Model Answers: Easy

1

The correct answer is **C** because in the **spongy mesophyll** plant cells are in direct contact with air (located in airspaces within the spongy mesophyll layer). Therefore, water will diffuse out of the cells in the spongy mesophyll and into the air. This is due to the air having a **lower water potential** than the cells in the spongy mesophyll. The water vapour in the air then exits the leaf via the stomata.

The cells on the outer surface of the epidermal cell layer are also in contact with the air, however, not much water is lost here due to the presence of a waterproof waxy cuticle (around 5-10% of water is still lost through the cuticle despite the waterproofing layer).

Transpiration Recap:

Transpiration is the evaporation of water from plants. Most of the water absorbed by the roots of a plant (usually over 95%) is not used for growth or metabolism, instead, the water is lost through transpiration. The transpiration of water causing water to be pulled up the xylem, carrying with it dissolved nutrients, to the leaves.

Transpiration is very important for maintaining moisture conditions in the environment - as much as 10% of the moisture in the Earth's atmosphere is from plant transpiration.

2

The correct answer is **B** because:

- The uptake of **minerals** and **ions** from the soil and into the **root hair cells** is **against** the concentration gradient
- Energy must be used to bring the minerals from an area of **low** concentration (the soil) to an area of **high** concentration (the root hair cell)
- The process is known as **active transport** and involves carrier proteins in the outer membrane of the root hair cell
- **ATP** is needed to drive the carrier proteins

Active transport is the movement of molecules across a cell membrane from a region of lower concentration to a region of higher concentration against the concentration gradient. Active transport requires **cellular energy** (either from ATP or an electrochemical gradient) to achieve this movement. Some examples of active transport include: the **sodium-potassium pump, sodium-glucose transport protein, exocytosis** and **endocytosis.**

3

The correct answer is **D** because the **salt** that was in the sea water will be left in the soil after the water has evaporated. This salt will **lower the water potential** of the soil and will therefore reduce the amount of water that the plant roots can absorb.

The oxygen, nitrogen and CO_2 levels of the soil would be unaffected once the sea water has evaporated. Additionally, high levels of **nitrogen** would actually be **beneficial** to plant growth (which is why nitrogen is a major component in fertilizers).

4

The correct answer is **B** because:

- Cell **B** has a thin cylindrical structure and is linked via **plasmodesmata** (openings in the cell wall between adjacent plant cells) to a **sieve tube element** (cell **C**)
- Cell **C** is identifiable as a **sieve tube element** due to its **hollow** structure, lack of nucleus and sieve plates at the ends of the cell (which allow the uninterrupted flow of assimilates between sieve tube elements)

5

The correct answer is **B** because:

- The **volume of water moved** = **πr^2 x distance moved** by the bubble
- r (radius) is equal to **half** the diameter so **r = 0.6 mm**
- So, to work out the distance moved in 15 seconds the formula is **$\pi(0.6^2 \times 7)$**
- Then to work out the rate in $mm^3\ min^{-1}$ **multiply** this number by **4**

6

The correct answer is **C**. **Hardened defensive spines** are a common adaptation of desert dwelling xerophytes. The primary function of spines is to protect the plant by **deterring animals** from herbivory (rather than reducing water loss). It should be noted, however, that as large quantity of water is stored in the tissues of xerophytes plants, a reduced chance of herbivory will indirectly lead to water savings.

Both **epidermal hairs** and **sunken stomata** lead to a reduction in the transpiration rate by ensuing a **boundary layer** of humid air is present around the stomata. This boundary layer reduces the water potential gradient, therefore reduces the amount of water lost from transpiration. A **lower stomatal abundance** leads to a reduction in water loss as there will be less gas exchange and therefore less opportunity for evaporation of water from the mesophyll tissue.

7

The correct answer is **A** because the apoplast pathway is the movement of water via the cell walls.

8

The correct answer is **C** because:

- The carbohydrate (predominantly in the form of sucrose) is soluble and therefore its addition impacts **water potential** in the phloem
- Soluble molecules can dissolve in water because they are able to bind to water molecules via **hydrogen bonds**
- When solutes are added to a solution, they reduce the water potential (i.e. result in a **more negative** water potential) as previously 'free' water molecules are now bound to the dissolved solutes
- The decrease in water potential (caused by the addition of sucrose) results in an **increase** in **hydrostatic pressure** as water moves into the phloem (via osmosis)

Water potential is a measure of the differences in potential energy between a water sample with solutes and pure water. Water moves via osmosis from an area of **higher** water potential (**more** water molecules, **less** solute) to an area of **lower** water potential (**less** water, **more** solutes)

9

The correct answer is **D** because:

- The casparian strip is a band of **suberin** (an **impermeable** substance) and is found in the **endodermal cell walls** of plant roots
- The casparian strip blocks the movement of water through the **apoplast** pathway (the water is diverted from the cell wall to the cytoplasm where it then follows the **symplast** pathway)

- The **apoplast pathway** is the movement of water via the **cell wall**
- The **symplast pathway** is the movement of water via the **cytoplasm**
- The **vacuolar pathway** is the movement of water via the **vacuole**

10

The correct answer is **D** because:

- **Translocation** refers to the movement of **sugars** (as well as other products of photosynthesis) in the plant
- Translocation also occurs in the **phloem** rather than the xylem

The movement of water in the xylem is controlled by a number of factors. Water is first absorbed by osmosis via the root hair cells, adapted to maximise osmosis by having thin walls and a large surface area. Once this water reaches the xylem it is transports through the xylem hollow, thick-walled

tubes to the rest on the plant. It is possible for the water to move in one direction, which is typically against gravity, due to water transpiring from the leaves and creating a pulling force on the water left in the plant.

Cohesion-Tension Theory Recap:

The movement of water up the xylem is possible due to the dipolar nature of water. Water forms hydrogen bonds with neighbouring water molecules creating cohesion. This results in a continuous column of water forming in the plant stem. Tension (a pulling force) is creating when the water evaporates out of the stomata. This movement of water out of the stomata results in the water column being pulled up the xylem towards the stomata, this is known as the transpiration pull. This pull will draw up the water and also put tension on the xylem, making it narrow and longer. This change in diameter of the xylem is measurable, for example the diameter of tree trunks will change according to transpiration rates.