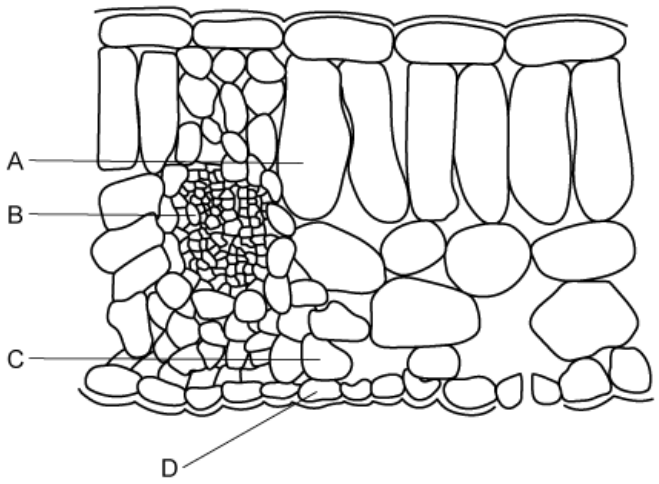
1.

The diagram below shows a section through a leaf.

Which cell type would have the highest concentration of oxygen on a bright, sunny day?

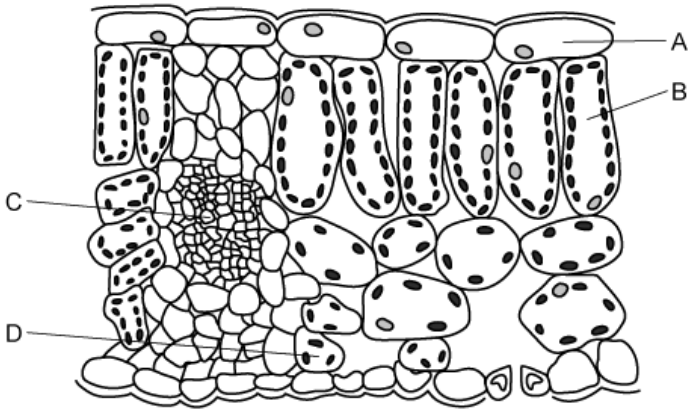


Answer: A

A is a palisade mesophyll cell which is where most photosynthesis takes place (due to palisade mesophyll cells having the highest concentration of chloroplasts). The more photosynthesis occurring, the greater the amount of oxygen produced as a waste product. Some oxygen will be used up by each type of plant cell in the process of aerobic respiration, but the amounts are similar in each type of cell.

2.

The diagram below shows a cross-section through a leaf as seen under a microscope.



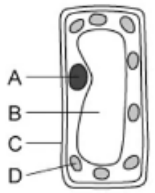
In which part of the leaf would the concentration of carbon dioxide be lowest on a warm, sunny day?

Answer: B

3.

The diagram below shows a palisade mesophyll cell found in the leaves of plants.

In which region of the cell would starch be stored?



Answer: D

4.

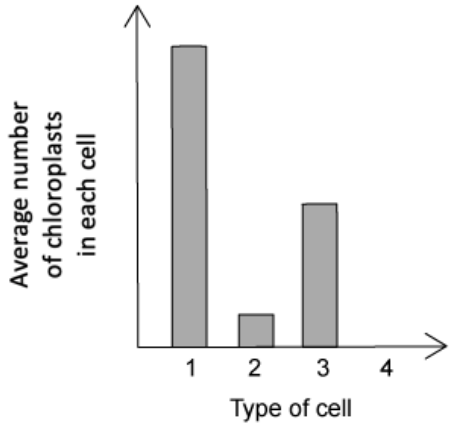
Which row of the table below shows the correct effects of deficiencies of essential minerals for plant growth?

	effect of magnesium ion deficiency	effect of nitrate ion deficiency
A	yellow leaves	stunted growth
B	stunted growth	long roots
C	small leaves	yellow leaves
D	stunted growth	yellow leaves

Answer: A

5.

The average number of chloroplasts found in four different types of cell from the leaf of a plant are shown in the bar chart below.



What are the names of the four types of cell?

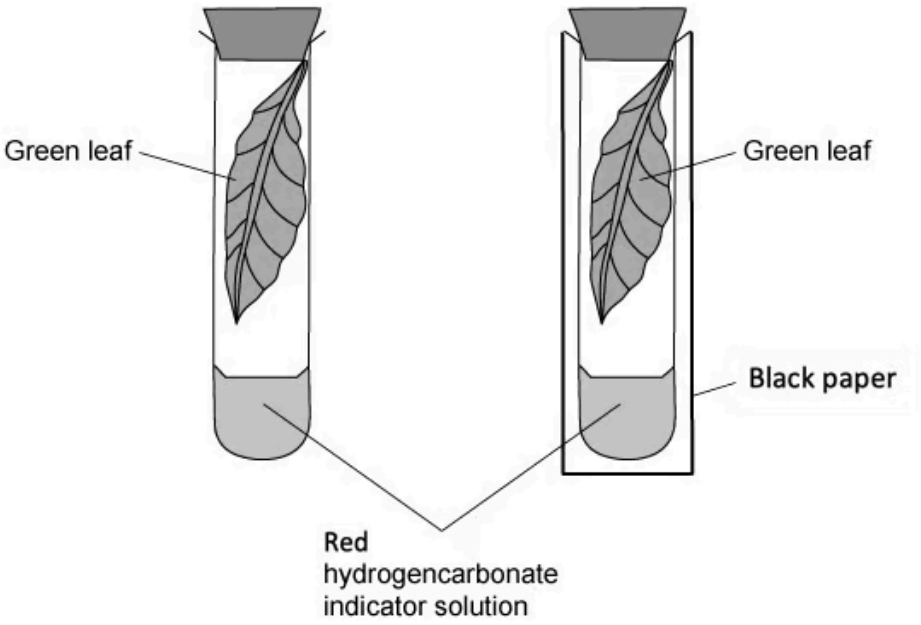
	1	2	3	4
A	spongy mesophyll cell	epidermal cell	palisade mesophyll cell	guard cell
B	palisade mesophyll cell	guard cell	spongy mesophyll cell	epidermal cell
C	epidermal cell	spongy mesophyll cell	palisade mesophyll cell	guard cell
D	palisade mesophyll cell	spongy mesophyll cell	guard cell	epidermal cell

Answer: B

6.

Two test tubes are set up with two similar leaves inside them, as shown in the diagram below.

One test tube is exposed to light, while the other is kept in the dark.



The test tubes are left for 4 hours.

What colour will the hydrogencarbonate indicator solution be in each test tube?

	dark	light
A	purple	yellow
B	colourless	yellow
C	purple	colourless
D	yellow	purple

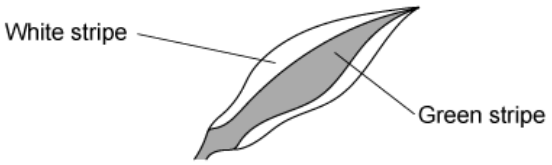
Answer: D

In the presence of low levels of carbon dioxide hydrogencarbonate indicator changes colour from red to purple, whereas in high levels of carbon dioxide hydrogencarbonate indicator changes colour from red to yellow.

7.

A student sets up a photosynthesis experiment.

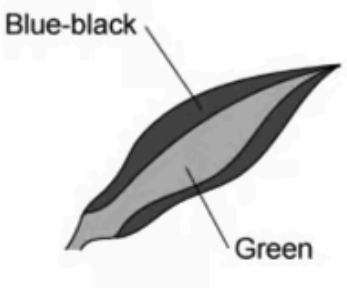
A plant with striped leaves (similar to the one shown below) was kept in bright light for four hours.



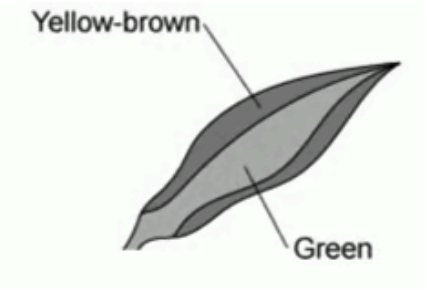
A leaf was removed from the plant and treated with ethanol in hot water to remove chlorophyll before iodine was used to test for starch.

Which diagram shows the result of the test?

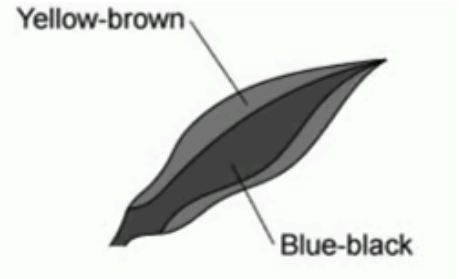
A.



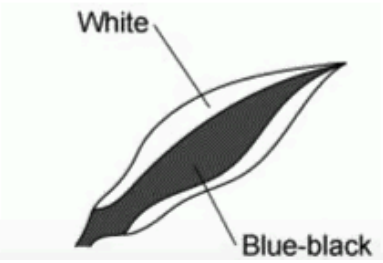
B.



C.



D.



