals in roots takes place through root hairs.

From soil, water and minerals enter the root epidermal cells by active and passive transport. From root epidermis, they move to cortex, and then into the xylem tissue in the centre of root. Inside roots, water and minerals move in three different pathways to reach the xylem.

Q37. Draw the sketch show transport of sap using different pathways.

Ans.



Q38. Name the structural components of xylem tissue.

Ans. Following are the structural components of xylem tissue:

1. Tracheids
2. Vessels
3. Xylem fibres
4. Xylem parenchyma

Q39. Compare tracheids with vessels.

Ans.

Tracheids	Vessels
- Tracheids are elongated thin cells that have thick walls made of lignin. - The ends of the cells are tapered and they are linked to each other by bordered pits, which enable the lateral movement of water between cells.	- Vessels are shorter and broad compared to tracheids. They are arranged in a linear fashion, forming continuous channels. - Perforation plates are present at the outer edges of these structures, enabling efficient movement of water.

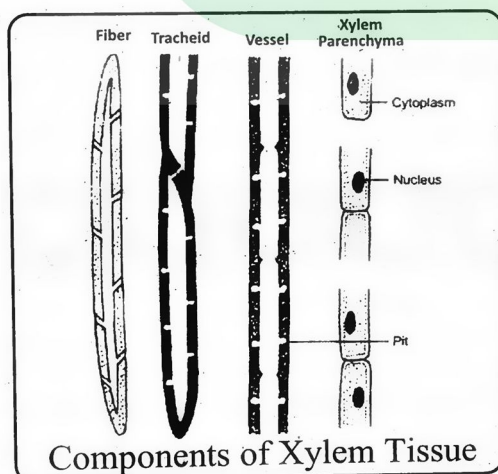
Q40. Characterize xylem fibres and xylem parenchyma.

Ans.

Xylem Fibres	Xylem Parenchyma
Xylem fibres are elongated cells with thickened lignified walls. At maturity, they are dead and enhance the structural integrity of the xylem. They offer additional structural support to the plant	Xylem parenchyma are living cells with thin walls that have the ability to retain and hold nutrients and water. Xylem parenchyma cells participate in the lateral translocation of water and nutrients and can also contribute to the healing and regeneration of xylem tissue.

Q41. Draw the diagrams showing different structural components of xylem tissue.

Ans.



Q42. Transpiration act as the primary driving force behind water transport in xylem. Justify.

Ans. Transpiration is the process by which water evaporates from the surface of plant leaves, specifically through stomata. As water vapour exits the leaf, a **negative pressure** is generated within the leaf tissue.

- This negative pressure creates a pulling force, drawing water upward from the roots through the stem and toward the leaves.
- Transpiration, therefore, act as the primary driving force behind water transport in the xylem.

Q43. Compare the roles of different forces of attraction involved in transpiration. / Compare the roles of adhesive forces and cohesive forces in movement of water.

Ans.

Adhesion	Cohesion
Adhesion is the attraction between water molecules and the walls of the xylem vessels.	Cohesion refers to the attractive force between water molecules themselves, caused by hydrogen bonding.

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| <ul style="list-style-type: none"> • Due to this attraction, water molecules stick to the walls of xylem vessels as they move upward. This property prevents any break in the water column within xylem. • Adhesion thus play a crucial role in maintaining the continuity of the water column, especially in tall plants where gravity exerts a significant downward force on the water column. | <ul style="list-style-type: none"> • Water molecules within the xylem stick together, forming an unbroken column from the roots to the leaves. • This cohesive property of water ensures that the “pull” initiated by transpiration at the leaf level extends down through the entire water column. |
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Q44. Tension is vital for the continuous ascent of water within xylem justify.

Ans. **Tension** is the negative pressure created by the pulling force of the transpiration at the leaf level. As water evaporates from the leaf surface, it creates a low-pressure area that extends through the xylem. This tension pulls the cohesive water column upwards. Tension is therefore vital for the continuous ascent of water within the xylem.

Translocation of Food

Q45. What do you know about TACT theory?

