InkBiology

ANSWER BOOK

Transpiration: the price of keeping the stomata open

Plant transport and mineral nutrition · Unit B08

AQA 3.3.2, 3.3.4.2 · OCR A 3.1.3 · Edexcel A Topic 4.1-4.4 · CAIE 7.2

6 questions · 22 marks

NAVY EDITION

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SECTION A · Short, 1 to 2 marks

A1 **B1** water evaporates from the wet cellulose walls of the mesophyll cells into the air spaces of the leaf. **B1** water vapour then diffuses out through the open stomata down a water potential gradient. [2]

SECTION B · Standard, 3 to 5 marks

B1 **M1** cross-sectional area = $\pi r^2 = \pi \times 0.50^2 = 0.785$ mm². **M1** rate of bubble travel in moving air = 47 ÷ 10 = 4.7 mm min⁻¹. **A1** rate of water uptake = 0.785 × 4.7 = 3.7 mm³ min⁻¹. **M1** percentage increase = (47 − 18) ÷ 18 × 100, dividing the change by the original still-air value. **A1** 161 per cent, accepting 160 to two significant figures. [5]

B2 **B1** ATP drives proton pumps that move hydrogen ions out of the guard cell across its plasma membrane. **B1** the inside of the cell becomes electrically negative relative to the outside, so potassium ions enter through channel proteins down the electrical gradient. **B1** chloride ions follow and stored starch is converted to malate, adding further solute to the guard cell. **B1** the extra solute lowers the water potential of the guard cell, so water enters from the neighbouring epidermal cells by osmosis and the cell becomes turgid. **A1** the wall facing the pore is thicker and less elastic and the cellulose microfibrils are wound in hoops, so the turgid cell lengthens by bowing away from its partner and the pore opens. [5]

B3 **B1** water vapour leaving the stomata saturates a boundary layer of still air held against the leaf surface. **B1** moving air sweeps that saturated layer away, so the air just outside the pore has a much lower water potential and the steep part of the gradient is restored. **B1** raising the humidity raises the water potential of the air outside the leaf, towards that of the saturated air in the leaf air spaces. **A1** the water potential gradient across the stoma is therefore shallower, so water vapour diffuses out more slowly. [4]

B4 **B1** a rise in temperature raises the rate whereas a rise in humidity lowers it. **B1** temperature acts on both steps, since molecules gain kinetic energy so evaporation from the mesophyll walls and diffusion out of the stomata are both faster, whereas humidity acts only on the diffusion step. **A1** warmer air also holds more vapour, so the air outside is further from saturation and the gradient steepens, while raising the humidity brings the water potential outside closer to that inside the leaf and makes the gradient shallower. [3]

B5 **B1** the lower surface of a floating leaf is in contact with water, so gases could not diffuse in or out through stomata placed there. **B1** stomata on the upper surface are in contact with the air, so carbon dioxide can diffuse in and oxygen and water vapour can diffuse out. **B1** any one further feature with a reason: a thin or absent cuticle since water loss is not a threat, little lignified tissue since the water supports the leaf, or large air spaces called aerenchyma giving buoyancy and carrying oxygen down to roots in anaerobic mud. [3]