Answer: C

8. **Why plants take up carbon dioxide during photosynthesis**
   - Carbon dioxide is the reactant of photosynthesis
   - Concentration of carbon dioxide is higher outside the leaf than inside, so it diffuses into the leaf

9. The rate of photosynthesis of parts of individual leaves can be measured using a hand-held device as shown in Fig. 1.

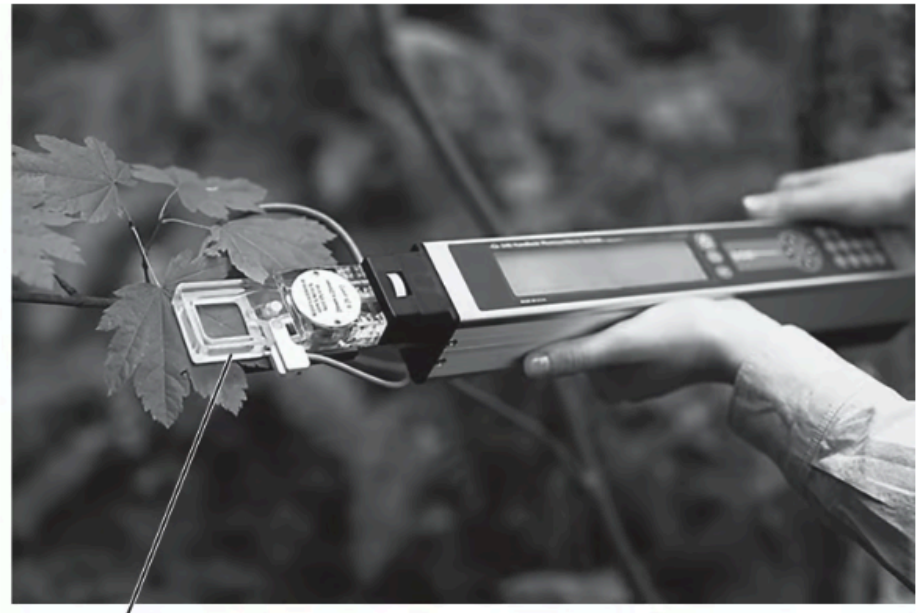


Fig. 1

This apparatus allows air to flow through the transparent chamber that encloses part of the leaf. The apparatus measures the carbon dioxide concentration of the air entering and leaving the chamber.

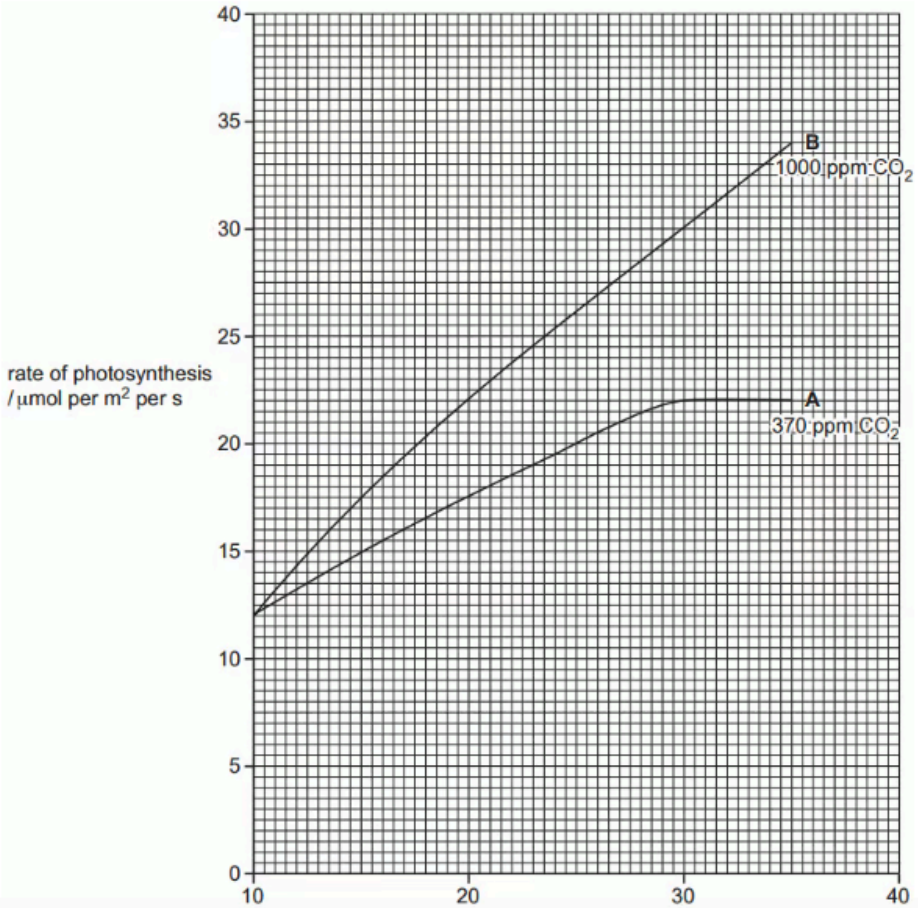
Explain how the results from the apparatus can be used to calculate the rate of photosynthesis.

- Calculate difference between initial carbon dioxide concentration (before entering the chamber) and final carbon dioxide concentration (after leaving the chamber)
- Divide by the time taken
- Rate of respiration should be taken into account

10.

A student used the apparatus shown in Fig. 1 to investigate the effect of temperature on the rate of photosynthesis of the leaves of Chinese plantain, *Plantago asiatica*, at two different concentrations of carbon dioxide, **A** and **B**.

Fig. 2 shows the results of the investigation.



a. Environmental factors that should have been kept constant

- Light intensity
- Water supply/ availability
- Humidity

b. Describe the effect of temperature on rate of photosynthesis when carbon dioxide concentration A was supplied

- Rate of photosynthesis increases and then levels off
- Levels off at 30℃

c. Explain the effect of increasing temperature on the rate of photosynthesis for carbon dioxide concentration B

- Temperature is the limiting factor (over whole range)

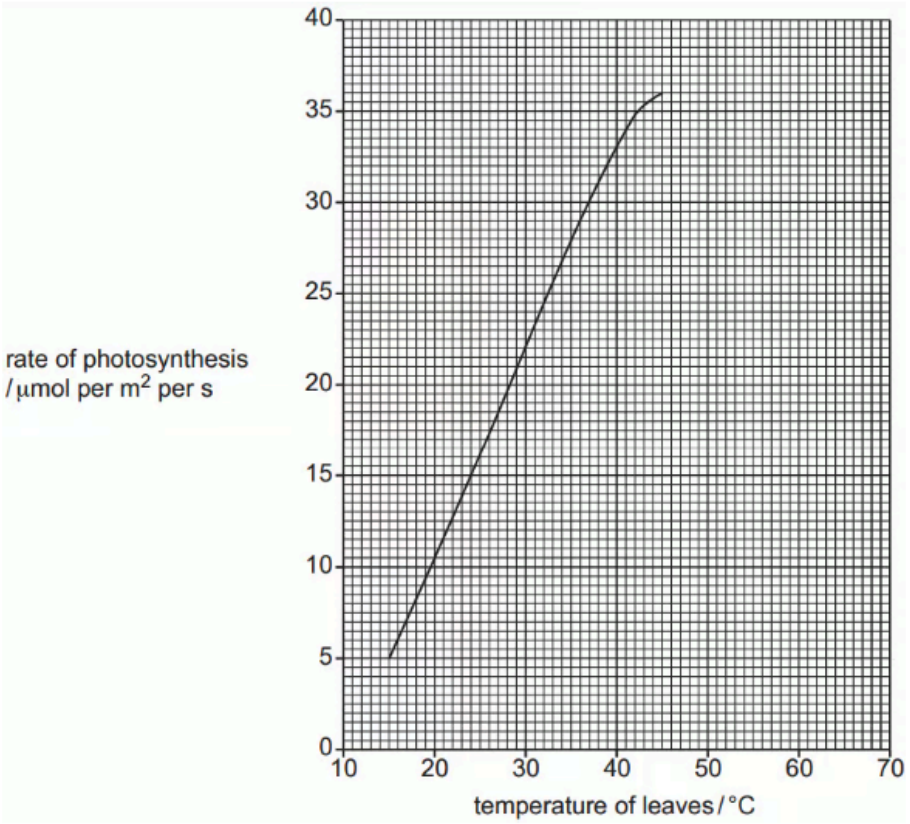
- Increased temperature increases kinetic energy / KE (of molecules)
- Increased movement of molecules increases rate of diffusion of CO2 into leaf
- Temperature influences/affects activity of enzymes
- More effective collisions occur between substrate molecules and enzymes / more enzyme-substrate complexes form
- More carbon dioxide is fixed / used in photosynthesis / converted into sugar
- Carbon dioxide (concentration) is not limiting

d. Student concludes that CO2 concentration is the factor limiting rate of photosynthesis between 30 and 35℃ for A. State evidence for this conclusion.
B shows that the rate of photosynthesis is higher / continues to increase if carbon dioxide is increased (at all temperatures)

11.

A similar investigation was carried out on Arizona honeysweet, *Tidestromia oblongifolia*, that grows in Death Valley in California where the highest temperatures may be greater than 45 °C.

The results are shown in Fig. 3.



Predict and explain what would happen to rate of photosynthesis if the investigation continued at temperatures higher than 45℃

- The rate of photosynthesis would decrease/ remains constant

- Because at such high temperatures, active site of enzymes will denature.
- At such high temperatures, stomata close, so CO2 cannot diffuse into the leaf.
- Plant is adapted to survive at high temperatures.

12.

A student investigated the effects of light and carbon dioxide on the rate of photosynthesis.

The number of bubbles of oxygen produced in one minute was counted in four different conditions.

Table 1 shows the results.

Table 1

test	conditions		number of bubbles of oxygen per minute
	light	carbon dioxide source added to the water	
1	present	no	2
2	absent	no	0
3	present	yes	20
4	absent	yes	0

State **two** conclusions about the conditions needed for photosynthesis using the information in Table 1.

- Light is needed for photosynthesis
- Carbon dioxide increases the rate of photosynthesis/ low levels of carbon dioxide results in a low level of photosynthesis.

13.

The volume of oxygen produced per hour was measured. The results can be seen in Table 1.