Ans. The TACT (Transpiration, Adhesion, Cohesion, Tension) also known as cohesion-tension theory, is a widely accepted model explaining how water moves against gravity through the xylem to reach all parts of the plant. This mechanism depends on both physical and chemical properties of water and the plant's interaction with its environment.

Q46. Enlist the structural components of phloem.

Ans. Phloem comprises of four major components

- Sieve elements
- Companion cells
- Phloem fibres
- Phloem parenchyma.

Q47. Write few lines about phloem tissue?

Ans. Phloem Tissue

- Phloem is a **vascular tissue** in plants responsible for the transport of organic nutrients, particularly the products of photosynthesis, from the leaves to other parts of the plant where they are needed or stored.
- The phloem is generally found on the **outer side** of both primary and secondary vascular tissue in plants with secondary growth and constitutes the inner bark.

Q48. Describe the importance of sieve tube elements in transport of sugars.

Ans. The cells of phloem that transport sugars and other organic material throughout the plant are called **sieve tube elements or cells**. Sieve tube elements have '**sieve areas**', which are the portions of the cell wall where pores interconnect the sieve tube elements. Sieve tube elements join to form long sieve tube, which is used to transport food from source to sink.

Q49. Which substances are stored in phloem parenchyma?

Ans. Phloem parenchyma stores substances, such as sugars, resins, latex, and mucilage, which are important for plant defence and moisture retention.

Translocation of Food in Plants

Q50. Which passive theories were proposed for transport in phloem? Which theory is most widely accepted?

Ans. Passive theories of phloem transport include: Diffusion and pressure flow theory. The pressure-flow theory, also known as the mass-flow hypothesis, is the most widely accepted explanation for the transport of sugars in plants through the phloem. This process of translocation moves sugar from the **source** (where they are synthesized) to the **sink** (where they are consumed or stored). This theory was proposed by **Ernst Munch** in **1930**. This theory relies on the principle of osmotic pressure differences between source and sink regions.

Q53. How intercalary meristem is different from apical meristem?

Ans.

Apical Meristem	Intercalary Meristem
- The type of meristem that are found at the tips of roots and shoots. - They are primarily responsible for the extension of the plant body. These are perpetual growth zones found and are responsible for the increase in the number of cells at the tips of roots and stems. - They play an important role in primary growth.	- The type of meristem situated at the base of internodes. - They are actually the part of apical meristem, which are separated by permanent tissues. - Play an important role in the production of leaves and flower, and are of temporary nature.

Q54. Characterize lateral meristem. Describe its main forms.

Ans. **Lateral meristems** are cylinders of dividing cells present along the peripheral regions. They are responsible for growth in thickness of stems and roots. They are found in woody plants and are crucial for secondary growth.

- There are two main forms of lateral meristems; vascular cambium and cork cambium.

Growth in Plants

Q51. What are growth pattern in plants?

Ans. Growth in plants refers to a permanent increase in size, which can occur in various dimensions such as height, width, and mass.

- Throughout life, the plant adds organs such as branches, leaves, and roots. Its organs increase in size from the tips but the rate of growth is not uniform throughout the body.

Q52. What are meristems? Give their types.

Ans. In higher plants, growth is limited to certain regions known as **growing points**. These growing points consist of groups of cells, called **meristems**, that are capable of continuous cell division.

- There are three types of meristems in plants i.e., **apical meristem**, **intercalary meristem** and **lateral meristem**.

- Vascular cambium** is located between the xylem and phloem and is responsible for production of secondary xylem and secondary phloem.
- Cork cambium** is formed in the outer layer of stems and roots. This tissue produces cork cells which replace the epidermis and forms the outer protective bark.

Q55. Define primary growth. Name its phases.

Ans. Primary growth is responsible for an increase in the length of the plants. It is facilitated by the activity of apical meristems. Herbaceous plants generally display primary growth with little secondary growth as compared to woody plants.

The process of primary growth in plants occurs in three phases.

1. Cell Division
2. Cell Elongation
3. Cell Differentiation

Q56. Describe the events of zone of cell division.

Ans.

- The cells of apical meristems undergo divisions and the number of cells is increased.
- It happens at the tips of apical meristems of root and shoot. The area of apical meristem where cell division occurs, is called **zone of cell division**.
- In this zone, cells are non-vacuolated and small. These cells have spherical nuclei in the centre of cytoplasm.

