■ PLANT PHYSIOLOGY

Chapter 8 — Exercise with Fully Solved Answers

Multiple Choice • Short Answers • Detailed Answers

■ About this Answer Key

This is a freshly prepared, watermark-free answer key created for the Chapter 8 “Plant Physiology” exercise. Every MCQ is ticked and explained, and every short and detailed question has a complete, exam-ready answer. Prepared with reference to **scholareye.xyz**.

Section A

Select the correct answers — with explanations

1. The primary function of root hairs is:

a) Transport of nutrients

b) Storage of food

✔ **c) Increase surface area for absorption**

d) Synthesis of proteins

✔ Explanation

Root hairs are thin, tubular outgrowths of epiblema (epidermal) cells. Their delicate, elongated shape greatly increases the surface area of the root in contact with soil water and minerals, making absorption far more efficient. They do not store food or transport nutrients themselves — that job belongs to the xylem and phloem.

2. Water moves from the soil into root cells by:

✔ **a) Osmosis**

b) Active transport

c) Diffusion

d) Bulk flow

✔ Explanation

Soil water is usually a very dilute solution and therefore has a higher water potential than the cell sap inside root hair cells. Water moves passively from this region of higher water potential to the lower water potential inside the cell, across the selectively permeable plasma membrane — this movement of water across a membrane is, by definition, osmosis.

3. The transpiration is regulated by:

a) Mesophyll | ✔ **b) Guard cells**

c) Xylem | **d)** Phloem

✔ Explanation

Guard cells surround each stomatal pore and change shape (swelling or shrinking) in response to changes in their turgor pressure. As they swell and bow outward the pore opens, and as they lose turgor the pore closes — this opening and closing directly controls how much water vapour escapes, so guard cells regulate the rate of transpiration.

4. In most plants the food is transported in the form of:

a) Glucose ✔ **b) Sucrose**

c) Starch **d)** Maltose

✔ Explanation

Sucrose is a non-reducing disaccharide, which makes it chemically stable and metabolically inert during transport, so it will not react with or be broken down by phloem tissue along the way. This stability, plus its high solubility, makes sucrose the preferred sugar for long-distance translocation through the phloem.

5. What is TRUE according to the pressure flow mechanism of food transport?

✔ **a) Water enters the source, creating pressure**

b) Water is pulled from the sink

c) Movement of food in phloem is due to gravity

d) Solutes move from low to high concentration

✔ Explanation

In the pressure flow (Munch) mechanism, sugar is actively loaded into the phloem at the source, lowering the water potential there. Water then follows by osmosis from the neighbouring xylem into the phloem at the source, building up a high hydrostatic (turgor) pressure. This high pressure at the source, compared to the lower pressure at the sink, is what drives the bulk (mass) flow of sap towards the sink.

6. Succulent organs are present in:

✔ **a) Xerophytes**

b) Hydrophytes

c) Mesophytes

d) Halophytes

✔ Explanation

Xerophytes are plants of dry habitats. Many of them develop fleshy, succulent stems or leaves (as in cacti) that store water gathered during brief rainy periods, allowing the plant to survive long spells of drought. This succulence is a key water-storage adaptation not typically needed by hydrophytes or mesophytes.

Section B

Write short answers

1. Define transpiration and its types.

Transpiration is the loss of water in the form of water vapour from the aerial (above-ground) parts of a plant, mainly the leaves.

Types of transpiration:

• **Stomatal transpiration** — water loss through stomata; accounts for about 90–95% of total water loss and is the most important type.

• **Cuticular transpiration** — water loss directly through the waxy cuticle covering the epidermis; usually a small amount since the cuticle resists water loss.

• **Lenticular transpiration** — water loss through lenticels (small pores) in the bark of woody stems; the smallest contributor, about 0.1%.

2. How is the transpirational pull important in plants?

Transpirational pull is the tension created in the xylem when water evaporates from the mesophyll cells of the leaf. Because water molecules are strongly cohesive (held together by hydrogen bonds), this tension is transmitted down an unbroken water column all the way to the roots.

It is important because it is the main driving force for the ascent of sap — it pulls water and dissolved minerals upward from the roots to the topmost leaves, even in very tall trees, without the plant having to spend metabolic energy on the process.

3. Transpiration is the loss of water from plants. Is it a harmful phenomenon? If no, what is its importance?

No, transpiration is not a harmful phenomenon under normal conditions; it is essential for the healthy functioning of the plant. It only becomes harmful if it occurs excessively under conditions of water shortage, leading to wilting.

Importance of transpiration:

- Generates the transpirational pull that drives the ascent of sap (water and minerals) from roots to leaves.

- Produces a cooling effect on the plant by evaporative loss of heat, protecting leaves from overheating in sunlight.

- Helps maintain cell turgidity and the plant's overall water balance.

- Assists in the distribution of absorbed minerals throughout the plant body.

4. Differentiate between:

i. Xylem and Phloem

Xylem	Phloem
Composed mainly of dead, lignified cells (tracheids and vessels). Transports water and minerals upward from roots to leaves in one direction only.	Composed of living cells (sieve tubes and companion cells). Transports food (mainly sucrose) in both upward and downward directions, depending on source and sink.

ii. Transpiration and Guttation

Transpiration	Guttation
Loss of water in vapour form, mainly through stomata; occurs chiefly during the day when stomata are open and evaporation is high.	Loss of water in liquid form as droplets, exuded through hydathodes at leaf tips/margins; occurs mainly at night or early morning when humidity is high and root pressure builds up.

iii. Hydrophytes and Halophytes

Hydrophytes	Halophytes
Plants adapted to grow in fresh water; have reduced roots, thin or absent cuticle, well-developed air spaces (aerenchyma) for buoyancy and gas exchange.	Plants adapted to grow in saline soils or water; possess a very high osmotic pressure of cell sap and often salt glands to excrete excess salt so they can still absorb water from salty surroundings.

iv. Hydrophytes and Xerophytes

Hydrophytes	Xerophytes
Adapted to an abundant water supply: poorly developed root and vascular system, thin cuticle, large intercellular spaces.	Adapted to a scarce water supply: deep, extensive roots, thick cuticle, sunken stomata, reduced leaf surface, and often succulent water-storing tissue.

v. Lenticular and Stomatal Transpiration

Lenticular	Stomatal
Water loss through lenticels (pores) in the bark of woody stems; contributes only a very small fraction (about 0.1%) of total transpiration and cannot be regulated by the plant.	Water loss through stomata on the leaf surface; contributes the largest share (90–95%) of total transpiration and is precisely regulated by guard cells.

