

14.2 Homeostasis in plants

Name: _____ Class: _____ Date: _____

Total: 12 marks

KEY WORDS stomata 气孔 • guard cell 保卫细胞 • abscisic acid 脱落酸
• transpiration 蒸腾作用 • calcium ion 钙离子

Objective

Build the skills to answer exam questions on **homeostasis in plants** — how **stomata** 气孔 open and close, the role of **guard cells** 保卫细胞, and **abscisic acid** 脱落酸 (ABA) in water stress.

You must be able to:

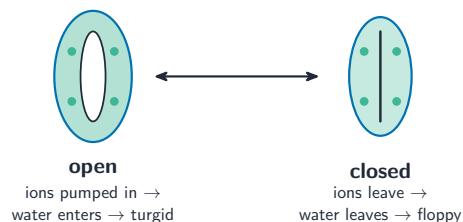
- explain why stomatal aperture balances CO₂ uptake against water loss
- describe how guard cells open and close stomata
- describe the role of ABA and calcium ions in closing stomata during water stress

1 Worked examples

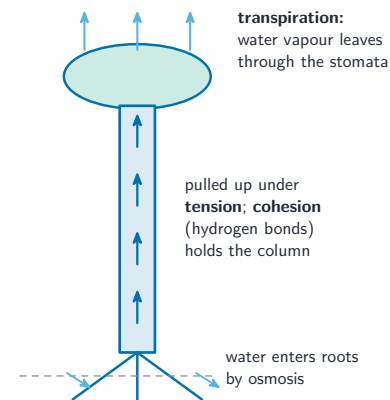
■ Why stomata open and close

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).

■ How guard cells work



Guard cells open the stoma when turgid (swollen with water); they close it when floppy



Guard cells control water loss through the stomata

- 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.

■ 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.

2 Practice

2.1 State the **two** opposing needs that the opening of stomata must balance. [2]

2.2 Name the hormone that closes stomata when a plant is short of water. [1]

3 Exam-style questions

3.1 A stoma opens when its guard cells: [1]

- **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

3.2 What is the role of calcium ions in the response to water stress? [1]

- **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

3.3 Explain the mechanism by which guard cells open a stoma. [3]

3.4 (a) Explain why a plant closes its stomata when the soil becomes dry. [2]

(b) Suggest one disadvantage to the plant of keeping its stomata closed for a long time. [2]

Solutions

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

2.2 abscisic acid (ABA).

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

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

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

3.4 (a) closing the stomata reduces water loss by transpiration, conserving the limited water.

(b) less carbon dioxide can enter, so the rate of photosynthesis falls / less food is made.