Q57. Describe the changes associated with cell elongation phase.

Ans.

- During elongation phase volume of cell increases due to uptake of water.
- Plasticity of cell wall increases and wall pressure is reduced. It happens at a little distance from the tips of apical meristems.
- The area where cell elongation occurs, is called **zone of cell elongation**. In this zone, cells are vacuolated and large. They have **nuclei in the peripheries** of cytoplasm.
- During this phase, different cells elongate in different dimensions and the final size of cells is attained.
- For example, the cells which are determined to develop into pith, cortex etc.

do not elongate much length-wise while the cells which are determined to develop into xylem tissue elongate more length-wise.

Q58. What happens after the cells got their final size and shape during primary growth? / Describe the final changes in plants during primary growth.

Ans. Cell Differentiation: After the cells have got their final size and shape, elongation stops and cells are specialized to perform specific functions, thus is termed as phase of cell differentiation.

- Their cell walls become thicker and many new structural features develop.
- It happens in the area next to the zone of elongation. This area is called zone of cell differentiation.
- In this zone, cells are fully differentiated and each type of cell performs specific function.

Q59. Define secondary growth. Which tissue/ cells are responsible for it?

Ans. Secondary growth refers to the increase in thickness or girth of stems and roots. It is due to the activity of lateral meristems, specifically the vascular cambium and cork cambium. It is more prominent in woody perennial plants, while herbaceous plants show only primary growth. The cells of vascular cambium divide and produce new cells on both of its outer and inner margins.

Q60. Secondary tissues cause increase in plants thickness. Justify.

Ans.

- Secondary tissues (particularly secondary xylem) cause increase in plant's thickness.
- The cells of vascular cambium divide and produce new cells on both of its outer and inner margins of vascular cambium make secondary phloem while the cells

produced on its inner margins make secondary xylem.

- Division in cork cambium produces cells on both outer and inner sides. The cells make new cork.

Q61. Define bark and annual rings.

Ans. Bark: The region of mature stem outside of the vascular cambium, which contains **secondary phloem, cork cambium and cork**, is collectively called **bark**.

A concentric layer of wood formed each year in woody plants is called annual ring. **Annual rings** are formed due to the seasonal activity of the cambium layer in trees. These rings provide valuable information about the age of the tree and the environmental conditions experienced during each growing season.

Q62. What is cambium? Describe the effect of seasonal changes on its activity and formation of annual ring?

Ans. The cambium is a meristematic tissue that generates new vascular tissues i.e., xylem and phloem.

- **In spring:** In spring, when conditions are favourable, the cambium is highly active, producing a large volume of xylem with wider vessels, resulting in lighter-coloured spring wood.
- **In autumn:** As the season changes to autumn, the cambium's activity decreases. It produces fewer xylem elements, which are narrower and denser, leading to the wood forms a complete annual ring.

★Q63. Define dendrochronology and its importance.

Ans. Dendrochronology is the scientific method of dating and studying tree rings to analyze past climate conditions and events.

Q64. What are plant growth regulators? Name their five major groups.

Ans. Plants regulate the rates of growth and the rate of metabolism in their cells. Special chemical messengers, called plant growth regulators or **plant hormones** regulate their growth. There are five major groups of plant growth regulators i.e., auxins, cytokinins, gibberellins, abscisic acid, and ethylene.

Q65. Describe some important roles of Auxins/Indole Acetic Acid.

Ans. Auxin (IAA) is one of the most important plant growth regulator it:

1. Promotes cell division in **cambium**.
2. In **roots**, promote growth at very low concentrations. Inhibit growth at higher concentrations, e.g., geotropism. Promote growth of roots from cuttings and calluses.
3. Promotes **bud initiation** in shoots but sometimes antagonistic to cytokinins and is inhibitory.

Q66. Where are gibberellins produced? Describe their important activities.

Ans. Gibberellins are produced in apical portions of roots and shoots and transported to other parts.

- Promote cell enlargement in the presence of auxins. Also promote cell division in apical meristem and cambium.
- Promote 'bolting' of some rosette plants.
- Promote bud initiation in shoots of chrysanthemum callus.
- Sometimes may substitute for red light. Therefore, promote flowering in long-day plants, while inhibit in short-day plants.