Section C

Write answers in detail

1. Describe the events involved in the opening and closing of stomata.

- In light, proton (H■) pumps in the plasma membrane of guard cells actively pump H■ ions out of the cell, creating an electrochemical gradient across the membrane.

- This gradient drives K■ ions into the guard cells through voltage-gated potassium channels; malate and chloride ions also accumulate inside the cell.

- The accumulation of these solutes lowers the water potential inside the guard cells, so water enters by osmosis and turgor pressure rises.

- Guard cells have unevenly thickened walls — thicker on the inner wall facing the pore and thinner on the outer wall — so as turgor increases, the cells bow outward, pulling apart and opening the stomatal pore.

- In darkness, under water stress, or in response to the hormone abscisic acid (ABA), K■ and other solutes move back out of the guard cells; water follows by osmosis, turgor pressure falls, the guard cells become flaccid, and the pore closes.

2. Explain the internal structure of root and describe the uptake of salt and water by root.

Internal structure (outside to inside):

- Epiblema (outermost single-celled layer, bearing root hairs) → Cortex (parenchyma cells for storage and radial water movement) → Endodermis (innermost cortical layer with a waterproof Casparian strip of suberin) → Pericycle (thin layer giving rise to lateral roots) → Vascular bundle (radially arranged xylem and phloem).

Water uptake:

- Water enters root hair cells by osmosis, since the soil solution has a higher water potential than the cell sap. It then moves inward by two pathways: the **apoplast pathway** (through cell walls and intercellular spaces, without crossing membranes) until it is blocked by the Casparian strip at the endodermis, and the **symplast pathway** (from cell to cell through the cytoplasm via plasmodesmata), which continues across the endodermis into the vascular tissue.

Salt (mineral) uptake:

- Mineral ions are mostly absorbed by active transport, using ATP-driven ion pumps and carrier proteins in the plasma membrane of root hair cells, allowing uptake even against a concentration gradient; some ions also enter passively by diffusion. The Casparian strip forces ions to pass through the selectively permeable membrane of endodermal cells, giving the plant control over which and how many ions finally reach the xylem.

3. Describe the mechanism of transport of water and salt in plants.

- Water and dissolved salts move upward from the root xylem to the leaves against gravity mainly through the **Cohesion-Tension Theory**.

- Transpiration from the leaf mesophyll cells creates a tension (negative pressure) at the top of the xylem, which pulls the water column upward.

- Water molecules cohere strongly to one another through hydrogen bonding (**cohesion**), keeping the water column in the narrow xylem vessels and tracheids continuous and unbroken under tension.

- Water molecules also adhere to the walls of the xylem conduits (**adhesion**), which helps support the column and resist the pull of gravity.

- At night, when transpiration is low, **root pressure** — generated by the active accumulation of ions in the root xylem, which draws water in by osmosis — can also push water upward, sometimes causing guttation.

- Salts, once actively loaded into the xylem by root cells, are simply carried passively along with this upward mass flow of water to all parts of the plant.

4. Explain the mechanism of food translocation by the Pressure Flow Mechanism.

- Also called the Munch hypothesis, this mechanism explains how sugars made during photosynthesis are transported through the phloem.

- At the **source** (e.g. a photosynthesising leaf), sugar is actively loaded into the companion cells and sieve tubes of the phloem.

- This loading lowers the water potential inside the phloem at the source, so water enters from the adjacent xylem by osmosis, raising the turgor (hydrostatic) pressure at that end.

- At the **sink** (e.g. a root, fruit, or growing tissue), sugar is unloaded and used or stored, raising the water potential inside the phloem there; water then leaves the phloem back into the xylem, lowering the pressure at the sink end.

- This pressure difference — high at the source, low at the sink — drives a passive, bulk (mass) flow of the sugary sap through the sieve tubes from source to sink; the direction of flow can change depending on which organ is acting as source or sink at a given time.

5. Explain osmotic adjustments in hydrophytes, xerophytes, and halophytes.

Hydrophytes (water plants):

- Since water is abundantly available, the osmotic pressure of their cell sap is kept low, close to that of the surrounding water. They have a poorly developed root and vascular system, thin or absent cuticle, and large air spaces (aerenchyma) for buoyancy and internal gas exchange.

Xerophytes (dry-habitat plants):

- To draw water from dry soil, these plants maintain a high osmotic pressure (concentrated cell sap) so that their water potential stays lower than that of the soil. They also reduce water loss through a thick cuticle, sunken stomata, reduced leaf surface (often as spines), and store absorbed water in succulent tissue.

Halophytes (salt-tolerant plants):

- Growing in saline soil or water, where the external water potential is very low (negative), they must maintain an even higher osmotic pressure of cell sap — by accumulating salts or synthesising compatible organic solutes — in order to keep absorbing water. Many also have salt glands/hairs to excrete excess salt and succulent tissue to dilute the absorbed salts.

✔ End of Solved Exercise

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