

Biological Processes

Made using advanced information

A Murray

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:

Additional resources may be supplied with this paper.

Other materials required:

- Pencil
- Ruler (cm/mm)

Duration: 2 hours 15 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **100**
- The total number of marks may take into account some 'either/or' question choices.

1. Fig. 5.1 shows part of a conjugated protein that is a respiratory pigment in muscle cells.

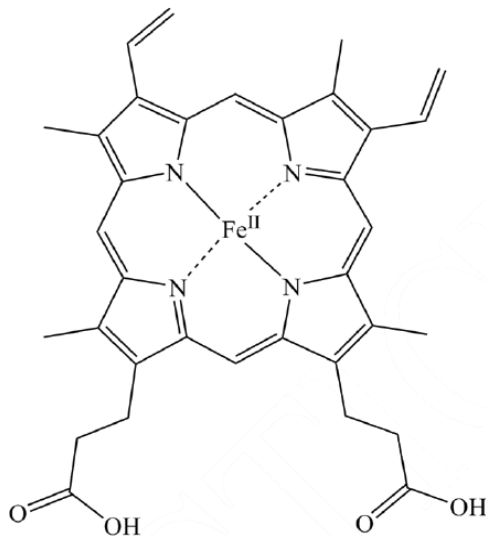


Fig. 5.1

Which part of the molecule does Fig 5.1 represent?

- A prosthetic group
- B disulfide bond
- C quaternary structure
- D polypeptide

Your answer

☐

[1]

2. Which of the following is **not** a role of an intracellular membrane?

- A cell to cell signalling
- B partially permeable barrier
- C site of chemical reactions
- D transport of substances across the membrane

Your answer

☐

[1]

3. After being mixed with iodine, which of the following would show a blue / black colour?

- A potato tuber cells
- B erythrocytes
- C sieve tube elements
- D neutrophils

Your answer ☐

[1]

4. Three types of microscope are listed below.

Select the row that shows the correct use for each type of microscope.

	Type of microscope and what it is used to observe		
	Light microscope	Transmission electron microscope	Laser scanning confocal microscope
A	an object at a certain depth within a cell	cell surfaces	organelles
B	an object at a certain depth within a cell	cell surfaces	whole cells and tissues
C	whole cells and tissues	organelles	cell surfaces
D	whole cells and tissues	organelles	an object at a certain depth within a cell

Your answer ☐

[1]

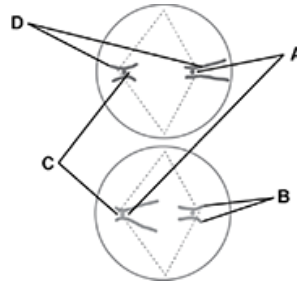
5. Which of the following statements describes an organelle which is **not** membrane bound?

- A. contains cristae
- B. modifies and packages proteins
- C. contains digestive enzymes
- D. is made of rRNA and protein

Your answer ☐

[1]

6. The diagram below shows the arrangement of chromosomes in a cell during metaphase 2.



Which letter indicates a homologous pair of chromosomes?

Your answer

[1]

7. DNA polymerase catalyses the formation of phosphodiester bonds during DNA replication.

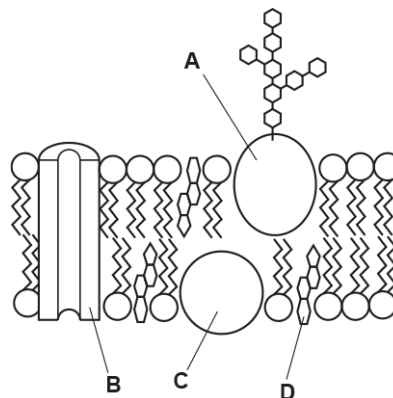
Which of the statements, **A** to **D**, will **not** affect the rate of phosphodiester bond formation?

- A** temperature
- B** length of DNA molecule
- C** pH
- D** free nucleotide availability

Your answer

[1]

8. The diagram below shows the structure of a plasma membrane.



Which label, **A** to **D**, indicates the component of the membrane that can affect its fluidity?

Your answer

[1]

9. Which of the following best describes a microscope with *high resolution*?

- A** The microscope can distinguish structures that are very close together.
- B** The microscope can view structures that are very small.
- C** The microscope is capable of high magnification.
- D** The microscope has an in-built eyepiece graticule.

Your answer

[1]

10. Animals receive different stimuli from their environment. Their synapses can manage multiple stimuli, often resulting in one response (such as a muscle twitching).

This action of the synapse is an example of

- A** spatial summation
- B** all or nothing response
- C** temporal summation
- D** cell signalling

Your answer

[1]

11. The kidneys of a healthy individual filter $178 \text{ dm}^3 \text{ day}^{-1}$ of fluid from the glomeruli into the renal capsules. However, only $1.5 \text{ dm}^3 \text{ day}^{-1}$ of urine is produced.

What percentage of the filtrate is reabsorbed back into the blood?

- A** 176.5

- B** 0.8
- C** 11.8
- D** 99.2

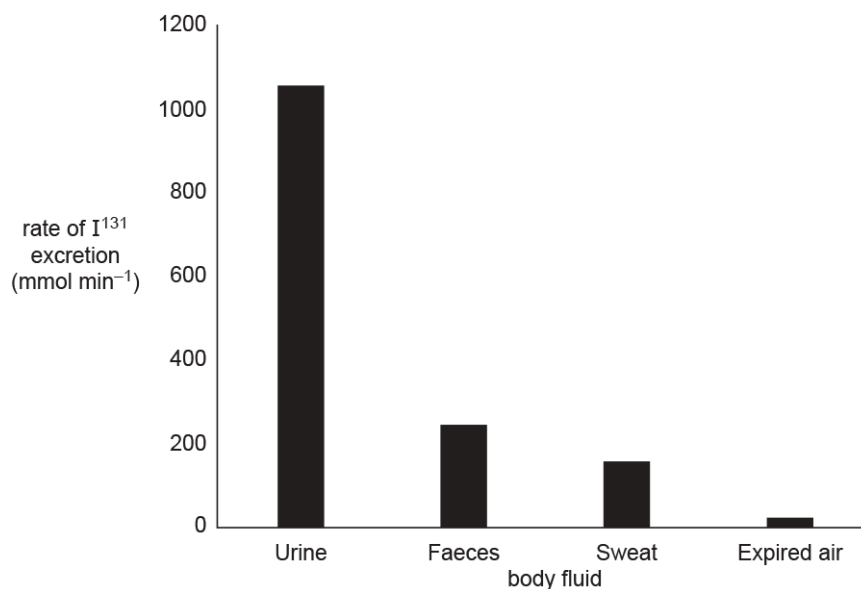
Your answer

[1]

- 12.** One treatment for thyroid cancer is radioactive iodine. The radioisotope I^{131} is used.

The thyroid gland absorbs any iodine that enters the body, so the radioactive isotope kills the cancerous cells in the thyroid gland. The I^{131} is then excreted from the body.

Different body fluids excrete different proportions of I^{131} , as shown in the following graph.



Which of the following, **A** to **D**, correctly explains the different proportions of I^{131} in each body fluid?

- A** I^{131} is very soluble in water.
- B** I^{131} is able to cross capillary walls.
- C** The kidneys are more efficient at excreting I^{131} than the lungs.
- D** The thyroid gland is well supplied with blood.

Your answer

[1]

- 13.** Citrate synthase catalyses the conversion of oxaloacetate into citric acid in the Krebs cycle. It exhibits product inhibition.

Which of the following is the correct description of citrate synthase?