Table 1

temperature / °C	rate of photosynthesis / $cm^3 hour^{-1}$			
	test 1	test 2	test 3	mean
20	18.4	19.3	19.6	19.1
25	31.6	35.1	31.9	32.8
30	42.9	44.2	44.9	44.0
35	40.6	39.8	42.0	40.8
40	23.1	20.5	22.4	22.0
45	1.9	14.2	2.2	**X**

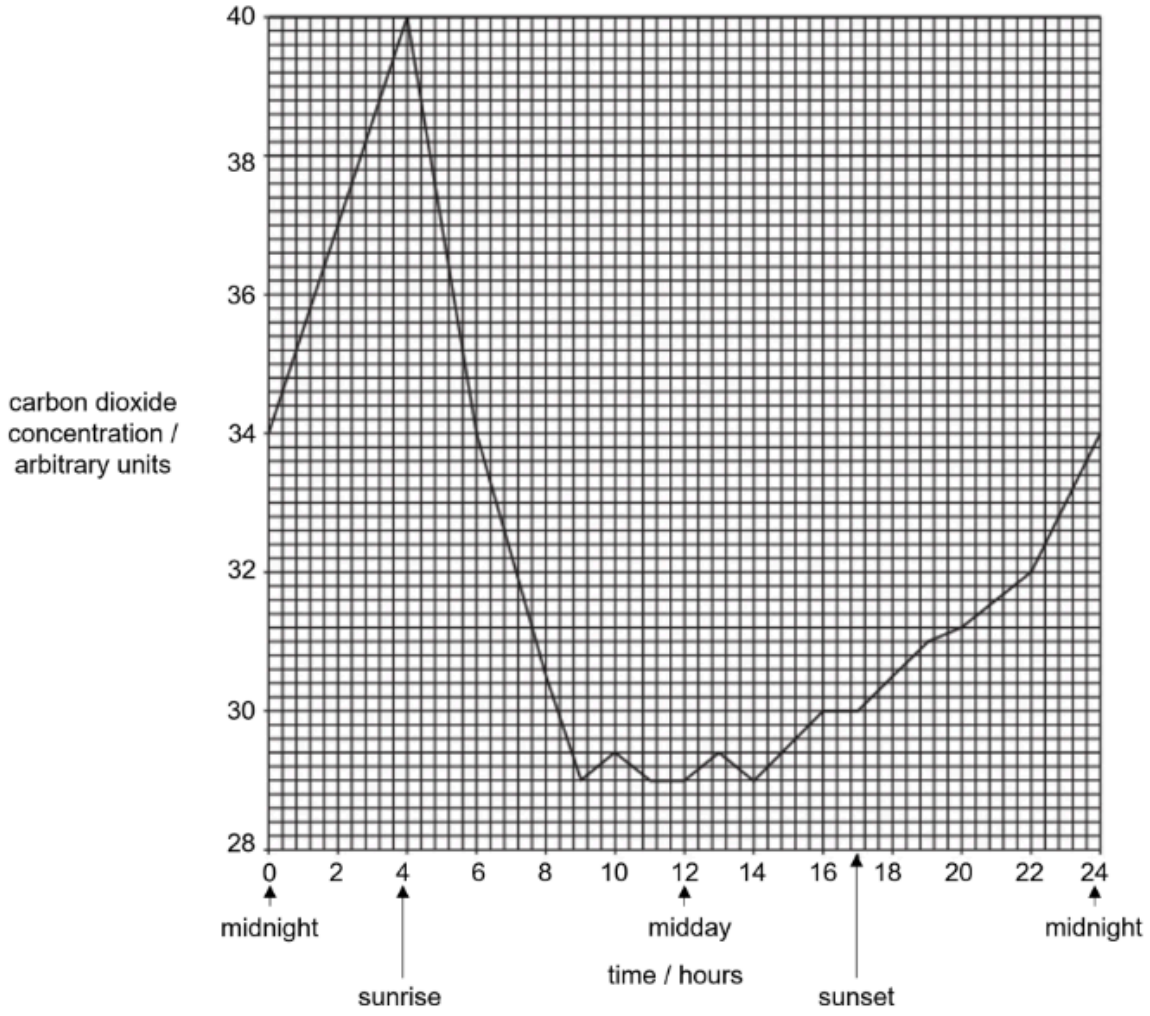
Calculate the mean rate of photosynthesis per hour when the temperature was 45 °C.

Exclude the anomalous result and calculate the mean.
Mean = 2.1 cm3/hr

14. **Testing a leaf for the presence of starch involves several steps. Explain the following:**
    a. Boiling the leaf at the start of the procedure
        - To kill the cells and break down the cell membranes // to make the cells more permeable for iodine solution
    b. Heating ethanol in a water bath
        - Ethanol is flammable / to avoid ethanol catching fire

15. **Energy conversion that occurs during photosynthesis:**
    light energy to chemical potential energy

16. **Why concentration of CO2 decreases between 04:00 and 09:00**



- sunlight is present / it is sunrise
- Carbon dioxide is absorbed / used by the plants
- for photosynthesis
- Photosynthesis is using carbon dioxide faster / at a higher rate than respiration can provide / replace it OR rate of photosynthesis is higher/faster than rate of respiration

Describe and explain the concentration of carbon dioxide between 16:00 and sunset

- Did not change / remained the same/constant
- Because rate of photosynthesis was equal to rate of aerobic respiration
- The amount of carbon dioxide absorbed by photosynthesis was the same as the amount of carbon dioxide released by aerobic respiration

Suggest why carbon dioxide concentration was highest at sunrise

- No photosynthesis occurred during the night
- This means no carbon dioxide was absorbed by the plant / the plant only released carbon dioxide by respiration

17. **Glucose is converted into insoluble starch for storage. Use your knowledge about osmosis to explain why plant cells don't use glucose as a storage molecule.**
    - Glucose is soluble and lowers the water potential of the cell
    - Water will move by osmosis from neighbouring cells
    - This increases the turgidity/turgor pressure of the cell

18.

Fig. 1 shows a diagram of a leaf.

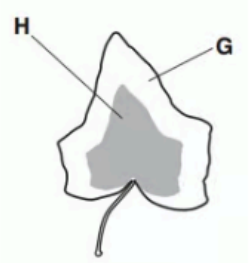


Fig. 1

- The part of the leaf labelled **G** contains no chlorophyll and is a white colour.
- The part of the leaf labelled **H** contains chlorophyll and is a green colour.

Glucose produced during photosynthesis is stored in the leaf as starch.

The leaf was boiled in ethanol to remove the chlorophyll. The leaf was then tested for the presence of starch with iodine solution.

This experiment was modified in order to investigate if light is needed for photosynthesis. Before carrying out the experiment, an important step had to be included to obtain accurate results.

a. **Describe this step**
   Destarch the plant by placing it in a dark cupboard for 24 hours

b. **Explain the importance of this step**
   - To ensure that any starch present in the leaf is used up / removed
   - This will avoid a positive result for starch in parts that were not exposed to light

19. **Purpose of adding NaHCO3 (sodium hydrogen carbonate) to water during a photosynthesis investigation of an aquatic plant**
    To act as a source of / provide carbon dioxide/CO2 to the plant

20. **Palisade and spongy mesophyll cells have large surface area. Explain why this is necessary for the functioning of the leaf cells.**
    - Cell surfaces are sites of gas exchange

- This means there is movement of gases by diffusion
- A large surface area gives efficient / faster gas exchange / diffusion / photosynthesis
- This is because carbon dioxide is raw material / needed for photosynthesis
- Diffusion allows absorption of carbon dioxide when light is available
- Diffusion also allows loss of oxygen when light available) / absorption of oxygen
- Oxygen is required for aerobic respiration
- Larger surface area also allows more evaporation
- Idea of maximising light absorption

21. Explain why there are many interconnecting air spaces within a leaf

- It allows for movement of oxygen/carbon dioxide/water vapour/gases / diffusion / gas exchange throughout the whole of the leaf
- This leads to faster / more efficient diffusion / gas exchange
- Gas exchange allows photosynthesis / respiration / transpiration / evaporation
- Reference to storage of carbon dioxide within the airspaces
- Air spaces connect to outside air via stomata

22. Describe the function of the stomata

- For gas exchange / diffusion of gases
- For photosynthesis / respiration / transpiration
- For diffusion of carbon dioxide into the cell / oxygen out of the cell
- Controls the rate of diffusion / transpiration / photosynthesis OR prevents wilting / excess water loss from the plant
- Aids in transpiration pull of water from the roots to the leaves

23. Why plants growing in soils lacking magnesium ions do not grow to full potential

- Magnesium is needed to synthesise chlorophyll
- Chlorophyll absorbs light to provide energy needed for photosynthesis
- Less light absorbed means less photosynthesis so plant synthesises/makes/produces less glucose
- Less glucose means less respiration and therefore less energy is released for growth
- Less glucose means less materials like amino acids / proteins / cellulose available for growth

24.

A student carried out an investigation into the effect of soil magnesium on plant growth.

In this investigation, the student set up two different environments as follows:

1. One plant was grown in sterile soil, provided with distilled water and placed in bright light.
2. One plant was grown in sterile soil, provided with magnesium dissolved in distilled water and placed in bright light.

Predict what the student will have observed after two weeks of growing in these conditions.

- Plant 2 will have shown a greater amount of growth compared plant 1
- Plant 1 will have yellow leaves

Explain this prediction

- Magnesium is needed for production of chlorophyll / chloroplasts
- In plant 1, lack of chlorophyll results in yellow leaves
- In plant 1, chlorophyll / chloroplasts are limiting factors OR in plant 2 there is more chlorophyll / chlorophyll is not a limiting factor
- More chlorophyll means more light can be absorbed for photosynthesis
- More photosynthesis means more glucose
- More glucose means more growth / more proteins / cellulose

When carrying out this investigation, students made sure they picked plants with the same number of leaves. Why?