Q67. Why are cytokinins important for plant growth?

Ans. Cytokinins are usually produced in roots, young fruits and in seeds.

Cytokinins **promote cytokinesis** during cell division. They increase the rate of **DNA replication** and the rate of **RNA** and protein

synthesis. They perform the following functions:

- Promote stem growth by cell division in apical meristem and cambium.
- Inhibit primary root growth.
- Promote lateral root growth.

Q68. Describe the effects of abscisic acid on plant stem, roots flowering and stomata.

Ans. Abscisic acid (ABA) is synthesized mainly in mature green leaves, fruits and root caps. It performs the following functions:

- Inhibits stem and root growth notably during **physiological stress** e.g., drought and waterlogging.
- Promotes bud and seed dormancy.
- Promotes **flowering in short day plants** and inhibits in long day plants (antagonistic to gibberellins).

Q69. How does Ethene/ethylene support the plants during physiological stress?

Ans. It is a natural product of the metabolism of plants. **Inhibits** stem growth, notably during **physiological stress**.

- **Inhibits root growth**
- Breaks root growth
- Promotes **flowering in pineapple**
- Promotes **fruit ripening**.

Osmoregulation in Plants

Q70. Define osmoregulation. How osmoconformers differ from osmoregulators?

Ans. **Osmoregulation** refers to the process by which an organism maintains a stable internal equilibrium of water and dissolved substances, irrespective of the surrounding environmental conditions.

- **Osmoconformers:** Many marine organisms undergo osmosis without the requirement for regulatory systems since their cells have the same osmotic pressure

as that of the sea are called osmoconformers.

- **Osmoregulators:** Organisms must actively acquire, retain, or eliminate water or salts in order to regulate their internal water and mineral balance are called osmoregulators.

Q71. Define hydrophytes. How are freshwater hydrophytes adapted to live in water?

Ans. Hydrophytes: These are the plants adapted to aquatic environments (marine and freshwater) by specialized mechanisms of osmotic adjustments.

Freshwater hydrophytes grow in hypotonic environments, where water continuously enters their cells.

- These plants remove excess water through structures like hydathodes or vacuoles to avoid overhydration.
- They actively absorb essential ions, such as potassium and calcium, to maintain osmotic balance and compensate for the dilute surroundings.
- With thin or absent cuticles, these plants facilitate water exchange and often have reduced root systems, relying on direct nutrient and water absorption from their environment.

Examples of hydrophytes are water lilies, lotus, seaweeds and tape grass.

Q72. How plants maintain osmoregulation in moderate environments?

Ans. Mesophytes live in moderate environments that are neither too dry nor too wet.

- They prefer soil that is not waterlogged and has a moderate salt content and humidity.
- Mesophytes have well-developed roots and shoots with a fully formed vascular system.

- They do not require any special adaptations to survive.
- Their leaves are flat, broad, and green with stomata on the surface.
- **Examples** of mesophytes include rose, tomatoes, and daisies.

Q73. How plants are adapted to live in dry conditions? / Describe the adaptations in succulents to reduce transpiration.

Ans. **Xerophytes** are plants that are adapted to survive in dry conditions.

- They have special adaptations to minimize water loss and store water.
- Plants that store water are known as **succulents**.
- They possess fleshy stems that can store water and used when needed.
- Other adaptations in xerophytes include waxy coatings on leaves to reduce water loss, leaf dropping during dry periods, and leaf folding or repositioning to absorb sunlight efficiently.
- **Examples** of xerophytes include thorn trees, desert marigold, and blue agave.

Q74. Differentiate between marine hydrophytes and halophytes.

Ans.

Marine Hydrophytes	Halophytes
• Marine hydrophytes thrive in saline (hypertonic) conditions, where water tends to leave their cells. • They excrete excess salts using specialized salt glands and synthesize organic solutes like proline, glycine, betaine, and sugars to retain water by increasing their internal osmotic potential. • They have thick cuticles which further reduce water loss, and they exhibit halophytic traits to tolerate high salinity.	• Halophytes inhabit saline soil with high concentrations of salts like NaCl, MgCl₂, MgSO₄, or saline water. • On such a substratum, only those plants can grow which can tolerate a relatively high concentration of these salts. These plants have succulent leaves and sometimes the stem is also succulent. • In certain cases, leaves are modified into spines. Examples of halophytes are sea arrowgrass and sea lavender.