	Type of respiration involved in	Location of enzyme	Inhibitor
A	anaerobic	cytoplasm	citric acid
B	aerobic	mitochondria	citric acid
C	aerobic	mitochondria	oxaloacetate
D	anaerobic	cytoplasm	oxaloacetate

Your answer

[1]

14. **Fig. 11.1** shows the heat flow through the skin of an athlete during vigorous exercise. Exercise starts at 400 seconds.

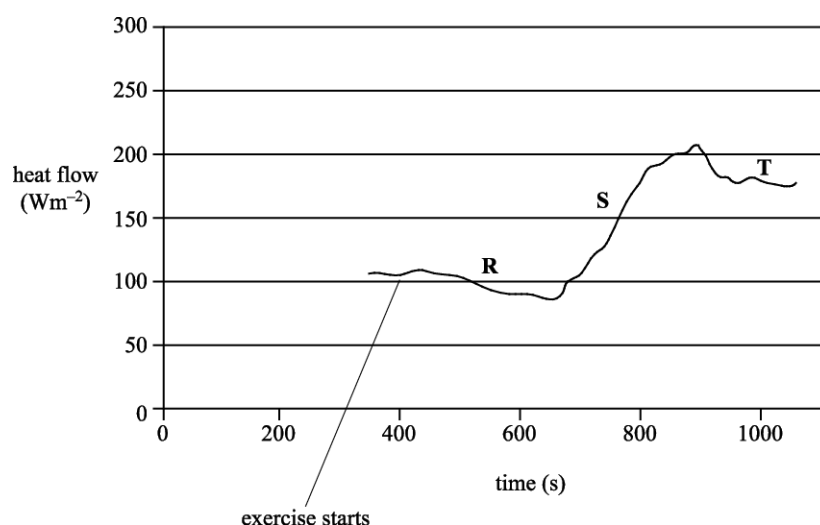


Fig. 11.1

Blood flow can be directed to those parts of the body that make the greatest demands.

Which row gives the best explanation of the stages in **Fig. 11.1**?

	R	S	T
A	Blood directed away from skin to avoid excess heat loss	Blood directed towards skin to release excess heat	Balance achieved between loss of excess heat and the need for oxygen in the muscles
B	Blood directed away from skin and towards the muscles to supply more oxygen for respiration	Blood directed towards skin to release excess heat	Balance achieved between heat loss and excess heat created in the muscles
C	Blood directed away from skin to avoid excess heat loss	Blood directed towards skin to gain heat from the environment	Balance achieved between heat loss and excess heat created in the muscles
D	Blood directed away from skin and towards the muscles to supply more oxygen for respiration	Blood directed towards skin to gain heat from the environment	Balance achieved between loss of excess heat and the need for oxygen in the muscles

Your answer

[1]

15. The following are statements about the liver:

- 1 stores bile in the gall bladder
- 2 contains sinusoids
- 3 receives blood from the gut and heart

Which of these statements relate to the exocrine function of the liver?

- A** 1, 2 and 3
- B** Only 1 and 2
- C** Only 2 and 3
- D** Only 1

Your answer

☐

[1]

16. Athletic sprinters require large amounts of energy in short periods of time. Many elite sprinters can run 100 metre races in under 10 seconds.

Under normal conditions, exercise requires an increased rate of breathing. It has been observed that some of the best sprinters only take one breath at the start of the race and do not inhale again until the end of the race.

Suggest how these sprinters can expend so much energy without needing to carry out aerobic respiration.

[2]

17. A response affected by plant hormones is phototropism.

A student completed an investigation into phototropism in cress seeds.

This was the method used:

- Place 50 cress seeds (*Lepidium sativum*) on a sterile paper towel in a petri dish.
- Water with 10 cm³ of distilled water.
Repeat for 3 different sets of seeds:
 - Set 1 is placed in a box to prevent light shining on the seeds.
 - Set 2 is placed in a box with light from above only.
 - Set 3 is placed in a box with light from the right hand side only.
- Keep all 3 sets at 25 °C.
- After 72 hours, remove 20 of the seedlings from each set and count how many have bent.

Identify **two** limitations of the student's method.

For each limitation, explain how it limits the validity of conclusions that can be drawn **and** suggest an improvement that would improve the validity of conclusions made.

limitation 1:

explanation:

improvement:

limitation 2:

explanation:

improvement:

[6]

18(a). Gibberellin causes stem elongation in plants.

Fig. 17.1 shows the effect of gibberellin on cabbage plants.

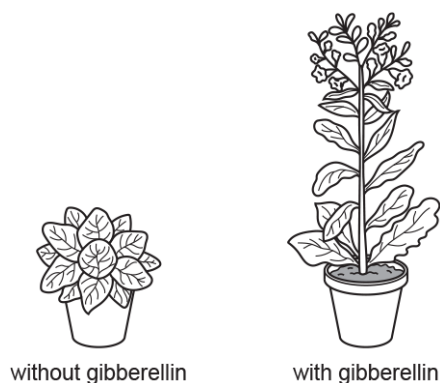


Fig. 17.1

Gibberellin causes an increase in the distance between the leaves on the stem, which is known as the internodal length.

A scientist carried out an investigation into the effect of gibberellin on cabbage plants.

The scientist applied a range of volumes of gibberellin and measured the rate of increase of internodal length over 30 days.

Table 17 shows the scientist's results.

Volume of gibberellin applied ($\times 10^{-3} \text{ cm}^3 \text{ kg}^{-1} \text{ day}^{-1}$)	Rate of increase of internodal length (mm day^{-1})
0.0	1
0.2	1
0.4	2
0.6	4
1.2	47
1.4	48
1.8	49
1.9	50
2.0	50

Table 17

- Plot the results from Table 17 as a suitable graph.

[4]

- ii. Gibberellin causes an increase in internodal length.

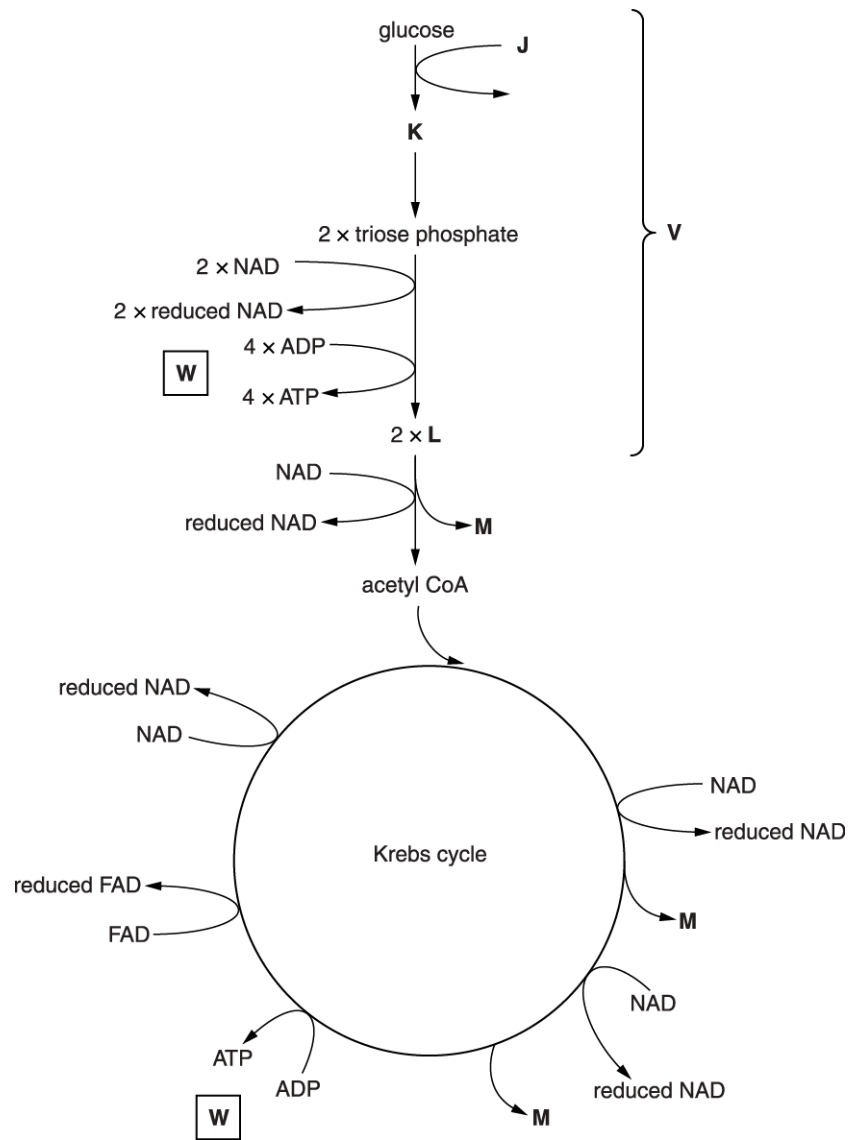
State one **other** role of gibberellin in plants.