- To ensure results were valid / comparable
- It was a control variable
- More leaves would mean more chlorophyll / chloroplasts
- More chloroplasts would lead to a faster rate of / more photosynthesis

25. Purpose of using aquatic plants for photosynthesis investigations

- The oxygen that is released can be seen as bubbles (because the plant is in water)
- This enables the investigator to count the number of bubbles produced in a minute // counting number of bubbles can be used to determine the rate of photosynthesis

26. Factors affecting the rate of photosynthesis

- Temperature
- Light intensity
- Carbon dioxide concentration
- Water
- Size/number/surface area of leaves
- Amount of chlorophyll/ number of chloroplasts
- Species/ type of plant

27. **Ways in which a plant uses carbohydrates produced during photosynthesis**
    - Glucose can be used in respiration to release energy to the plant
    - It may be converted into starch molecules for storage of energy; energy reserve in case the plant is unable to photosynthesise (if it's dark/winter)
    - It may be converted into cellulose or lignin to build cell walls
    - It could be converted into sucrose for transport in the phloem
    - It may form nectar to attract insects for pollination
    - Glucose in fruits to attract animals
    - May be converted to lipids: energy source in seeds // for synthesis of new cellular material eg. membranes
    - May be converted to amino acids: used to make proteins for growth

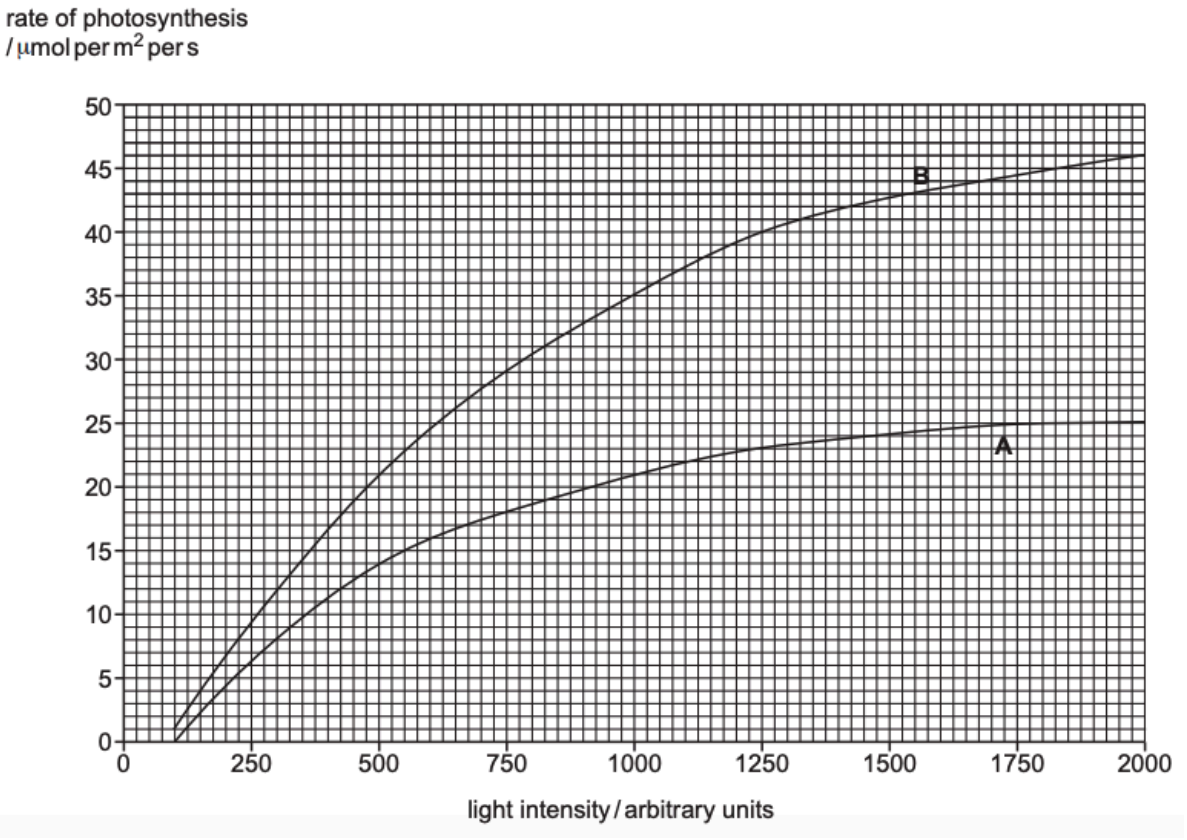
28. **Describe appearance of a plant that is deficient in nitrate**
    - Yellow leaves
    - Stunted growth

29. **Describe the movement of carbon dioxide from the atmosphere into the chloroplasts**
    - There is a higher concentration of carbon dioxide/CO2 in the atmosphere compared to inside the leaf
    - Carbon dioxide/CO2 diffuses into the leaf through open stomata
    - Into the air spaces between spongy mesophyll cells
    - It diffuses through the cell wall and cell membrane of mesophyll cells
    - It dissolves in the cytoplasm before diffusing into chloroplasts

30.

(b) Scientists investigated the effect of light intensity on the rate of photosynthesis in the leaves of eucalyptus trees at two different concentrations of carbon dioxide, **A** and **B**.

The results are shown in Fig. 2.1.



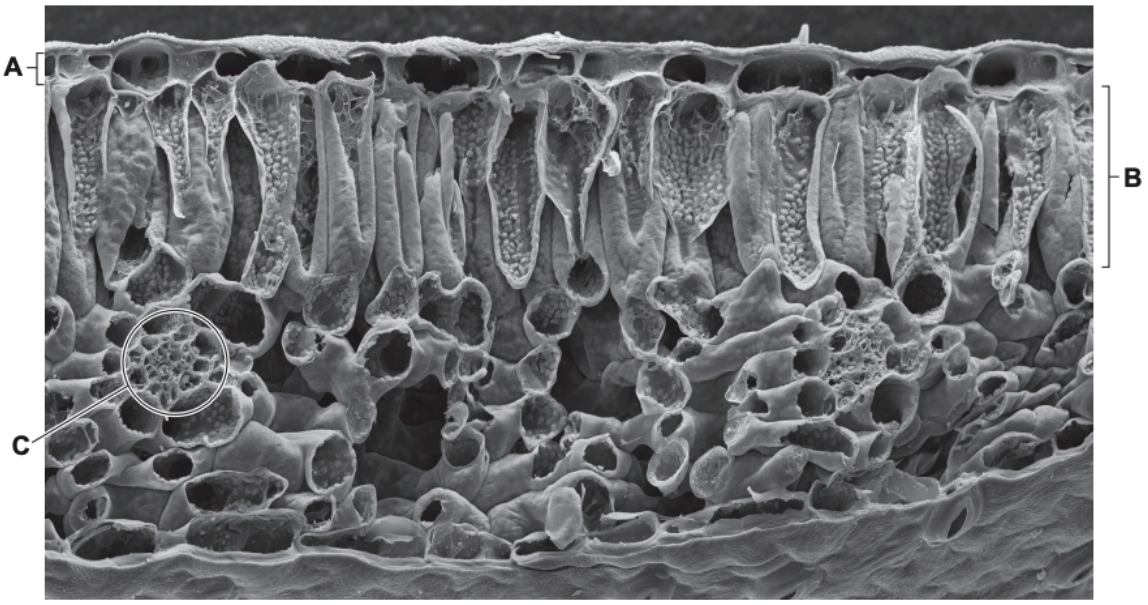
Explain the effect of increasing light intensity on the rate of photosynthesis when the the concentration of carbon dioxide was 1000 ppm (B). Use the term limiting factor in your answer.

- light intensity is the limiting factor, at all light intensities used / AW
- because rate of photosynthesis does not level off (even at high light intensities)
- carbon dioxide / temperature / chlorophyll / another factor, was not a limiting factor
- correct reference to (light) energy
- light is absorbed by chlorophyll

31. mineral required for the synthesis of chlorophyll

Magnesium

32.



Describe how the tissue labelled B is adapted to maximise photosynthesis.

- B is the palisade, mesophyll / tissue / layer / cells ;
- cells are tightly packed / AW ;
- ref. to many chloroplasts / lots of chlorophyll ;
- (cells) positioned at the top of the leaf ;
- (large vacuole) ensures chloroplasts are at the edge of cells ;