★Q75. What are Helophilous?

Ans. Halophytes growing in marshy places near seashore form a special vegetation known as the mangrove or tidal woodland. These are also called **helophilous** halophytes.

Thermoregulation in Plants

Q76. How plants are adapted to survive in heat stress? / What are heat-shock proteins?

Ans.

- High temperature **denatures** the **enzymes** and damages the metabolism.

- Plants use **evaporative cooling** to cope with high temperature. Hot and dry weather, however, causes water deficiency resulting in closing of stomata, thus plants suffer in such conditions.
- Most plants have **adapted** to survive in heat stress as the plants of temperate regions face the stress of **40°C** and **higher** temperature.
- The cells of these plants synthesize large quantities of special proteins called **heat-shock proteins**.

- These **proteins embrace** enzymes and other proteins thus help to prevent their denaturation.

Q77. Low temperature alters the fluidity of the cell membrane, how come plants of these regions are adapted?

Ans. Low temperature

- Low temperature alters the fluidity of the cell membrane, because lipids of the membrane become locked into crystalline structures, which affects the transport of the solutes. The structure of the membrane proteins is also affected.
- Plants respond to cold stress by **increasing proportion of unsaturated fatty acids**, which help membrane to maintain structure at low temperature by preventing crystal formation. This adaptation requires time. Because of this reason, rapid chilling of plants is more stressful than gradual drop in air temperature.

Q78. How does the plant native to cold regions prevent ice-crystal formation in freezing temperature?

Ans. Freezing temperature

Freezing temperature causes **ice crystal formation**. The confinement of ice formation around cell wall does not affect as badly and plants survive.

Q80. Differentiate between phototropism and geotropism.

Ans.

Phototropism	Geotropism
• It is the movement of parts of plant, in response to stimulus of light and is caused by the differential growth of part of a plant like stem or root. • The tips of shoots usually show positive phototropism while roots show negative phototropism.	• It is the movement of plant parts in response to gravity. • Roots display positive geotropism and shoots negative geotropism.

- However, formation of ice crystals within protoplasm perforates **membranes and organelles** hence killing the cells.

Adaptations: The plants native to cold region such as **oaks, maples, roses** and other plants have adapted to bring **changes in solutes composition** of the cells, which causes **cytosol to super cool without ice formation**, although ice crystals may form in the cell walls.

Movements in Plants

Q79. Define tropic movements. Name the major types of tropic movements in plants.

Ans. Tropic movements: The growth movements in plants that are triggered by an external stimulus, are collectively called tropic movements or tropisms.

- Such movements occur as a curvature of whole organ towards or away from stimuli such as light, touch, chemical, water and gravity.
- Following are the major types of tropic movements in plants.
 1. Phototropism
 2. Geotropism
 3. Thigmotropism
 4. Chemotropism
 5. Hydrotropism

Q81. Compare thigmotropism with chemotropism.

Ans.

Thigmotropism	Chemotropism
- It is the type of movement in plants in response to stimulus of touch, for example climbing vines. - When they come in contact with some solid object, the growth on the opposite side of contact increases and the tendril coils around the support.	- It is the type of movement in plants in response to some chemicals is called chemotropism. - For example, the sugary environment on the stigma of a flower induces pollen tube to grow inside the pistil/carpel to reach the ovule.

Photoperiodism

Q82. Define photoperiodism.

Ans. The response to changes in day length that enables plants to adapt to seasonal changes in their environment is termed as **photoperiodism**. Simply, it is response of plants to the length of day and night e.g., in strawberries flowering is induced by dark periods longer than a critical length.

Q83. Classify plants on the basis of photoperiodism. / How did Garner and Allard classified plants on the basis of day length?

Ans. Effect of photoperiodism was first studied in 1920 by Garner and Allard. They studied that tobacco plant flowers only after exposure to a series of short days.