[1]

- (b). Explain why gibberellin is classed as a plant **hormone**.

[3]

19. ATP is produced in cells by the process of respiration. Some of the reactions involved in the process of respiration are outlined in the figure.



- i. Compound **J** is required for the reaction pathway to start.

Identify compound **J**.

[1]

- ii. Identify compounds **K** to **M**.

K

L

M

[3]

- iii. Name the pathway labelled **V**.

[1]

- iv. ATP is produced in two different ways during respiration.

- o Some ATP is produced at the points labelled W.
- o ATP is also produced using reduced NAD and reduced FAD on the inner mitochondrial membrane.

Outline the differences in the two ways by which ATP is produced in respiration.

[3]

20. A group of students set up a simple respirometer, as shown in **Fig. 1.1**, and used it to determine the rate of respiration in germinating mung beans.

- They placed a small muslin bag of soda lime into the syringe and then added five germinating mung beans, which were held in place with the syringe plunger.
- The students measured the movement of the red fluid in the capillary tube.
- After each set of readings the plunger was reset to return the fluid to its original position.

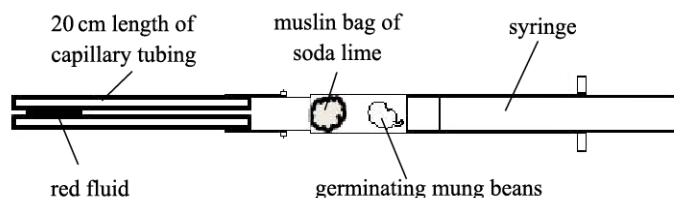


Fig. 1.1

The results are shown in **Table 1.1**.

Time (s)	Distance moved by the red fluid in capillary tube (mm)		
	1	2	3
0	0.0	0.0	0.0
30	11.5	12.0	12.5
60	22.5	21.5	17.5
90	31.0	32.0	32.5
120	41.5	42.0	42.5
150	53.0	54.0	53.5
180	63.0	63.0	64.0
210	72.5	71.0	71.5
240	78.5	79.5	79.0
270	87.5	88.5	87.0

Table 1.1

- a. Give **one** limitation of using this method to investigate respiration rate.

[1]

- b. Read the procedure carefully. Identify **one** variable that had not been controlled in this experiment **and** suggest an improvement to control that variable.

Variable

Improvement

[2]

- c. Describe how you would add the red fluid to the capillary tube at the start of the experiment.

[1]

- d. The data shows an anomalous result at 60 seconds.

Explain why the result is considered to be anomalous **and** describe one correct way of dealing with this type of result.

[2]

- e. Using the data the student obtained, calculate the mean rate of respiration for germinating mung beans between 90 and 150 seconds.

Answer.....

- f. What additional information would be needed to calculate:
i. the volume of oxygen taken up by the seeds.

[1]

- ii. the oxygen uptake for this batch of seeds to be comparable with data from another type of bean.

[1]

- g. * The group of students wanted to find out if the rate of respiration of a small invertebrate animal was comparable to that of the mung beans.

Adapt the procedure used to investigate the respiration rate of a small invertebrate, such as a woodlouse or caterpillar, with that of mung beans.

Comment on the results you might expect from this experiment and the conclusions you might draw.

[6]

21. Photosynthesis involves two main stages:

- the light-dependent stage, which involves photosystems
- the light-independent stage, which involves the Calvin cycle.

Photosynthetic pigments are arranged in groups known as photosystems I and II.

i. Name the primary photosynthetic pigment in these photosystems.

[1]

ii. Name an accessory pigment.

[1]

iii. State the advantage to the plant of having a range of accessory pigments in photosystems.

[1]

- iv. Name the compound that is synthesised in the light-dependent stage as a result of the generation of an electrical and pH gradient across the thylakoid membrane.

[1]

22. Fig. 1.1 is a diagram representing a three-dimensional view of a chloroplast.

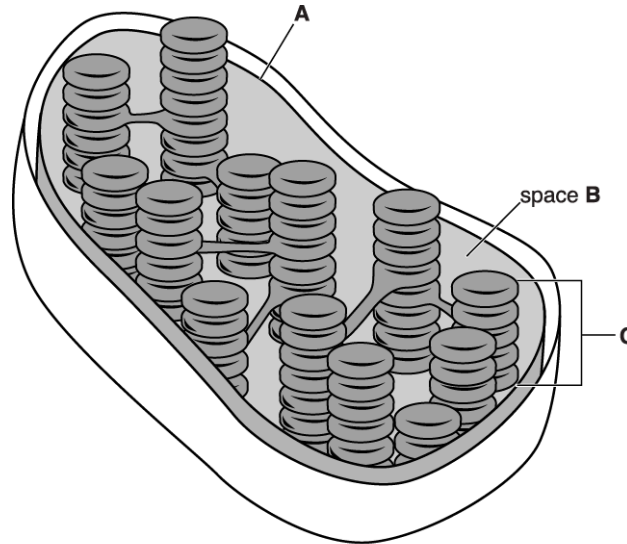


Fig. 1.1

- i. Name parts **A** to **C** in Fig. 1.1.

A

B

C

[3]

- ii. Describe **two** ways in which the structure of part **C** is adapted to its function.

iii. A key aspect of photosynthesis is the metabolic pathway involving carbon dioxide.

Place a tick (✓) in the appropriate box to indicate the part of the chloroplast (**A**, **B** or **C**) in which the metabolic pathway involving carbon dioxide is located.

A	
B	
C	

23. Plants photosynthesise and respire. **Fig. 18.1** shows the rate of production of carbohydrate in photosynthesis and the rate of use of carbohydrate by respiration.

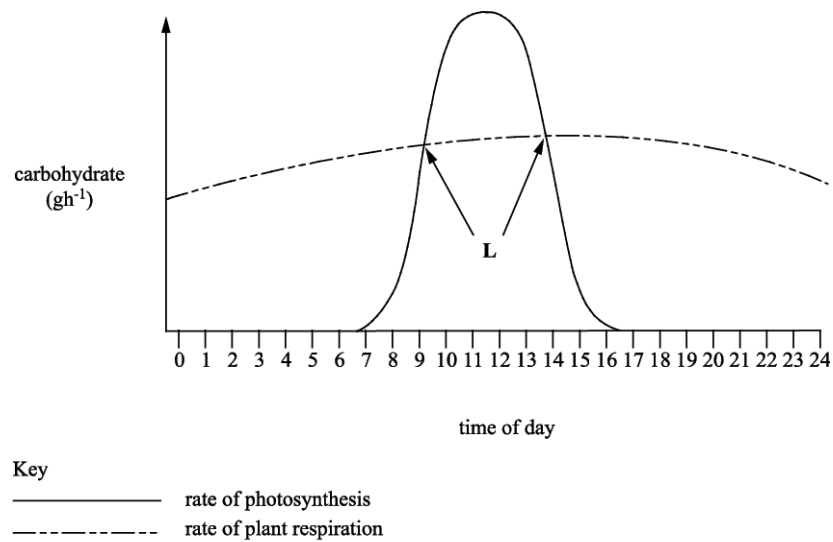


Fig. 18.1

- i. Explain the shape of the curve for the rate of photosynthesis in **Fig. 18.1**.