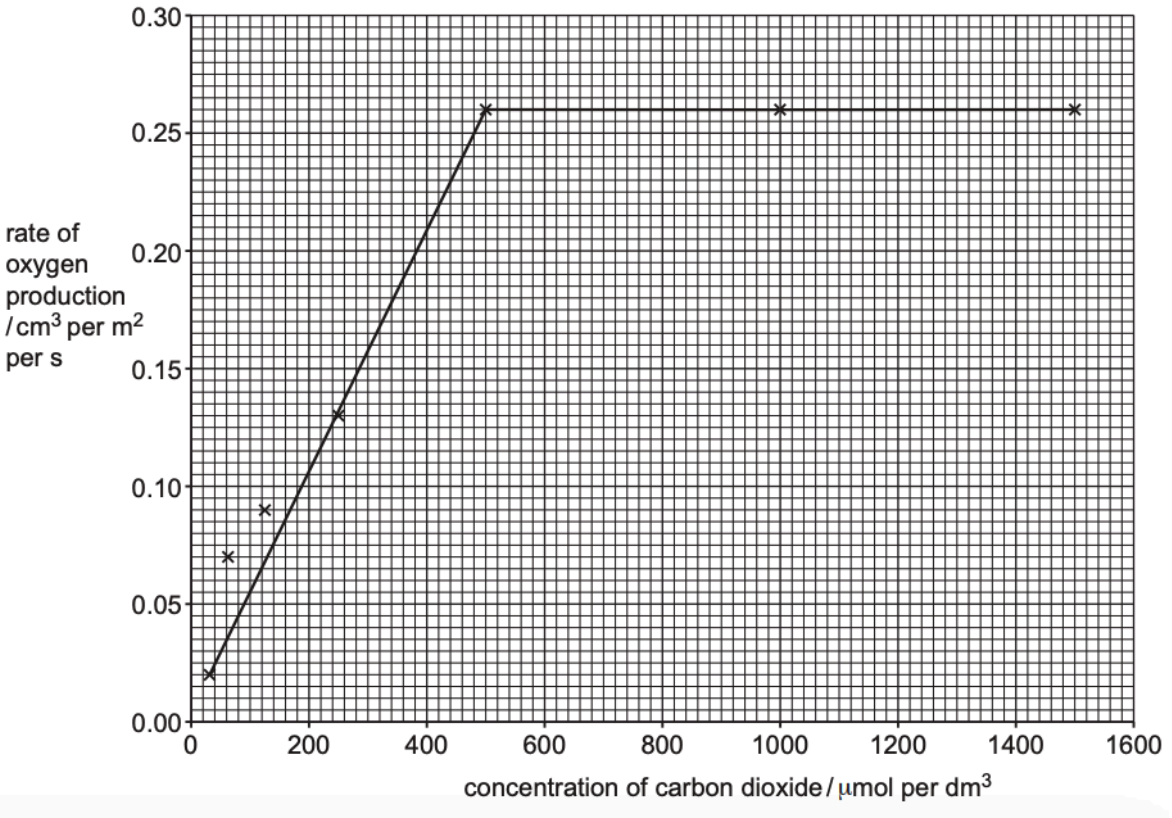
33. why some parts of a plant can act as both a source and a sink.

- (acts as a) source when it is (moving sucrose from) a region of production / photosynthesising ;
- (acts as a) sink when it is, growing / storing / respiring / a region of utilisation ;

34. Suggest why the rate of oxygen production is not the same as the rate of photosynthesis.

- not all the oxygen is, released / collected / measured (from the plant) ;
- some is used in respiration ;
- some is dissolved in the water ;
- (therefore) the rate of photosynthesis may appear lower than it actually is ;

35.



Explain the results shown

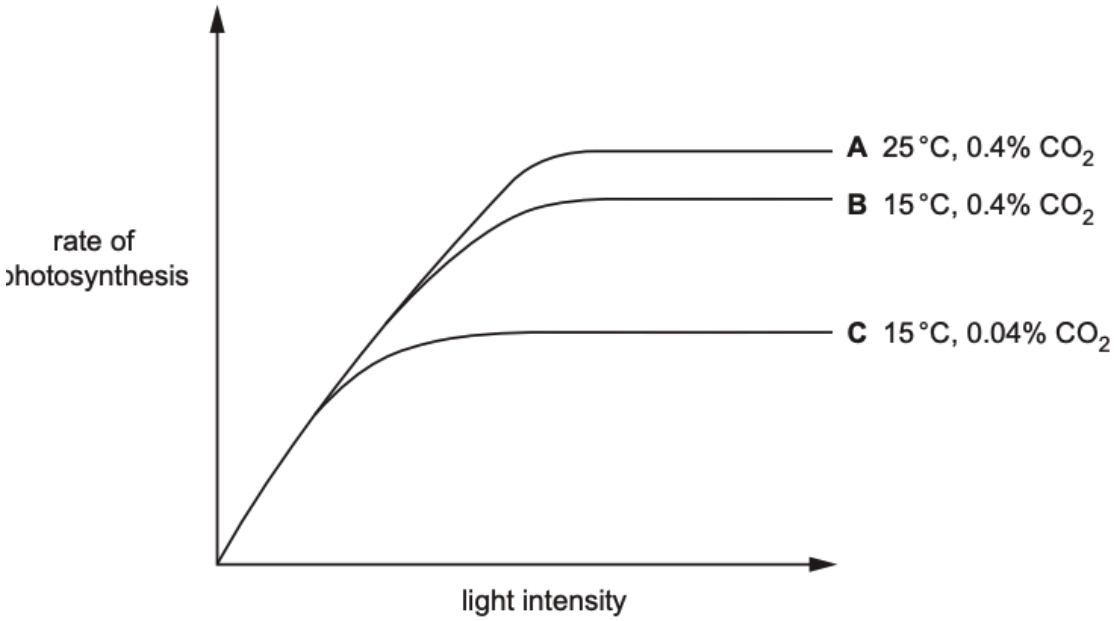
- carbon dioxide is required for photosynthesis ;
- initially carbon dioxide concentration is limiting the rate of photosynthesis ;
- (after 500 µmol per dm3) carbon dioxide concentration is not limiting the rate of photosynthesis / other factors are limiting the rate of photosynthesis ;
- ref. to named limiting factor

The investigation was repeated with the same type of aquatic plant at 10°C (instead of 20). Draw the shape of the graph for this.

- initial gradient is less steep ;
- plateau below original line ;

36.

Fig. 4.1 shows the effect of light intensity on the rate of photosynthesis at different temperatures and concentrations of carbon dioxide.



Describe and explain the reasons for the shape of lines B and C

Light

- (B and C as light intensity increases) the rate (of photosynthesis) increases and remains constant
- rates (of photosynthesis) are the same at low(est) light intensities
- light provides energy (for photosynthesis)
- where the line rises / initially, light intensity is limiting / the limiting factor
- line(s) / rate levels off where light intensity is not limiting
- in B light intensity becomes limiting at higher light intensity than C

Carbon dioxide

- line C levels off, at a lower rate (of photosynthesis) / lower light intensity
- carbon dioxide (concentration) is, lower for C / 0.04% vs 0.4%
- carbon dioxide is, reactant / substrate / raw material / needed for photosynthesis
- in C carbon dioxide is a limiting factor at a lower light intensity / in B carbon dioxide is a limiting factor at a higher light intensity

Temperature

- Temperature is limiting for B and C at high light intensities

37. Functions of phloem

- Translocation

- Transport of sucrose / amino acids / sugars
- Transports nutrients from source to sink
- Transport can occur in both directions

38.

Aphids have been used to investigate the translocation of sucrose in phloem tissue. While they are feeding on phloem sap aphids excrete a sucrose-rich fluid known as honeydew.

In an investigation, two groups of four aphids were placed at intervals along the stem of a young willow plant, as shown in Fig. 3.2.

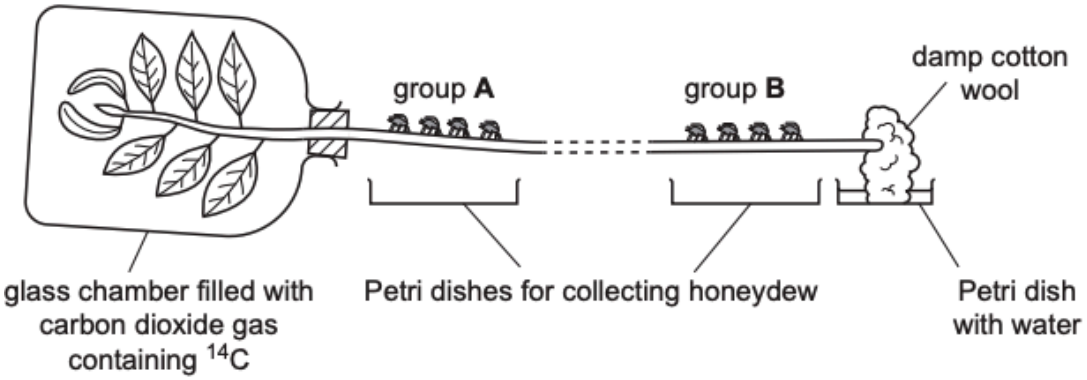


Fig. 3.2

The leaves were enclosed in an airtight glass chamber. A special form of carbon dioxide gas that contained radioactive carbon-14 (^{14}C) was supplied to the leaves for a short period of time.

Samples of honeydew were collected at intervals from the groups of aphids. The time taken for sucrose containing ^{14}C to travel the distance between group **A** and group **B** was recorded.

Aphid: an insect

Outline how ^{14}C in carbon dioxide gas becomes incorporated into the sucrose molecules that are translocated in the phloem.

- carbon dioxide / ^{14}C enters leaf through stomata by diffusion
- photosynthesis occurs
- carbon dioxide and water is used to make glucose / (simple) sugar
- photosynthesis is catalysed by enzymes
- reactions occur in chloroplasts
- glucose / (simple) sugars, converted to sucrose

39. 2 parts of a plant that are sinks for sucrose

- buds / root (tips) / tubers / storage
- organs / flowers / fruits / seeds / young or growing leaves / shoot tips / nectaries

40. **Sucrose is used in the cells of the sinks in a plant. Describe the uses of sucrose by sinks.**
    - sucrose is converted to glucose
    - glucose respired to provide energy
    - for plant process that requires energy e.g. growth / reproduction / flowering / active transport / absorption of ions / cell division / mitosis / metabolism / fruit formation
    - sucrose is stored as starch
    - used to make cellulose (for cell walls)
    - converted to amino acids (used to make proteins)
    - used to make nectar

41. **Uses of carbohydrates in plants**
    - cellulose
    - for cell walls
    - starch
    - for energy/respiration
    - to attract insects to flowers / nectar / fruits

42. **Uses of amino acids in plants**
    - to make proteins
    - for enzymes
    - for growth

43. **Why plants take up carbon dioxide during photosynthesis**
    - carbon dioxide is raw material / substrate / reactant
    - concentration of carbon dioxide is higher outside leaf than inside (so carbon dioxide diffuses into the leaf)

44.