- Tobacco plant naturally flowers under same conditions, in autumn, but flowering could be induced by artificially exposing to short days.
- With further studies they were able to classify flowering plants into **long-day plants**, which require long days for flowering, **short-day plants**, which require short days for flowering and **day-neutral plants** which flower without being influenced by photoperiod.

Q84. What are phytochromes? describe its forms.

Ans. **Phytochrome**, a photoreceptor protein exists in two forms i.e., **P₆₆₀** and **P₇₃₀**.

P₆₆₀ is a quiescent form. It absorbs red light at a wavelength of 660 nm and is converted to **active P₇₃₀** which absorbs far red light at 730 nm and is converted to **P₆₆₀**.

- In nature, the P₆₆₀ to P₇₃₀ conversion takes place in day light and P₇₃₀ to P₆₆₀ conversion occurs in the dark.
- The rate at which P₇₃₀ is converted to P₆₆₀ provides the plant with a “**clock**” for measuring the duration of darkness.

Q85. P₇₃₀ to P₆₆₀ interconversion act as plant time regulator for flowering
Comment.

Ans. It has been found that red light inhibits flowering in short-day plants but promotes flowering in long-day plants, under conditions during which flowering normally takes place.

- This observation led to the hypothesis that the P₇₃₀ to P₆₆₀ interconversion might be the **plant time-regulator for flowering**.
- According to this hypothesis, P₇₃₀, converted from P₆₆₀ by the absorption of red light, would inhibit flowering in short day plants but promote flowering in long day plants.
- Because P₇₃₀ accumulates in the day and diminishes at night, short day plants could flower only if the night were long enough, during which a great amount of P₇₃₀ would not be completely inactivated, so that

enough P_{730} would remain at the end of night to promote flowering.

Vernalization

Q86. Define vernalization. Write its significance.

Ans. The process of induction of flowering in plants by exposing them to a certain low (chilling) temperature is called **vernalisation**.

- For some plants, vernalisation is an absolute requirement while in some cases it simply assists in inducing flowering.

- The **duration** of low temperature (chilling) treatment varies from **four days to three months**.

Significance

- Photoperiodism and vernalisation serve to synchronise the reproductive behaviour of plants with their environment, ensuring reproduction at favourable times of year.
- They also ensure that members of the same species flower at the same time, encouraging cross pollination for genetic variability.

LONG QUESTIONS (EXERCISE)

Q1. Describe osmoregulation in Hydrophytes and Halophytes?

Ans. See Q20. and Q21. of theory.

Q2. Describe the Physiological adaptation of plants to extreme conditions. How do plants adjust their cell membrane composition and protein structures to survive high and low temperatures?

Ans. See Q22. of theory.

Q3. What is the role of meristem in the growth of plants?

Ans. See Q13. of theory.

Q4. Describe the mechanism of opening and closing of stomata?

Ans. See Q4. of theory.

Q5. Explain the concept of photoperiodism and its influence on plant flowering. How do short-day, long and day-neutral plants differ in their flowering responses, and what role does phytochrome plays in this process?

Ans. See Q24. of theory.

INQUISITIVE QUESTIONS

Q1. Can you explain the hypothesis regarding the opening and closing of stomata?

Ans. The guard cells function as multisensory hydraulic valves. The two hypotheses which may explain the opening and closing of stomata are starch sugar hypothesis and influx of K^+ ion.

Starch Sugar Hypothesis

In 1856, German botanist H. Van Mohl proposed that guard cells in leaf epidermis are solely responsible for photosynthesis, producing sugars during the day. As sugar concentration increases in guard cells, the water potential drops. Water moves into guard cells causing them to become turgid and open the stomata and vice versa.

Influx of K^+ ion

The opening of stomata in plants is facilitated by the active transport of potassium ions (K^+) into guard cells, which reduces their osmotic potential. This influx of K^+ leads to water entering the guard cells through osmosis, causing them to become turgid and open the stomata.

Q2. What mechanisms enable carnivorous plants to supplement their nutrient uptake despite being autotrophs?