[2]

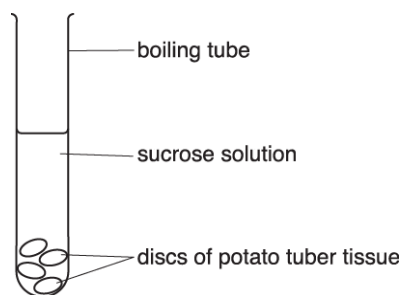
- ii. Explain the shape of the curve for the rate of plant respiration in **Fig. 18.1**.

[2]

- iii. What is happening at the points indicated by the letter **L**?

[1]

- 24.** The figure shows some of the apparatus used in an experiment investigating water potential in potato tuber tissue.



The discs were placed in boiling tubes containing sucrose solutions of different concentrations for four hours. The percentage change of mass was then calculated.

The results are shown in the table.

Concentration of sucrose solution (mol dm ⁻³)	Change in mass of potato discs (%)
0.00	+18.00
0.10	+12.50
0.20	+2.50
0.30	– 3.00
0.40	– 8.00
0.45	–11.50

- i. State **two** details of the procedure that must be followed to obtain valid results.

1

2

[2]

- ii. Explain how a student could use the data in the table to determine the water potential of the potato tuber tissue.

25(a). A group of students investigated the effect of temperature on the membranes of beetroot cells.

A colorimeter was used to measure the concentration of purple betalain pigment that leaked out of the cells when they were exposed to different temperatures.

Table 23 shows a summary of the data collected.

Temperature (°C)	Number of readings	Mean absorbance (arbitrary units)	Standard deviation
0	10	0.04	0.01
10	10	0.04	0.02
20	10	0.04	0.02
30	10	0.06	0.02
40	10	0.09	0.03
50	10	0.21	0.06
60	10	0.44	0.18

Table 23

- i. Using the Student's t -test formula below, calculate the value of t between the data for **50 °C and 60 °C**.

$$t = \frac{|\bar{x}_A - \bar{x}_B|}{\sqrt{\frac{s_A^2}{n_A} + \frac{s_B^2}{n_B}}}$$

where:

$\bar{x}$ is the mean
S is the standard deviation
n is the number of readings

Answer

- ii. The critical value for t at the significance level of 5%, with 18 degrees of freedom, is 2.10.

Use the value of t that you calculated in part (i) to explain whether the null hypothesis should be accepted or rejected.

[2]

- (b). The students plotted the data onto a graph, shown in Fig. 23.

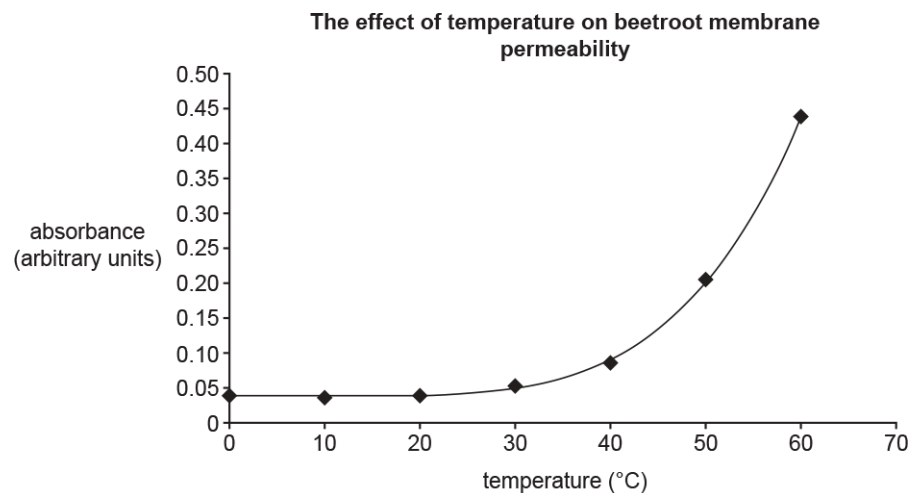


Fig. 23

Describe and explain the pattern of data shown on the graph as temperature increases.

[3]

26. The majority of cells in phloem tissue are either companion cells or sieve tube elements.

A scientist isolated companion cells and conducted some experiments to investigate the mechanism involved in loading sucrose into the sieve tubes.

He recorded the following observations:

observation 1	isolated companion cells became slightly negatively charged compared with their surroundings
observation 2	companion cells could decrease the pH of the surrounding solution from 7.0 to 5.6
observation 3	the pH inside the companion cells rose from 7.0 to 8.2
observation 4	treatment with cyanide (which stops aerobic respiration) prevents the change in pH occurring

From **observation 1**, the scientist concluded that the mechanism involved a transfer of charged particles (ions) between the companion cells and their surroundings.

- i. What conclusions can be drawn from **observations 2 and 3** about the mechanism?

[2]

- ii. What conclusions can be drawn from **observation 4** about the mechanism?

[1]

27. Fig. 25.1 shows a potometer.

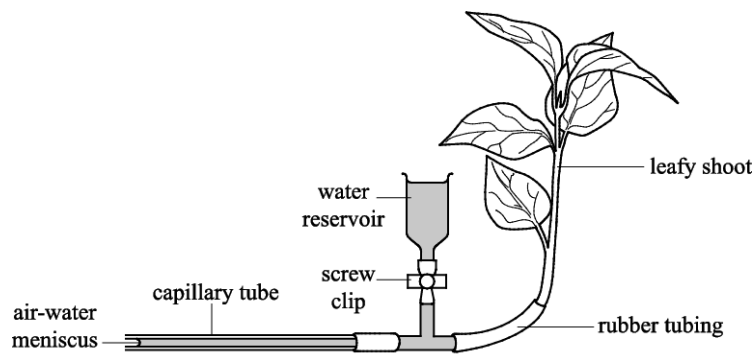


Fig. 25.1

- a. A student used this apparatus to investigate the role of stomata in transpiration. The student noted the position of the air-water meniscus each minute for five minutes.

The student then covered the underside of one of the leaves in petroleum jelly before repeating the measurements. This was continued until the undersides of all the leaves had been covered.

Table 25.1 shows the results.

Number of leaves with undersides covered in petroleum jelly	Position of meniscus (mm) at					
	0 min	1 min	2 min	3 min	4 min	5 min
0	0	23	44	65	84	102
1	0	20	40	58	77	95
2	0	16	31	47	61	76
3	0	11	23	37	50	62
4	0	9	17	24	32	40
5	0	6	11	16	22	28

Table 25.1

The student presented these results as a graph. **Fig. 25.2** shows the graph.