The rate of photosynthesis of parts of individual leaves can be measured using a hand-held device as shown in Fig. 2.1.

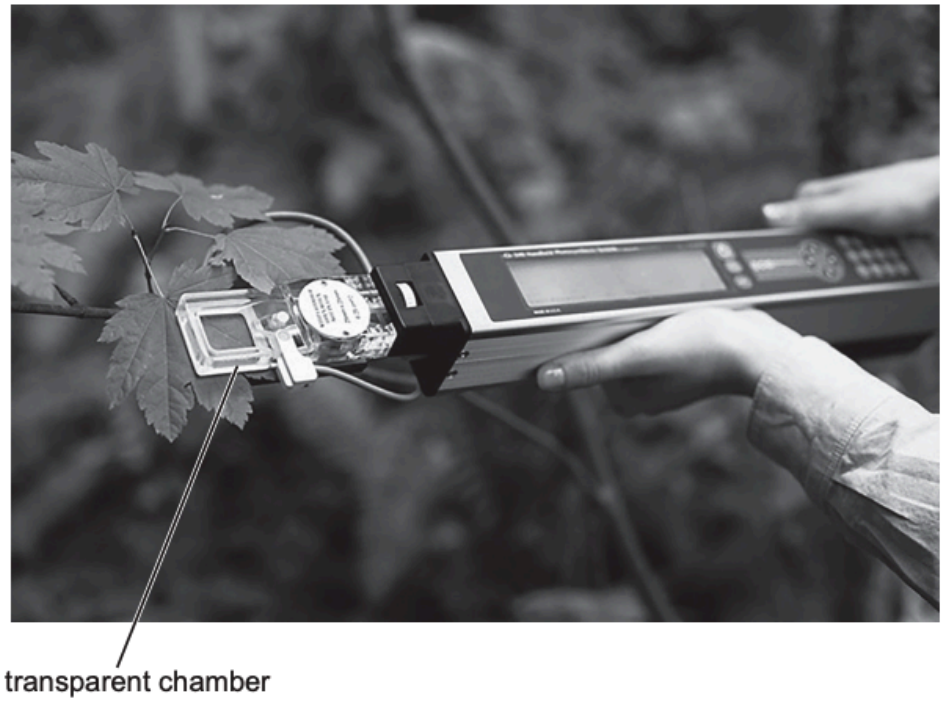


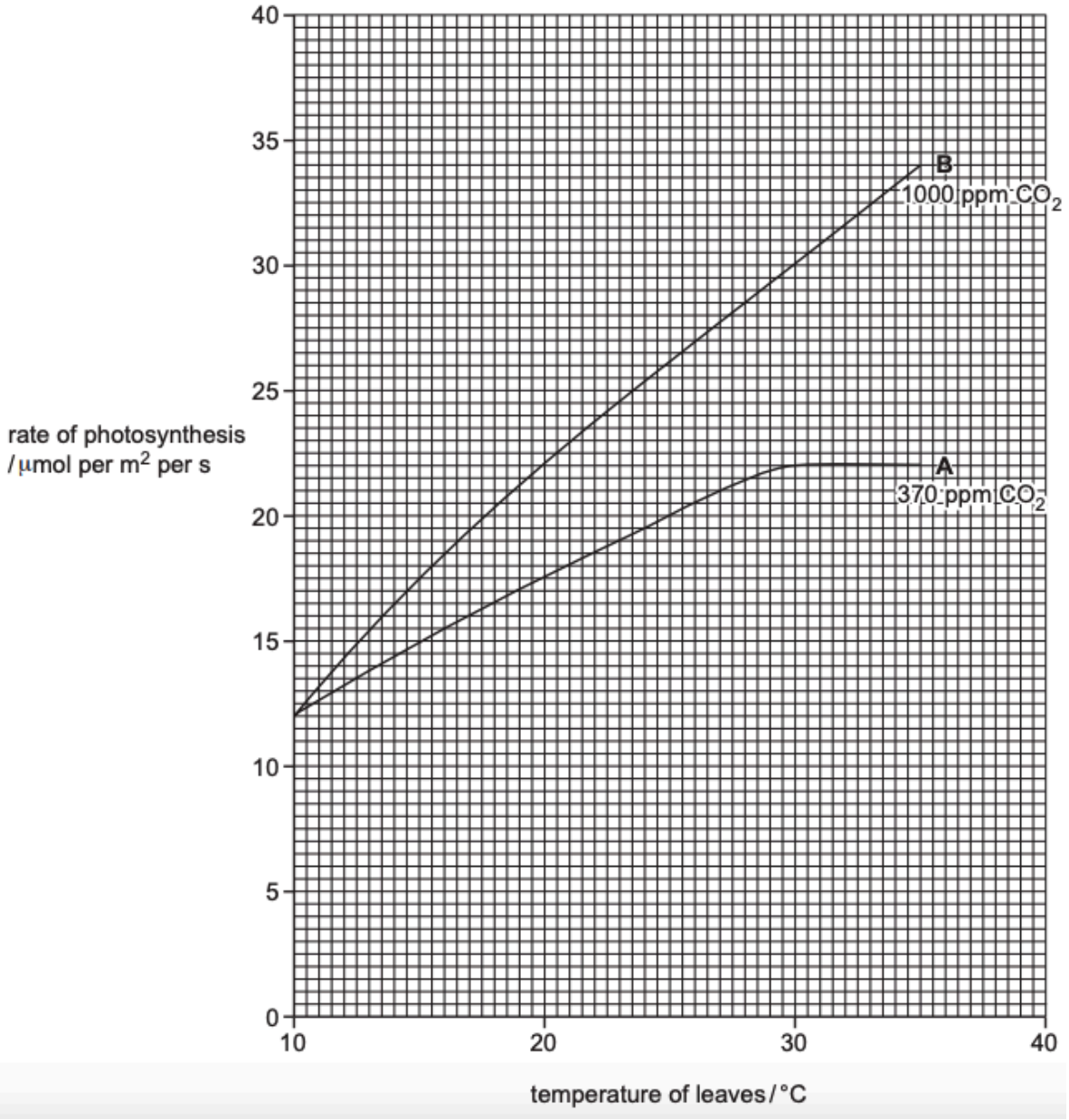
Fig. 2.1

This apparatus allows air to flow through the transparent chamber that encloses part of the leaf. The apparatus measures the carbon dioxide concentration of the air entering and leaving the chamber.

Explain how results from the apparatus can be used to calculate rate of photosynthesis.

- subtract concentration of carbon dioxide at the end from the concentration at the start
- divide by the time taken / per unit time
- take rate of respiration into account

45.



A student used the apparatus shown in Fig. 2.1 to investigate the effect of temperature on the rate of photosynthesis of the leaves of Chinese plantain, *Plantago asiatica*, at two different concentrations of carbon dioxide, **A** and **B**.

Fig. 2.2 shows the results of the investigation.

State environmental factors that should have been kept constant in this investigation.

- Water supply
- Light intensity
- Humidity

Describe the effect of temperature on the rate of photosynthesis when carbon dioxide concentration A was supplied.

- increases and, reaches a plateau / remains constant / levels off

- increases between 10 °C to 30 °C / levels off at 30 °C
- any comparative use of figures for rate with units at least once

Explain the effect of increasing temperature on the rate of photosynthesis for carbon dioxide concentration B. Use the term limiting factor in your answer.

- temperature is the limiting factor (over whole range)
- increased temperature increases kinetic energy / KE of molecules
- increases rate of diffusion of carbon dioxide into leaf
- temperature influences / affects activity of enzymes
- more effective collisions between substrate molecules and enzymes (in plant) / more enzyme-substrate complexes formed
- more carbon dioxide is fixed / used in photosynthesis / converted into sugar
- carbon dioxide (concentration) is not limiting

