

3 Plants have several different photosynthetic pigments in their chloroplasts.

- (a) A student separated and identified the chloroplast pigments present in a leaf extract from a spinach plant using two slightly different methods.

Method A

- A type of chromatography known as thin layer chromatography (TLC) was used to separate the pigments.
- A mixture of ether and cyclohexane was used as a solvent in TLC.

Method B

- The student repeated TLC but treated the spinach leaf extract with a chemical. The chemical causes a magnesium ion in a pigment to be replaced by two hydrogen ions.
- The student used a leaf from the same spinach plant, and used the same solvent as in method A.

The student calculated R_f values and compared these to reference values to identify the pigments.

Fig. 3.1 shows the results for method A and method B.

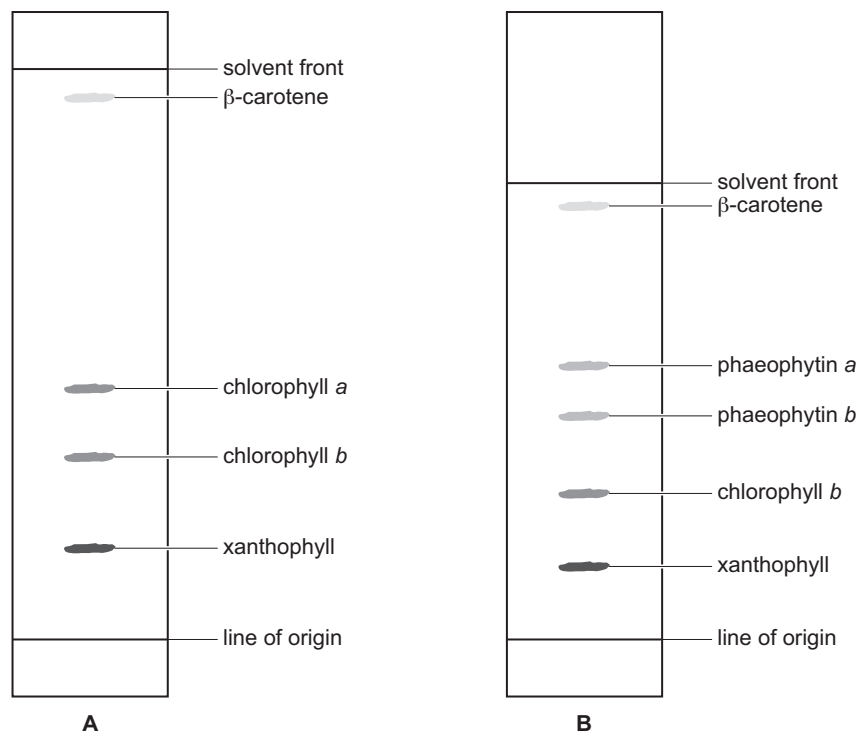


Fig. 3.1

- (i) Calculate the R_f value of β -carotene in Fig. 3.1.

$$R_f = \dots\dots\dots [2]$$

- (ii) Suggest **two** explanations for the differences in appearance of chromatograms A and B in Fig. 3.1.

- 1
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- 2
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- [2]

- (iii) The student found some different R_f values for the chloroplast pigments of spinach in a scientific paper.

The values in the scientific paper were different from the reference values that the student originally used to identify the pigments on chromatograms A and B in Fig. 3.1.

Suggest **one** reason, other than measurement error, for the different R_f values.

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- [1]

(b) Fig. 3.2 shows the absorption spectra of some chloroplast pigments.

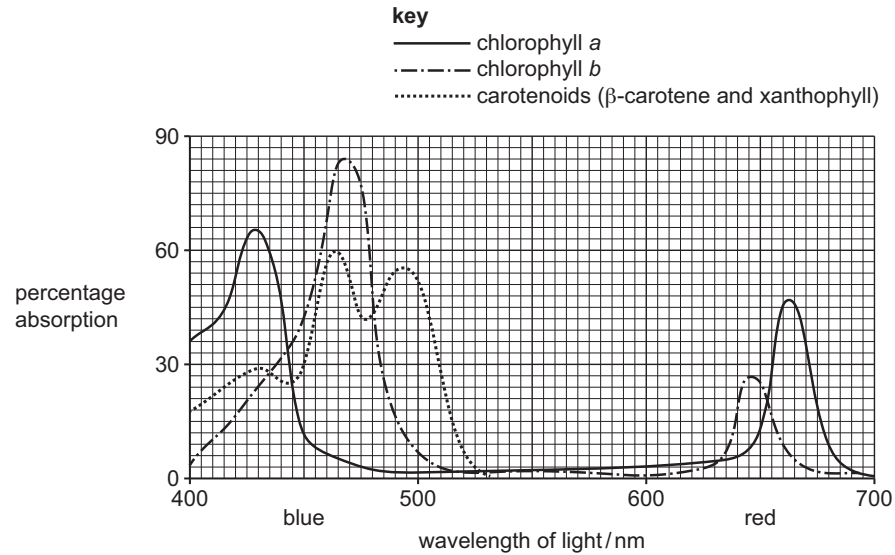


Fig. 3.2

Use Fig. 3.2 to compare the similarities and differences between the absorption spectra of chlorophyll *a* and carotenoids.

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(c) In some species of plant, the absorption of light stimulates seed germination.