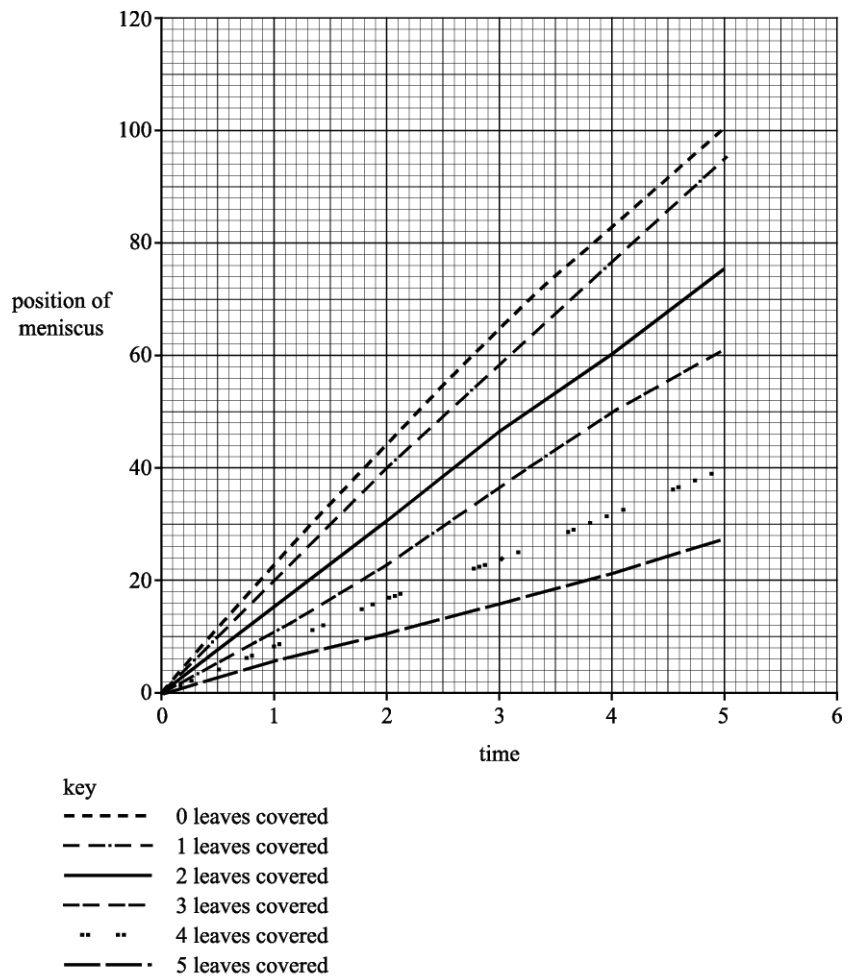


Fig. 25.2

- i. State two different types of information the student has missed from the graph.

[2]

- ii. Use the graph to calculate the minimum rate of transpiration.

Show your working.

Answermm min⁻¹[2]

- b. Suggest how water is being lost from the cut stem when all the leaves have been treated with petroleum jelly.

[2]

- c. Suggest **two** possible sources of error in this investigation.

[2]

28. Birds and humans have similar pancreas tissues, with the same cell types contributing to exocrine and endocrine roles.

- i. Fig. 21.1 shows a transverse section of pancreas tissue from a bird.

Select which letter identifies the following structures:

islet of Langerhans

[1]

acinus

[1]

- ii. Fig 21.2 shows a high-power image of cells from the pancreas.

In the space provided below draw **five adjacent** cells, annotating them to show visible features.

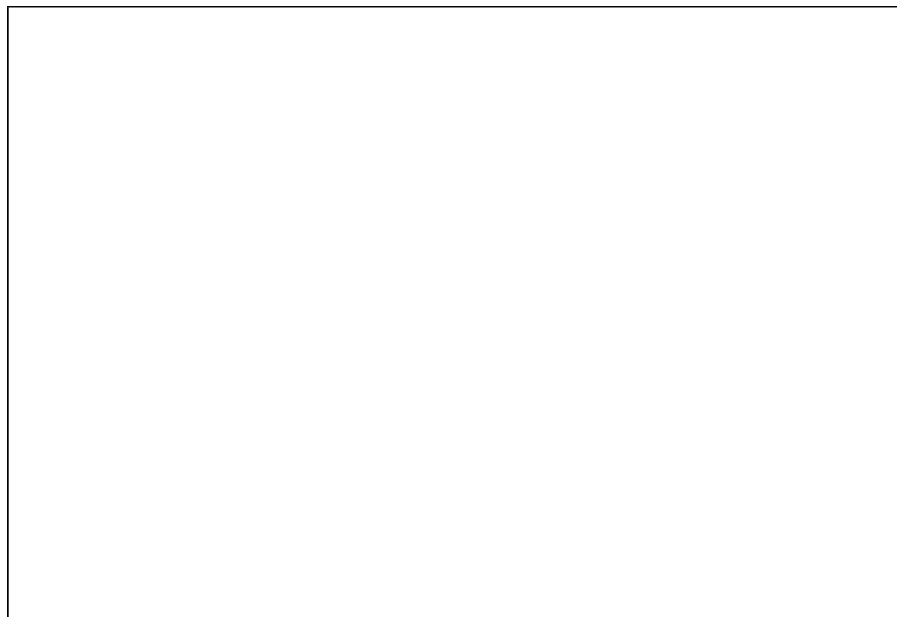


Fig 21.1

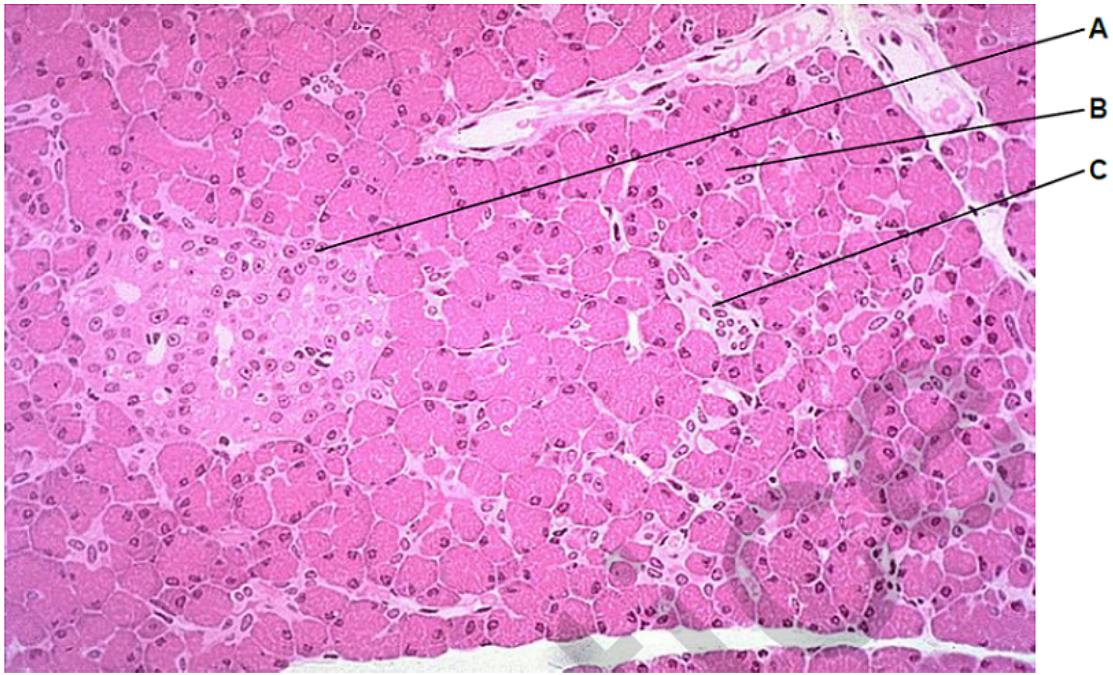
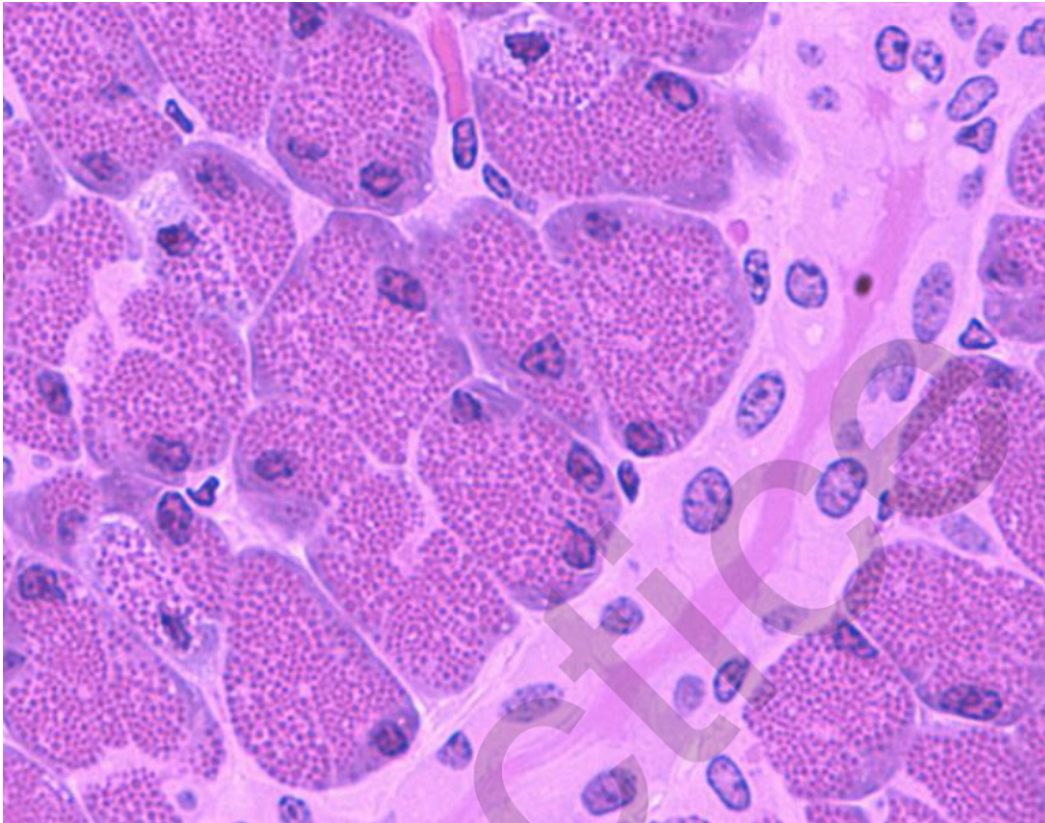