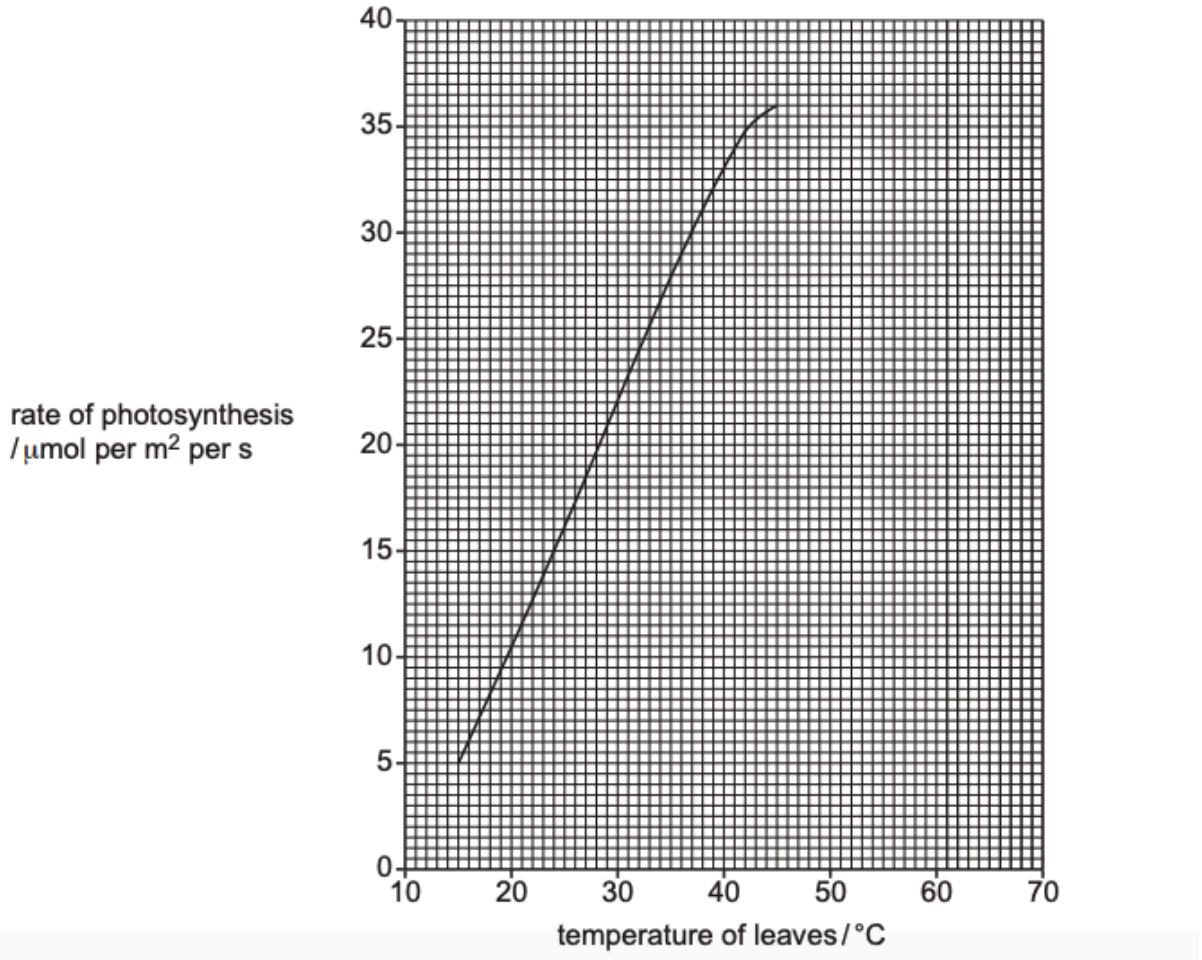
The student concluded that carbon dioxide concentration is the factor limiting the rate of photosynthesis between 30°C and 35°C for the results shown for A. State evidence for this conclusion.

B shows that rate of photosynthesis is higher / continues to increase if carbon dioxide is increased (at all temperatures)

46.

A similar investigation was carried out on Arizona honeysweet, *Tidestromia oblongifolia*, that grows in Death Valley in California where the highest temperatures may be greater than 45 °C.

The results are shown in Fig. 2.3.



Predict and explain what would happen to the rate of photosynthesis if the investigation is continued at temperatures higher than 45°C.

prediction:

- rate of photosynthesis remains constant / decreases / slows

explanation:

- enzymes / active sites are denatured at high temperatures
- stomata close, so, little / no carbon dioxide can enter leaves
- plant is adapted to survive at high temperatures

47.

Researchers used carbon dioxide that contained a traceable source of carbon (^{13}C) to investigate translocation of sucrose from the leaves of bean plants, *Phaseolus vulgaris*.

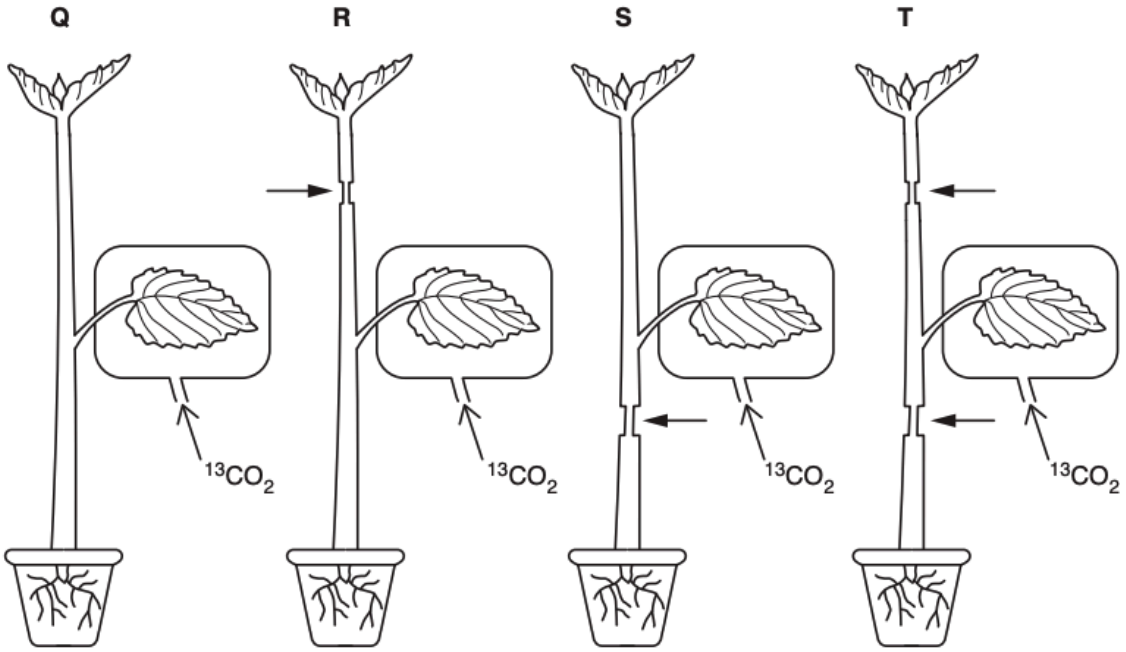
Fig. 2.2 shows that glucose produced in photosynthesis is converted to sucrose for translocation.

carbon dioxide ⟶ glucose ⟶ sucrose

Fig. 2.2

Researchers selected four plants, **Q**, **R**, **S** and **T**, which had leaves that were of similar sizes. The leaves on the four plants were supplied with $^{13}CO_2$.

After the leaves had started to make sucrose, the researchers cut away a ring of tissue in different places as shown in Fig. 2.3. The rings of tissue that were removed from plants **R**, **S** and **T** contained the phloem.



Key: ⟶ the positions on the stems where rings of tissue containing phloem were removed.

Fig. 2.3

The quantities of sucrose containing ^{13}C in the shoot tips and in the roots were determined.

The results are shown in Table 2.1.

Table 2.1

plant	quantity of sucrose containing ^{13}C/arbitrary units	
	shoot tip	root
Q	3.24	0.94
R	0.00	0.44
S	4.14	0.00
T	0.00	0.00

Describe and explain the effect of removing the phloem on the translocation of sucrose in plants Q, R, S and T.

- Q- sucrose is in shoot and root
- T- no sucrose in shoot or root
- R- sucrose in root only / (in root but) not in shoot
- S- sucrose in shoot only / (in shoot but) not in root
- no transport of sucrose where phloem is removed
- phloem transports sucrose in both directions
- leaf is source / carbon (dioxide) is fixed in leaf / sucrose is made in leaf
- roots / shoots are sinks
- Q is a control

48. How glucose is produced in leaves

- glucose is produced by photosynthesis
- light energy is trapped by chlorophyll
- light energy is converted to chemical energy
- carbon dioxide and water are used / react together
- to produce glucose and oxygen

49. Why roots sometimes act as a source rather than a sink

- sometimes leaves cannot produce enough glucose/ carbohydrates
- sometimes roots release energy / glucose / sucrose
- for respiration
- example of use of energy in a plant: flowering / new leaves / growth

50.

Soybean plants, *Glycine max*, were grown in two separate plots.

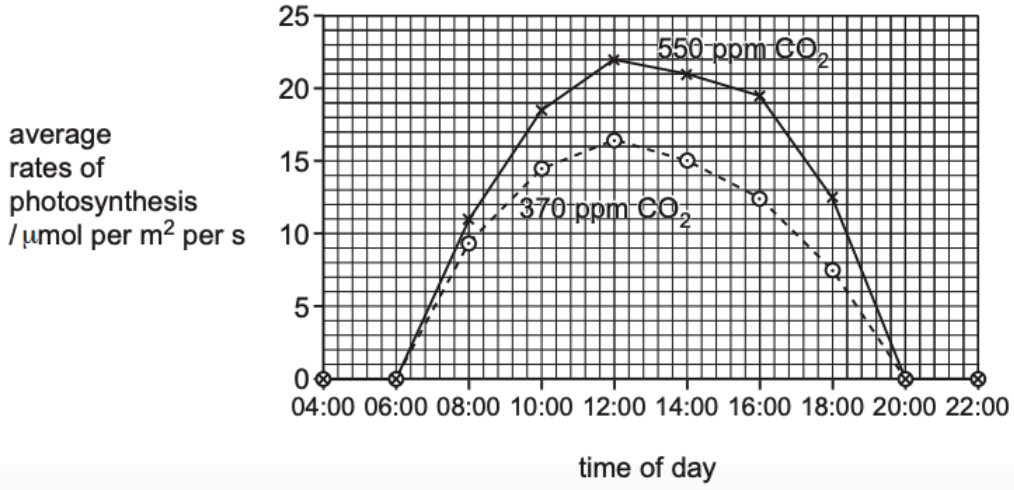
Each plot used a carbon dioxide enrichment system to control the atmospheric carbon dioxide concentration.

The atmospheric carbon dioxide concentrations in the two plots were kept at:

- 370 ppm, which is similar to the current atmospheric carbon dioxide concentration
- 550 ppm, which is a possible future atmospheric carbon dioxide concentration.

When the soybean plants were fully grown, scientists calculated the average rates of photosynthesis at regular intervals from 04:00 to 22:00 for both plots.

The results are shown in Fig. 2.1.



