14. Homeostasis

14.2 Homeostasis in Plants

Paper 4

Question Paper

1 Stomata in leaves respond to changes in environmental conditions by opening and closing. This regulates carbon dioxide uptake and water loss.

(a) Describe the mechanism by which stomata open in sunlight.

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(b) Stomatal conductance is a measure of the rate of water vapour loss from the intercellular air spaces of leaves to the atmosphere through the stomata.

A student investigated the effect of different concentrations of abscisic acid (ABA) on stomatal conductance in *Helianthus annuus*, the common sunflower.

The student treated the roots of 15 sunflower plants with different concentrations of ABA solution. The plants were left in standardised conditions for 24 hours.

After 24 hours, the student measured:

- the concentration of ABA in the xylem sap of each plant
- the stomatal conductance of the leaves of each plant.

The results are shown in Fig. 3.1.

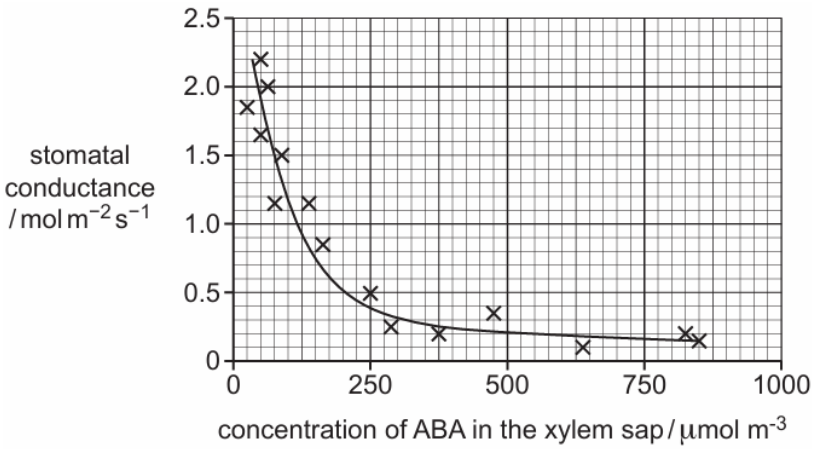


Fig. 3.1

(i) With reference to Fig. 3.1, describe the relationship between the concentration of ABA in the xylem sap and stomatal conductance.

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(ii) Suggest explanations for the results shown in Fig. 3.1.

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2 The leaves of many plants have stomata that show a regular daily rhythm of opening and closing over a period of 24 hours.

(a) Explain why it is important for plants to open and close their stomata in a daily rhythm.

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(b) Fig. 2.1 shows the results of an experiment to monitor this rhythm over three days and nights for the plant *Arabidopsis thaliana*. The percentage of open stomata is shown. Each day consisted of 14 hours of light (white bar) and each night consisted of 10 hours of darkness (black bar).

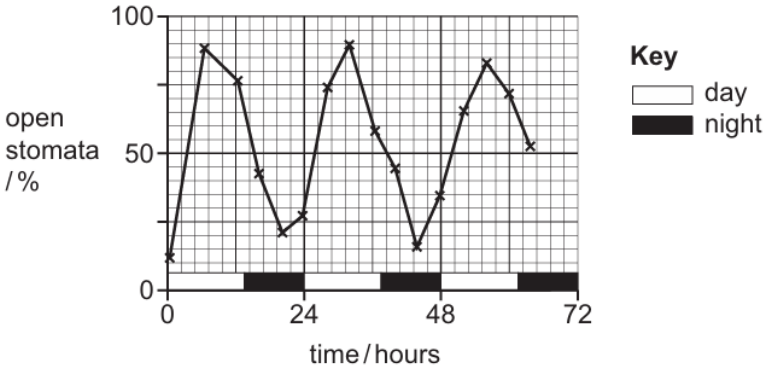


Fig. 2.1

Fig. 2.1 shows that the percentage of open stomata increases in the first seven hours of the experiment. Describe the sequence of changes that occurs in the guard cells that leads to the stomata opening.

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(c) The experiment was repeated with *A. thaliana* plants that were left in darkness from 14 to 96 hours. The results are shown in Fig. 2.2.

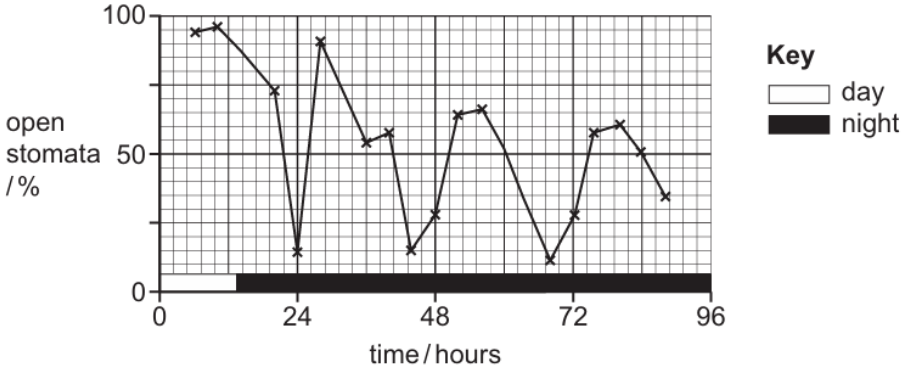


Fig. 2.2

With reference to Fig. 2.1, explain what Fig. 2.2 shows about the role of genes and the role of the environment in controlling the rhythm of stomatal opening and closing in *A. thaliana*.