Fig 21.2



END OF QUESTION PAPER

Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1			A	1	
			Total	1	
2			A	1	
			Total	1	
3			A	1	
			Total	1	
4			D	1	
			Total	1	
5			D	1	
			Total	1	
6			A	1	
			Total	1	
7			B ✓	1	<u>Examiner's Comments</u> This question tests understanding of the factors that limit enzyme controlled reactions in the context of a specific enzyme, DNA polymerase. Most candidates will know that changes in temperature, pH and substrate concentration will affect enzymes activity. Here, candidates needed to recognise that free nucleotides were the substrate rather than the DNA molecule. Many candidates were unable to make this distinction correctly and gave B as their response. Candidates also needed to read the question carefully. The question asks for a factor that will not affect the rate of this enzyme's activity.
			Total	1	
8			D ✓	1	<u>Examiner's Comments</u> The correct response, D, was selected by many candidates. The most common incorrect response was A. Possibly candidates were thinking about how glycoproteins can increase the stability of the membrane through hydrogen bonding to external water molecules.
			Total	1	
9			A ✓	1 (AO1.1)	<u>Examiner's Comments</u> The vast majority of candidates answered this straightforward definition question correctly.

			Total	1	
1 0			A	1	
			Total	1	
1 1			D	1	
			Total	1	
1 2			C ✓	1	Examiner's Comments This question proved challenging for some and required skills in applying knowledge to novel context to choose the most appropriate response.
			Total	1	
1 3			B	1	
			Total	1	
1 4			B	1	
			Total	1	
1 5			D	1	
			Total	1	
1 6			<i>two from</i> cells are able to tolerate, high levels of lactate / acidity / low pH (1) have high phosphocreatine stores (1) use of stored ATP (1)	2	
			Total	2	
1 7			related to light (L) L1 light intensity / brightness, is not, controlled / specified OR size of hole in box not specified ✓ L2 different, light intensities / brightness, could lead to variation in, phototropism / bending ✓ L3 <i>idea that</i> light intensity / brightness, stays the same ✓	6 max	<i>Mark limitation, explanation and improvement as continuous prose within each numbered prompt. If marks come from more than one letter within either numbered prompt, award that which gives the highest mark</i> IGNORE reference to any other variables ALLOW wavelength / colour instead of intensity throughout (L) <i>For L3 if statement not used other examples may</i>

			related to selection of seedlings (S) S1 no method for, selecting / AW, (20) seedlings ✓ S2 could lead to biased results ✓ S3 <i>idea</i> of random selection ✓ related to measuring bend of seedlings (B) B1 degree of bending (of seedlings) not considered ✓ B2 <i>idea</i> of a (reproducible) comparison is not possible OR could lead to biased results ✓ B3 measure angle of bend ✓ related to replicates (R) R1 experiment / trial, was not repeated ✓ R2 cannot, calculate mean / identify anomalies / carry out statistical analysis ✓ R3 repeat (experiment at least) twice OR carry out (at least) three trials ✓ related to size of dish (D) D1 size of petri dish not, controlled / specified ✓ D2 different sized dishes could affect, spacing of seeds / access to light ✓ D3 specify, size / volume / diameter, of petri dish ✓	<i>include</i> e.g. use of, light meter / photo sensor e.g. use lamps of same bulb wattage e.g. use same distance from lamp e.g. use same, wavelength / coloured bulb <i>For S1</i> IGNORE only 20 seedlings selected <i>For S3</i> ALLOW count, all / more / 50, seedlings ALLOW reasonable method of selection e.g. photograph and allocate numbers e.g. mini grid then select random numbers <i>For B1</i> ALLOW bending judgement, not quantitative / is subjective <i>For B3</i> ALLOW descriptions of method e.g. use of protractor e.g. use a, standard / model (for comparison) <i>For R2</i> IGNORE reference to, fair test / accuracy / reliability <i>For D3</i> ALLOW use the same sized dish Examiner's Comments Q21(b) proved challenging and candidates seemed to have had little preparation in analysing and redesigning experiments. The majority of marks
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					awarded pertained to the control of light and selection of seedlings. Very few achieved maximum marks and Examiners commented on the fact that some candidates gave responses that included aspects of the experiment that had already been taken into account in the method provided.																						
			Total	6																							
1 8	a	i	x (horizontal) axis labelled volume of gibberellin applied ($\times 10^{-3} \text{ cm}^3 \text{ kg}^{-1} \text{ day}^{-1}$) AND y (vertical) axis labelled rate of internodal length increase (mm day^{-1}) ✓ linear scale on both axes AND at least 50% of area covered ✓ line graph AND points plotted accurately to ± 1 small square ✓ suitable curved line of best fit drawn ✓	4 (AO3.2)	<table border="1"><thead><tr><th>Volume of gibberellin applied ($10^{-3} \text{ cm}^3 \text{ kg}^{-1} \text{ day}^{-1}$)</th><th>Rate of increase of internodal length (mm day^{-1})</th></tr></thead><tbody><tr><td>0.0</td><td>1</td></tr><tr><td>0.2</td><td>1</td></tr><tr><td>0.4</td><td>2</td></tr><tr><td>0.6</td><td>4</td></tr><tr><td>0.9</td><td>22</td></tr><tr><td>1.2</td><td>47</td></tr><tr><td>1.4</td><td>48</td></tr><tr><td>1.8</td><td>49</td></tr><tr><td>1.9</td><td>50</td></tr><tr><td>2.0</td><td>50</td></tr></tbody></table> IGNORE extrapolations Units must be given for both axes ALLOW solidus i.e. / for brackets () NOTE () or / should be seen at least once NOTE non-linear x axis data ALLOW one error in plotting ALLOW ECF if non-linear scale used DO NOT ALLOW ruled lines between points <u>Examiner's Comments</u> Candidates who had acquired skills in practical techniques with regards to presenting data often achieved all four marks here. However, there is still uncertainty among some candidates of how to draw a line of best fit or which variables to assign to the x and y axes. OCR support The mathematical Skills Handbook provides support on plotting graphs:	Volume of gibberellin applied ($10^{-3} \text{ cm}^3 \text{ kg}^{-1} \text{ day}^{-1}$)	Rate of increase of internodal length (mm day^{-1})	0.0	1	0.2	1	0.4	2	0.6	4	0.9	22	1.2	47	1.4	48	1.8	49	1.9	50	2.0	50
Volume of gibberellin applied ($10^{-3} \text{ cm}^3 \text{ kg}^{-1} \text{ day}^{-1}$)	Rate of increase of internodal length (mm day^{-1})																										
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1.8	49																										
1.9	50																										
2.0	50																										

