Exercise walk-through

Homeostasis in plants ▪ 14.2

eXercise

You must be able to

- explain why stomatal aperture balances CO_2 uptake against water loss
- describe how guard cells open and close stomata
- describe the role of ABA and calcium ions in closing stomata during water stress

Method — Why stomata open and close

A stoma must let in **carbon dioxide** 二氧化碳 for photosynthesis while limiting water loss by **transpiration** 蒸腾作用. So stomata usually open by day and close at night (a daily rhythm).

Method — How guard cells work

- to **open**: guard cells pump in ions, lowering their **water potential** 水势; water enters by **osmosis** 渗透; they swell, become turgid and bend apart, opening the pore.
- to **close**: ions leave, water follows out, the guard cells go floppy and the pore closes.

Method — How guard cells work

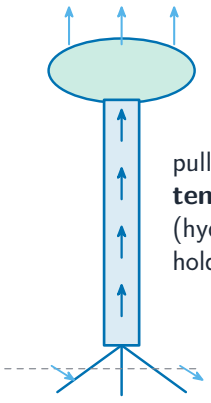
open

ions pumped in $\rightarrow$
water enters $\rightarrow$ turgid

closed

ions leave $\rightarrow$
water leaves $\rightarrow$ floppy

Method — How guard cells work



transpiration:
water vapour leaves
through the stomata

pulled up under
tension; **cohesion**
(hydrogen bonds)
holds the column

water enters roots
by osmosis

Guard cells control water loss through the stomata

Method — Water stress and ABA

When the plant is short of water, the hormone **abscisic acid** (ABA) is released. It makes the guard cells lose ions and water, so the stomata close and save water. **Calcium ions** 钙离子 act as a **second messenger** 第二信使 inside the guard cells.

Practice 2.1 ▪ 2 marks

State the **two** opposing needs that the opening of stomata must balance.

Solution 2.1

Worked steps

letting in carbon dioxide for photosynthesis B1; limiting water loss by transpiration B1.

Practice 2.2 ▪ 1 mark

Name the hormone that closes stomata when a plant is short of water.

Solution 2.2

Method: Water stress and ABA

Worked steps

abscisic acid (ABA) B1.

Exam-style 3.1 ▪ 1 mark

A stoma opens when its guard cells:

A lose ions and become floppy

B gain ions, so water enters by osmosis and they become turgid

C lose water by osmosis

D release abscisic acid

Solution 3.1

Method: How guard cells work

A lose ions and become floppy

B gain ions, so water enters by osmosis and they become turgid ✓

C lose water by osmosis

D release abscisic acid

Worked steps

B. Gaining ions lowers the water potential, water enters by osmosis, and the turgid guard cells open the pore.

Exam-style 3.2 ▪ 1 mark

What is the role of calcium ions in the response to water stress?

A they are pumped out to open the stomata

B they act as a second messenger inside the guard cells

C they replace water in the guard cells

D they are absorbed for photosynthesis

Solution 3.2

Method: Water stress and ABA

A they are pumped out to open the stomata

B they act as a second messenger inside the guard cells ✓

C they replace water in the guard cells

D they are absorbed for photosynthesis

Worked steps

B. Calcium ions act as a second messenger inside the guard cells.

Exam-style 3.3 ▪ 3 marks

Explain the mechanism by which guard cells open a stoma.

Solution 3.3

Method: How guard cells work

Worked steps

guard cells actively pump in ions, lowering their water potential B1; water enters by osmosis, so they become turgid B1; the unevenly thickened walls make them bend apart, opening the pore B1.

Exam-style 3.4 ▪ 2 marks

(a) Explain why a plant closes its stomata when the soil becomes dry.
(b) Suggest one disadvantage to the plant of keeping its stomata closed for a long time.

Solution 3.4

Method: How guard cells work

Worked steps

(a) closing the stomata reduces water loss by transpiration **M1**, conserving the limited water **A1**.
(b) less carbon dioxide can enter **M1**, so the rate of photosynthesis falls / less food is made **A1**.