The absorption of light increases the production of gibberellin in the embryo of a seed.

Describe the role of gibberellin in the germination of a seed.

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[Total: 13]

(a) Complete Table 5.1 to show the features of three cell-signalling molecules of the endocrine system: antidiuretic hormone (ADH), glucagon and insulin.

Put a tick (✓) or a cross (X) in every box.

Table 5.1

feature	ADH	glucagon	insulin
binds to receptors on cell surface membranes			
results in molecules moving from cells into the blood			
is secreted as a result of detection by osmoreceptors			

[3]

Describe **other** ways in which the endocrine system and the nervous system differ.

[4]

Fig. 5.1 shows a transmission electron micrograph of a longitudinal section of striated muscle tissue that is in a relaxed state.

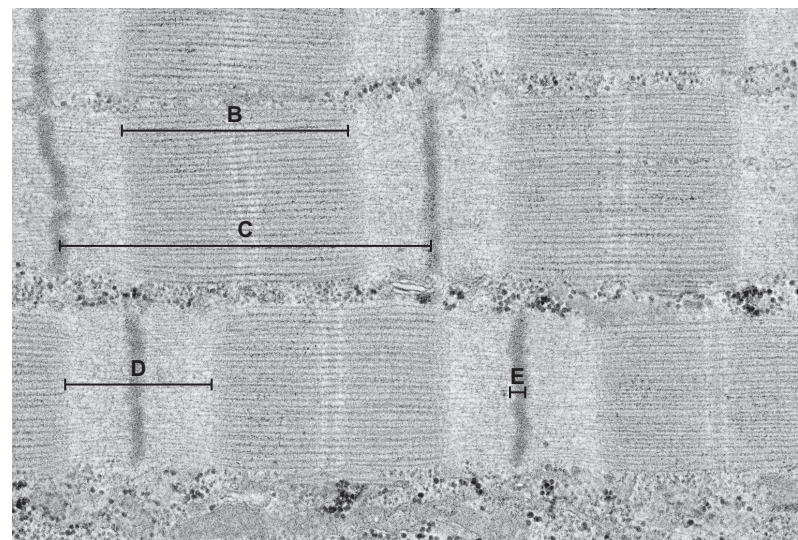


Fig. 5.1

..... [1]

..... [1]

[4]

- 1 Juglone is a chemical produced by plants in the genus *Juglans*, which includes different species of walnut tree.

Fig. 1.1 shows a black walnut tree.

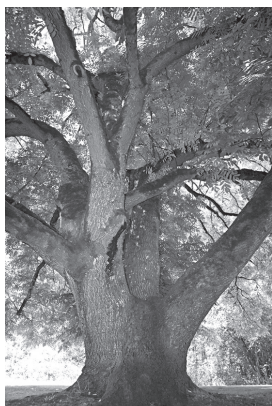


Fig. 1.1

Juglone produced by a black walnut tree can diffuse into the soil surrounding the tree.

Groups of scientists have observed that juglone affects different species of plant growing close to black walnut trees.

Juglone can reduce the percentage of seeds that germinate, delay the start of germination or reduce growth. In some studies, juglone has no effect on germination or growth.

A student planned to investigate the effect of juglone on the cucumber plant, *Cucumis sativus*.

In the investigation, the student:

- placed some damp soil containing juglone in a tray
- added some cucumber seeds to the soil
- placed the container in a suitable environment for germination and growth.

Fig. 1.2 shows cucumber seedlings (young plants) a few days after germination.



Fig. 1.2

The student planned to compare the effect of exposing cucumber seeds to:

- juglone solution with a concentration of $1.0 \times 10^{-3} \text{ mol dm}^{-3}$, which is a concentration that has been measured in soils surrounding black walnut trees
- a control treatment.

The student planned to determine:

- the percentage of cucumber seeds that germinated in soil
- the growth of each cucumber seedling 10 days after the appearance of the seedling above the soil.

- (a) Identify the independent variable in this investigation.

..... [1]

[2]

..... [7]

- (d) Another student investigated the effect of juglone on a different species of plant called crimson clover, *Trifolium incarnatum*.

The student recorded the number of days required for germination of:

- 10 seeds treated with a juglone solution with a concentration of $1.0 \times 10^{-3} \text{ mol dm}^{-3}$
- 10 seeds not treated with a juglone solution.

- (i) The student used the *t*-test to analyse the results. The *t*-test is appropriate for the number of seeds that were used.

Suggest **two other** reasons why the *t*-test is an appropriate statistical test to use for this investigation.

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 [2]

- (ii) The null hypothesis for this *t*-test was:

There is no difference between the time taken for seeds to germinate when treated with juglone and the time taken for seeds to germinate when not treated with juglone.

The calculated value of *t* was **2.090**.

The student compared **2.090** to the values in Table 1.1.

Table 1.1

degrees of freedom	probability level (<i>p</i>)			
	0.10	0.05	0.01	0.001
17	1.740	2.110	2.898	3.965
18	1.734	2.101	2.878	3.922
19	1.729	2.093	2.861	3.883
20	1.725	2.086	2.845	3.850
21	1.721	2.080	2.831	3.819

Using Table 1.1 and the calculated value of *t* of **2.090**, state **and** explain what the student can conclude about the results.

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 [3]

[Total: 18]