					https://www.ocr.org.uk/Images/294471-biology-mathematical-skills-handbook.pdf
		ii	Any one from seed germination flowering in long-day plants cellular , transcription / translation prevents leaf abscission aids stomatal opening promotes fruit development promotes , activity of amylase / hydrolysis of starch ✓	1 max (AO1.2)	Examiner's Comments Many candidates gained credit here. Seed germination was the most commonly seen correct response.
		b	(gibberellin is) a chemical messenger ✓ - produced in one part of plant but has effects in another part / AW✓ - affects activity / AW , of target , cells / tissues ✓ - long-lasting / acts over long period of time ✓ - wide-spread effect ✓	3 max (AO1.2)(AO2.1)	IGNORE functions of gibberellin ALLOW cell-signalling molecule e.g. causes activity of target cells to be altered e.g. causes response in target cells Examiner's Comments Good responses recognised the need to explain why gibberellin is classed as a hormone to achieve maximum marks. However, many candidates misunderstood the question and offered descriptions about how hormones work when they reach target cells or described the role of gibberellin in plants.
			Total	8	
1 9		i	(2 molecules of) ATP / adenosine triphosphate;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks
		ii	K hexose (1,6) (bis)phosphate; L pyruvate; M carbon dioxide / CO ₂ ;	3	Mark the first answer on each prompt line. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks K CREDIT glucose (6) phosphate / fructose (1) phosphate / fructose (1,6) diphosphate / hexose diphosphate DO NOT CREDIT glucose (1,6) bisphosphate L ACCEPT pyruvic acid M if used, formula must be correct
		iii	glycolysis / glycolytic;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks Examiner's Comments

					Parts (i), (ii) and (iii) were well answered, indicating the candidates' good knowledge of respiration.
		iv	by substrate level phosphorylation; detail; by, chemiosmosis/ oxidative phosphorylation; detail;	3 max	e.g. - by removing phosphate from a compound (in the reaction pathway) e.g. - hydrogen lost from, redNAD / redFAD - electrons pass down, ETC / electron transport chain - ref to proton gradient / electrochemical gradient - ref to ATP synth(et)ase Examiner's Comments Detail of oxidative phosphorylation was good, although there was some confusion as to where the protons were pumped and whether they moved down or up a gradient. The detail on substrate level phosphorylation was lacking. Candidates were expected to indicate that the phosphate to phosphorylate ADP came directly from a compound in glycolysis or Krebs cycle. The only information offered by most candidates was that ADP added a phosphate to become ATP.
			Total	8	
20	a		<i>idea that</i> the oxygen will leak from the connectors so reduce the gas movement (1) or oxygen uptake may not be a good representation of respiration rate in germinating seedlings (1) or a small volume of gas is being measured in the capillary (1) or measurements only taken every 30 seconds (1) or difficult to read the meniscus (may be subjective) (1)	1	ALLOW seal not air tight so will not prevent gas escaping during the experiment or <i>the idea</i> that gas leakage is a problem and needs to be prevented. ALLOW the respiratory substrate stored in the seed will affect the oxygen needed or the idea that if photosynthesis has begun oxygen uptake will be disrupted. ALLOW need to record the maximum volume of gas taken up during the experiment. ALLOW alternative wording e.g. 'more frequent readings are needed'.

	b	<i>Variable</i> the mass of the seeds is not given (1) <i>Improvement</i> take the mass of the seedlings at the start (1) <i>Variable</i> the volume / mass of soda lime is not specified (1) <i>Improvement</i> use a known mass of soda lime each time (1) <i>Variable</i> the size of the syringe is not given (1) <i>Improvement</i> use a 2 cm³ syringe (1) <i>Variable</i> the capillary tube internal diameter is not given (1) <i>Improvement</i> use a capillary tube of length 20 cm and a 1 mm internal diameter (1) <i>Variable</i> temperature not controlled (1) <i>Improvement</i> allowing apparatus to, stabilise / equilibrate to temperature, before taking readings (1) AVP (1)	2	The control method must be suitable, and be directly linked to the variable. ALLOW suggested mass values. ALLOW suggested mass values. ALLOW alternative size if suitable for the activity. ALLOW <i>idea that</i> only a linear measurement is obtained not a volume. ALLOW alternative size if suitable for the activity. ALLOW use of a water bath and thermometer to stabilise the temperature. Must be explicit to provide valid data e.g. no scale on the capillary tube, no timing, no details of how to take the readings. Details must be workable and suitable to provide valid results e.g. scale on the capillary tube, use of timing devices, description of how to take readings from the scale etc.
	c	dipped into a small beaker and allowed to run	1	ALLOW suitable details of how the red fluid is added.
	d	<i>Explanation</i> it is more than 10% from the mean or it is different from the other data at 60 seconds or it does not follow trend for the times for replicate 3 (1) <i>Action</i> anomaly should be identified and excluded from processing or anomaly must be identified but could be included in calculations or repetition to obtain another reading (1)	2	ALLOW 'it is out of line' ALLOW 'it is out of line'
	e	0.36 mm s ⁻¹ (1)	1	Rate and units required for the mark.
f	i	the internal diameter of the capillary tube (1)	1	
	ii	the mass of the bean seeds (1)	1	