Ans. Insectivorous plants supplement organic molecules into their food in addition to inorganic nutrients. These organic chemicals are acquired through the process of capturing and breaking down insects and tiny animals. All insectivorous plants are true autotrophs. However, their development accelerates when they capture prey. Apparently, nitrogenous compounds of animal body are of benefit to these plants. The captured insects are broken down by enzymes that are released by the leaves. Pitcher plant, venus fly trap and sundew are some of the known insectivorous plants.

Pitcher plant: Pitcher plant has leaves modified into a sac or a pitcher, partly filled with water.

Venus-fly trap: Venus-fly trap has a “trap” consisting of two lobes that are hinged at the end of each leaf.

Sundew catches its prey with shiny drops of “dew”, where the plant’s common name comes from.

Q3. How can you say that parenchyma and sclerenchyma provide support to plants?

Ans. Support in Plants

Supporting tissues play an important role in maintaining the structural integrity, support and flexibility of plants. These tissues consist of parenchyma, collenchyma, sclerenchyma, xylem and phloem.

1. Parenchyma

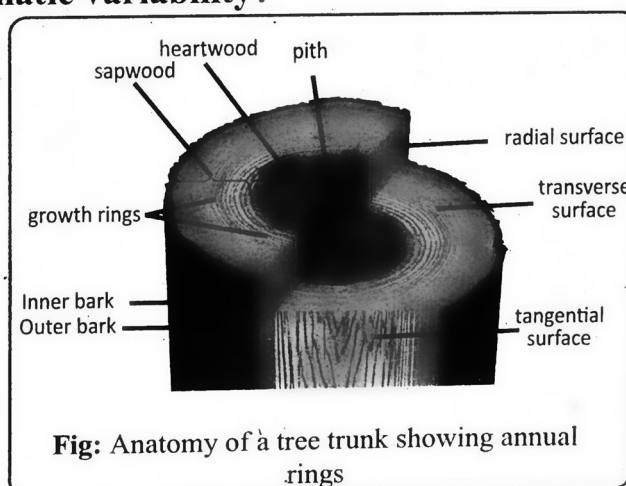
The parenchyma cells of the epidermis, cortex, and pith absorb water. This water creates an internal hydrostatic pressure known as **turgor pressure** that maintains the rigidity of cells.

2. Sclerenchyma

The cells of sclerenchyma tissue possess thick secondary cell walls. These walls are saturated with lignin, an organic compound that confers strength and rigidity to the walls.

Q4. How do the annual rings depict climatic variability?

Ans. Annual rings are formed due to the seasonal activity of the cambium layer in trees. This process is influenced by environmental factors and results in the production of two distinct types of wood each year: **spring wood** (early wood) and **autumn wood** (late wood). These rings provide valuable information about the age of the tree and the environmental conditions experienced during each growing season.



The cambium is a meristematic tissue that generates new vascular tissues i.e., xylem and phloem.

In spring: In spring, when conditions are favourable, the cambium is **highly active**, producing large volume of xylem with wider vessels, resulting in lighter-coloured spring wood.

In autumn: As the season changes to autumn, the cambium's **activity decreases**. It produces fewer xylem elements, which are narrower and denser, leading to the formation of darker autumn wood.

Q5. How does pressure flow theory explain the movement of sugars through a plant?

Ans. Pressure flow theory: The pressure-flow theory, also known as the **mass-flow hypothesis**, is the most widely accepted explanation for the transport of sugars in plants through the phloem. This process of translocation moves sugar from the source (where they are synthesized) to the sink (where they are consumed or stored). This theory relies on the principle of osmotic pressure differences between source and sink regions.

There is a higher water potential at the source end while a lower water potential at the sink end. The difference in water potential causes water to flow from source to sink. Since sucrose is dissolved in water, it is carried along from source to sink along with water.

Q6. What strategies would you adopt to induce flowering in a plant?

Ans. Flowering can be induced by growing plants in controlled environment.

1. By variation in critical length and dark periods

- For inducing flowering in short day plants, keep them in light for short duration and increasing their dark period artificially.
- For inducing flowering in long day plants, keeping them in dark for shorter duration can induce flowering.

2. By temperature treatment

Biennial and perennial plants are stimulated to flowering by exposure to low temperature (chilling) from four days to three months, this process is also called vernalization.