InkBiology

ANSWER BOOK

Phloem and translocation: pumped at the ends, flowing in the middle

Plant transport and mineral nutrition · Unit B08

AQA 3.3.4.2 · OCR A 3.1.3 · Edexcel A Topic 4.1–4.4 · CAIE 7.2

6 questions · 18 marks

NAVY EDITION

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SECTION A · Short, 1 to 2 marks

A1 **A1** a hydrogen ion pump, which spends ATP. **A1** a sucrose and hydrogen ion co-transporter protein. [2]

A2 **B1** sucrose is not an intermediate in respiration, so it is not drawn into the metabolism of every cell it passes; accept that it is a non-reducing sugar and so does not react on the way. [1]

SECTION B · Standard, 3 to 5 marks

B1 **B1** ATP drives a pump that moves hydrogen ions out of the companion cell into the cell wall, building up a hydrogen ion gradient. **B1** the hydrogen ions leak back in through a co-transporter that will only carry them with a sucrose molecule, so sucrose is brought in against its own concentration gradient. **B1** sucrose passes on into the sieve tube element through the plasmodesmata, so the water potential of the sap falls sharply. **B1** water enters from the xylem alongside by osmosis, and because the sieve tube has stiff walls and is already full, the hydrostatic pressure inside it rises. **A1** at the sink sucrose is unloaded and converted to something else, so water leaves and the pressure falls there, and sap flows from the high-pressure end to the low-pressure end carrying everything dissolved in it. [5]

B2 **B1** ringing removes the phloem and leaves the xylem intact, so sugar accumulating above the cut and roots starving below it show that organic solutes travel in the phloem. **B1** ringing establishes the route and the direction of flow at that point, but it says nothing about the mechanism moving the sap. **B1** sap continuing to flow from an abandoned stylet shows that the contents of a sieve tube are under positive hydrostatic pressure and that nothing living is needed to push it out. **A1** judgement: the stylet result supports the pressure gradient that mass flow requires, but neither experiment excludes another mechanism producing the same observations, so the evidence supports the hypothesis rather than proving it. [4]

B3 **B1** in late summer sucrose made in the leaves is unloaded into the tuber and stored as starch, so the tuber is a sink. **B1** in spring the stored starch is broken down and sucrose is loaded into the phloem, so the tuber becomes a source. **A1** the new shoot is then the sink, so sap travels up the stem rather than down it; the direction is set by which end of the sieve tube currently holds the higher pressure. [3]

B4 **B1** mass flow claims that the movement along the tube is driven by a pressure difference generated at the ends, not by anything pumping in the middle. **B1** a sieve tube element is still a living cell and depends on ATP from its companion cell simply to stay alive and keep its plasma membrane intact. **A1** poisoning the middle of the route kills those cells and the tube stops working, which is not the same as showing that ATP was being spent to push the sap along. [3]