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3 There are more than 600 plant species in the genus *Ipomoea*. Many species are grown for their attractive flowers, and some species are used as crop plants.

(c) Scientists investigated the response of stomata to changing carbon dioxide (CO_2) concentrations in the beach morning glory, *I. pes-caprae*.

The scientists placed *I. pes-caprae* plants in chambers. They measured the width of open stomata (stomatal apertures) after the plants had been exposed to different CO_2 concentrations for 40 minutes. Light intensity and temperature were kept constant.

The relationship between CO_2 concentration and the mean width of stomatal apertures is shown in Fig. 3.2.

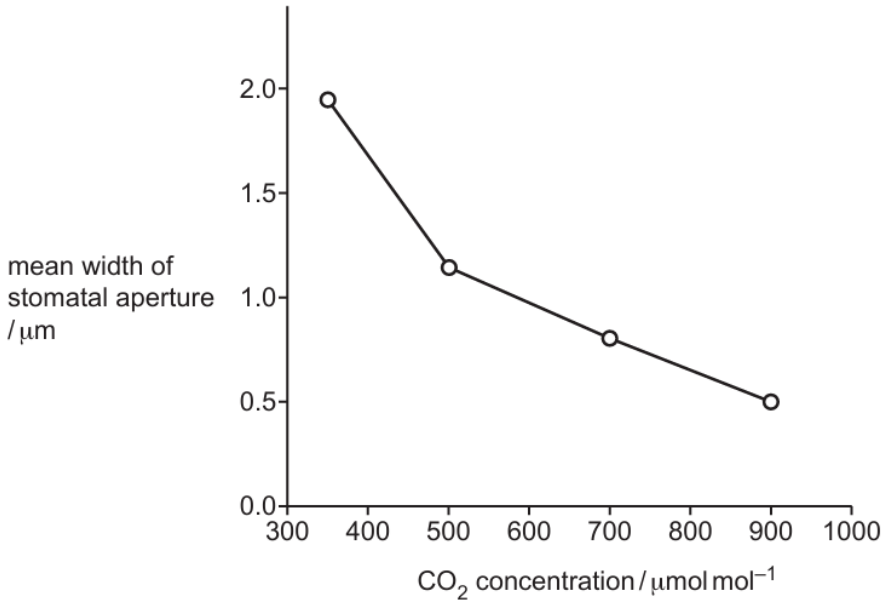


Fig. 3.2

(i) In 2016, a study measured the atmospheric CO_2 concentration as 400 μmol mol^{-1}.

In the future, climate change may reduce water availability and increase atmospheric CO_2 concentrations in some habitats.

Suggest how the stomatal response shown in Fig. 3.2 would allow *I. pes-caprae* to survive the effects of climate change.

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(ii) Under certain conditions, the closure of stomata is controlled by abscisic acid.

Describe how abscisic acid causes the closure of stomata.

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4 **(a)** Stomata are involved in both transpiration and photosynthesis in plants.

Fig. 9.1 is a diagram of an open stoma, its guard cells and surrounding epidermal cells.

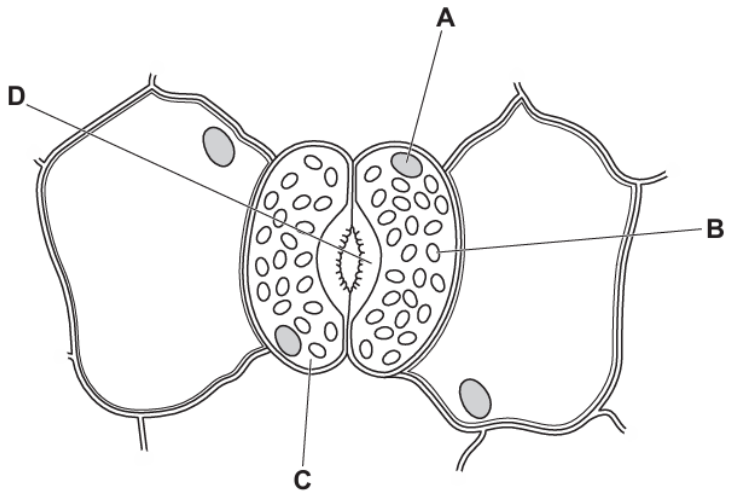


Fig. 9.1

Complete Table 9.1 by choosing the correct letter from Fig. 9.1 to match the feature stated in Table 9.1.

Each letter may be used once, more than once or not at all.

Table 9.1

letter	feature
.....	location of Calvin cycle
.....	made mainly of cellulose

[2]

(b) The opening and closing of stomata are due to changes in environmental conditions. Hydrogen ions (H^+) and potassium ions (K^+) are involved in the opening of stomata.

Describe how hydrogen ions and potassium ions are involved in the opening of a stoma.

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