Describe and explain the effect of carbon dioxide concentration on the average rates of photosynthesis of the soybean plants from 04:00 to 22:00.

description:

- both plots / 550 and 370 ppm follow same trend / pattern
- photosynthesis starts at 06:00 and stops at 20:00
- rate of photosynthesis peaks at 12:00 / midday / noon
- rate of photosynthesis at 550 ppm is greater than at 370 ppm
- comparative data quote between two plots with units at least once

explanation:

- maximum light at 12:00 / dark until 6:00 / after 20:00
- light intensity is a limiting factor
- because light is required for photosynthesis
- CO2 is a limiting factor
- at high atmospheric CO2, the concentration gradient (to air spaces) is steeper / diffusion is faster
- effect of CO2 concentration is most at high light intensities

- temperature is a limiting factor
- higher temperature causes increased rate of photosynthesis

51. How epidermis is adapted for photosynthesis

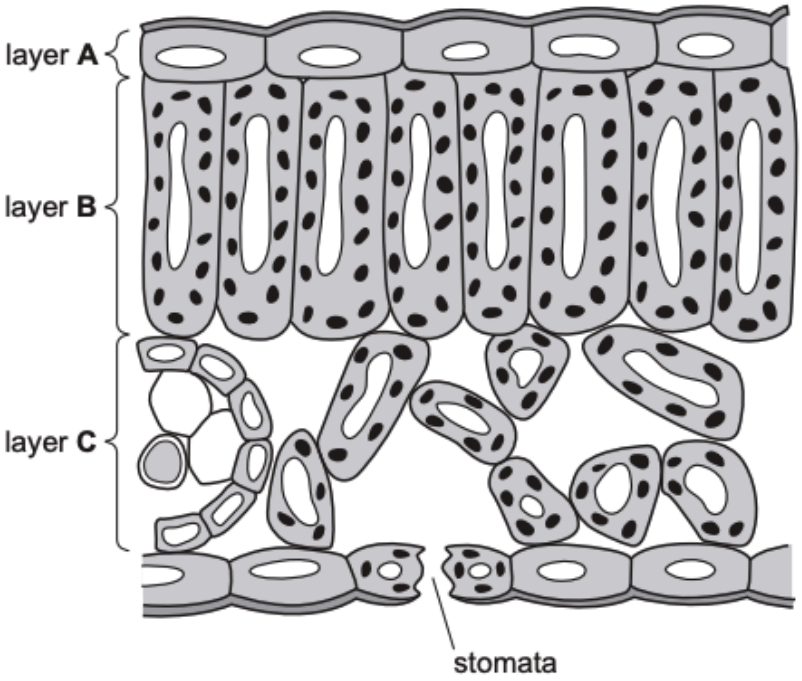
- thin/flat: so less cytoplasm / more light, to pass through
- transparent/clear/no chloroplasts: allows light to pass through
- stomata/guard cells: allow gases to enter / leave the leaf / gas exchange

52. How mesophyll is adapted for photosynthesis

- Palisade contains many chloroplasts: to trap light energy
- Palisade is vertically / tightly packed / column shaped: maximise light received by cells / reduce number of cross / cell wall
- Contains air spaces/ loosely packed/ spongy: for diffusion/ movement of gases within leaf

53.

Fig. 1.1 is a diagram of part of a cross-section of a leaf.



Explain how layer B and layer C in Fig. 1.1 are adapted for their functions.

- ref to photosynthesis ;
- B is the palisade (mesophyll / tissue / layer / cells) and C contains spongy (mesophyll / tissue / layer / cells) / vascular bundles / xylem / phloem ;

<u>Any three for layer B</u>

- cells are, tightly / vertically, packed or columnar or few cross walls ;

- (cells / layer) positioned (immediately) below, layer A / the upper epidermis ;
- to (maximise) light (energy) reaching, cells / chloroplasts / layer ;
- ref to many chloroplasts / lots of chlorophyll ;
- (large) vacuole keeps the chloroplasts towards the sides of cells ;

any three for layer C

- cells are loosely packed / layer contains (interconnecting) air spaces (between cells)
- (mesophyll / air spaces) to allow, gas exchange / diffusion of (named) gases ;
- (mesophyll / air spaces) to allow evaporation (of water) from cell surfaces (into air spaces) ;
- (xylem) has, thick / lignified / waterproofed / pitted, cell wall ;
- (xylem) (long) continuous tube / no cytoplasm / hollow or no end / cross, walls ;
- (xylem) to allow transport of, water / mineral ions ;
- (phloem) to allow, translocation / transport of, sucrose / sugar / amino acids ;

54. Why plants store starch.

- Energy store/sink
- Reserve store of energy in case the plant cannot photosynthesise/ it is in a state of dormancy / night / winter

55. Girdling involves removing a complete circle of bark and phloem from around a tree:

Explain why the area above the girdle in Fig. 4.1 will become swollen. Use the terms source and sink in your answer

- ref to translocation ;
- carbohydrates / glucose / sugars / amino acids, made in the leaves OR ref to photosynthesis in leaves ;
- glucose / carbohydrates, converted to sucrose ;
- leaves act as a source and roots act as a sink ;
- phloem transports sucrose / amino acids ;

- sucrose / (named) sugars, collect above the girdle ;

Explain why the leaves in girdled trees are still able to receive mineral ions from the roots.

- xylem is still intact / idea that xylem is further inside the trunk ;
- mineral ions transported by xylem ;

56. Explain why glucose made during photosynthesis is required for the absorption of mineral ions by the roots.

- glucose required, for (aerobic) respiration / to release energy / for ATP production ;
- ref. to active transport ;
- to transport mineral ions, from low to high concentration / against their concentration gradient ;

57. Explain the effect of a lack of magnesium ions on the colour of plant leaves.

- (leaves are) yellow / (leaves show) chlorosis ;
- magnesium required for making chlorophyll ;

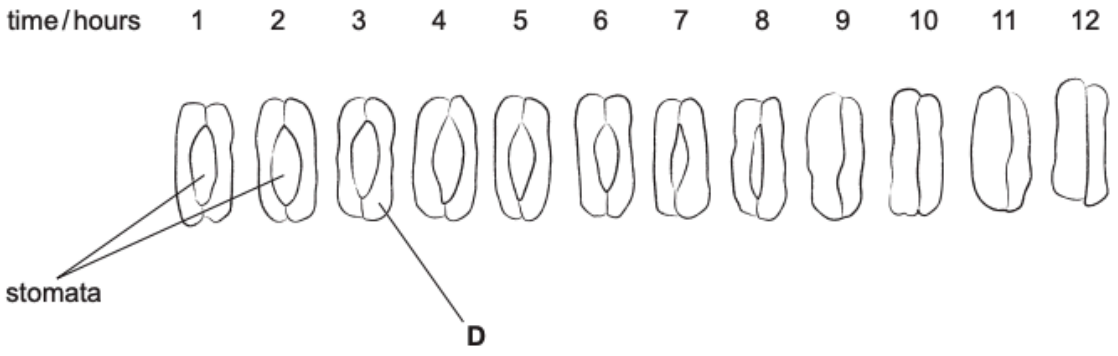
58. State the main function of the stomata.

Gas exchange

59.

(c) A student placed a plant in a very hot room for 12 hours. There was a bright light in the room and the plant was not given any water during the 12-hour period.

Fig. 1.2 shows a series of sketches that the student made of the stomata during the investigation.



State the advantage to the plant of the change to the stomata shown

- reduce water loss (through transpiration) ;
- ref to preventing wilting ;

The student increased the humidity in the room and repeated the investigation. Predict and explain the effect of high humidity on the stomata.

- stomata will take longer to close / reduces (stomatal) closure / reduces (stomatal) response ;
- reduced, water vapour / concentration / diffusion, gradient (between the air spaces and the outside) ;
- so the (guard) cells do not lose water (as, quickly / much as the first experiment) ;
- the (guard) cells, stay / become, turgid or (guard) cells take longer to become flaccid

60. **Suggest why oxygen and water are required for germination.**

Oxygen

- aerobic respiration

Water

- used in (named) cell process
- Is a solvent
- used for turgor pressure

61. **Describe the pathway taken by a molecule of carbon dioxide, from the air outside a leaf to a spongy mesophyll cell.**

- enters through stomata / between guard cells
- moves through interconnecting / intercellular / air spaces

Outline how carbon dioxide in a glasshouse moves into leaves

- diffusion / high concentration to low concentration
- through stomata / guard cells

62. **Artificial photosynthesis uses a catalyst to utilise green light to convert carbon dioxide to fuels, such as propane. Suggest advantages to the environment of using artificial photosynthesis on a large scale.**

- reduces extraction / conserves (named) fossil / non-renewable fuels
- (temporarily) removes carbon dioxide / greenhouse gases (from atmosphere) / does not add more carbon dioxide / greenhouse gas (to the atmosphere) / process is *carbon neutral*
- does not cause / prevents a further increase in enhanced greenhouse effect
- does not cause / prevents further increase in global warming / prevents further climate change
- is a sustainable process / uses renewable fuel source

63. **Glasshouses are designed to maximise crop plant yield. Explain why carbon dioxide enrichment is used in many glasshouses to increase crop plant yield.**
    - carbon dioxide is needed for photosynthesis
    - (atmospheric) carbon dioxide concentration is a limiting factor
    - glucose is a product of photosynthesis / needed for growth

    Suggest how carbon dioxide concentration in a glasshouse can be enriched.
    (named fossil fuel) burners / carbon dioxide gas cylinders

    Explain the possible effects of excessive heat on plants in a glasshouse
    - enzymes are involved in photosynthesis / respiration
    - too much heat can denature enzyme / change shape of active site
    - Describe transpiration / water vapour loss
    - more likely to wilt
    - decrease in yield / death