			* Level 3 (5–6 marks) Describes a clear and detailed experiment that has been effectively adapted for use with chosen invertebrate to allow for the comparison of the rate of respiration with that of mung beans. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Describes an experiment to compare the rate of respiration of chosen invertebrate with mung beans but there is insufficient detail of the procedure to allow a valid comparison. <i>There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.</i> Level 1 (1–2 marks) An attempt to describe an experiment to investigate the respiratory rate of an invertebrate but little comparison with mung beans. If results or conclusion suggested, likely to be muddled or inaccurate. <i>The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.</i> 0 marks No response or no response worthy of credit.	6	Relevant points include: experiment • mass of invertebrate and mass of beans the same • safe and ethical use of invertebrates e.g. add screen so that animal(s) cannot touch the muslin bag • bigger syringe needed (5–10 cm³) • keep temperature constant / same for both assays • keep light constant / same for both assays • use same mass of soda lime in both assays • measuring distance moved by coloured, red liquid at regular time intervals • repeat experiments. results and conclusions • invertebrates rate of respiration is expected to be higher than the rate of respiration of the beans <i>because</i> • invertebrates are moving around • metabolic processes require energy / generate heat.
			Total	15	
2 1		i	chlorophyll, a / A;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks ACCEPT chlorophyll 680 and chlorophyll 700 (Note that both are required for this option) IGNORE P680 / P700 DO NOT CREDIT chlorophyll a Examiner's Comments Most candidates named chlorophyll a as the primary pigment although some simply stated chlorophyll without any further clarification and very occasionally chlorophyll b was given. A small number of candidates suggested chlorophyll alpha or gave P680 / P700 as a response, neither of which were credited.
		ii		1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks

			chlorophyll b / xanthophyll(s) / carotenoid(s) / (β / beta-) carotene;		DO NOT CREDIT karatine (as could be confused with keratin) Examiner's Comments Most candidates were able to name a suitable accessory pigment, most frequently either carotene or carotenoid, although there were some references to xanthophylls (with various spellings). However, those candidates who had given chlorophyll b as their answer to (i) frequently supplied an incorrect response to this section.
		iii	able to, absorb / use, a range of / different / more / other, (light) <u>wavelengths</u> / λ;	1	e.g. absorb wavelength(s) not absorbed by primary pigment IGNORE frequency IGNORE absorb all wavelengths IGNORE ref to chlorophyll b DO NOT CREDIT ref to reflection where a pigment absorbs and reflects the same wavelength Examiner's Comments The advantage of a plant having a variety of accessory pigments was generally well understood. The most common reason for not achieving the mark was to refer only to light frequencies or to simply state that more light could be absorbed.
		iv	ATP;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks DO NOT CREDIT O₂ / oxygen / red NADP / NADPH DO NOT CREDIT inaccurate name for ATP e.g. 'ATP (adenine triphosphate)' = 0 marks Examiner's Comments Most candidates correctly named ATP. The most common incorrect answer was NAD / NADP or water, indicating that the question had not been read carefully. Several candidates lost marks for incorrectly defining ATP - typically as adenine triphosphate or adenosine triose phosphate.
			Total	4	
2 2		i	A. inner membrane (of, double membrane / envelope, surrounding organelle) ;	3	Mark the first answer on each prompt line. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks A. DO NOT CREDIT inter membrane DO NOT CREDIT inner envelope membrane DO

			B. stroma; C. granum / grana / granal stack / thylakoid stack;		NOT CREDIT ref to cell / surface / plasma / membrane B. correct spelling only C. IGNORE thylakoid unqualified / lamellae Examiner's Comments The parts A, B and C in Figure 1.1 of a chloroplast were correctly named by most candidates. Where errors occurred, they were usually for the misidentification of A (e.g. the inner envelope membrane, thylakoid membrane, or even inner mitochondrial membrane). Very occasionally, stroma was confused with matrix while other candidates referred to C as simply thylakoids.
		ii	1. contain, (named) pigment (molecules) / photosystems; 2. contain, (named) electron carriers / ETC / ATP synth(et)ase; 3. <i>idea</i> that has a large surface area (in a small volume) for, light absorption / light dependent reaction(s) / light dependent stage / electron transport;	2 max	1. IGNORE 'accessory' 2. IGNORE enzymes unqualified 3. IGNORE ref to different wavelengths Note: 'the membranes containing the pigments have a large surface area for absorbing light' = 2 marks (mps 1 & 3) Note: 'there is a large surface area for electron transport chain' = 2 marks (mps 2 & 3) Examiner's Comments The majority of candidates were able to describe at least one way in which the structure of the granum (part C) was adapted to its function. References to the presence of pigments, chlorophyll or photosystems on the granal membranes were very frequent and many candidates also went on to add that ATP synthase or the electron carriers would also be contained within the membranes. Many also recognised that there would be a large surface area for light absorption or the light independent stage, although this was also a common omission in weaker answers. Many discussed close proximity to stroma and consequently events occurring in the stroma.

		iii	<table><tr><td>A</td><td></td></tr><tr><td>B</td><td>✓</td></tr><tr><td>C</td><td></td></tr></table> ;	A		B	✓	C		1	DO NOT CREDIT if more than one tick entered Examiner's Comments The vast majority of candidates correctly ticked B for the stroma. The most common error was selection of C, thinking that the light independent reactions take place in the grana.
A											
B	✓										
C											
			Total	6							
2 3		i	increased photosynthetic activity during daylight (1) as light intensity increases there is increased activity of the light dependent reaction (1)	2	No marks available for describing the shape of the curve.						
		ii	daytime temperatures generally higher than night time (1) rate of respiration increases with increased temperature as its enzymes are temperature-dependent (1)	2	No marks available for describing the shape of the curve.						
		iii	compensation point(s) / carbohydrate produced by photosynthesis equal to carbohydrate used in respiration (1)	1							
			Total	5							
2 4		i	1 discs same, size / thickness / surface area / surface area to volume ratio / diameter ✓ 2 same (variety / part, of) potato ✓ 3 no skin on potato ✓ 4 ref to removing excess water before (re)weighing ✓ 5 same, number / amount, of discs (in each solution) ✓ 6 same volume (sucrose) solution ✓ 7 same temperature ✓ 8 cover the tubes ✓	max 2	Mark first two answers only, ignoring the numbered sections IGNORE mass / balance used / soak time / repeats IGNORE a list of variables unqualified 1 ACCEPT same cork borer used ACCEPT 'pieces of potato' etc. for 'discs' ACCEPT 'length' as equivalent to 'diameter' IGNORE same shape/similar size etc 4 e.g. blotting / shaking 7 ACCEPT in context of room / environment / solution Examiner's Comments This question was relatively well answered but many candidates stated soak time as a factor, despite the question specifying four hours. Some candidates correctly named the variable but failed to keep it the same. A significant number of students did not						

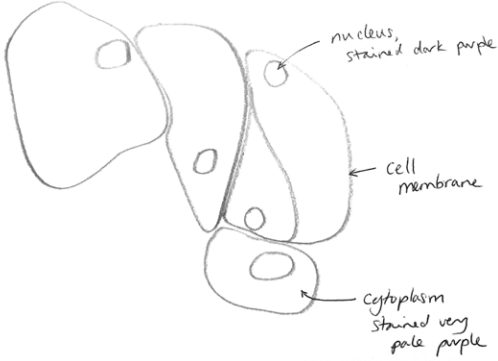
				appreciate that the question referred to the validity of the results and gave responses relating to ensuring the accuracy or reliability of results, e.g. using suitable measuring equipment for the volumes or to doing repeats. Candidates did not always use the term volume rather than 'amount', or refer to the discs rather than just the potato tuber.
	ii	1 <i>idea that</i> no change of mass occurs when the water potential of (sucrose) solution = water potential of potato (tissue) ✓ 2 ref. to no change in mass (of potato) between 0.2 and 0.3 mol dm⁻³ ✓ 3 plot graph of concentration of, sucrose / solution, against (%) change in mass and find which (sucrose) concentration gives no change in mass of potato OR carry out the experiment again with more (sucrose) concentration intervals between 0.2 and 0.3 mol dm⁻³ ✓ 4 look up the water potential of the (sucrose) solution (e.g. on calibration curve or table), of that concentration / of the concentration which gives no mass change ✓	max 3	ACCEPT Ψ for water potential throughout IGNORE ref to solute potential / isotonic 2 correct units must be stated once ACCEPT 'between 0.2 and 0.3 mol dm⁻³ the water potential of the solution and the potato will be the same' 3 x and y axes interchangeable When an axis has been identified it can be referred to by letter later. Needs some ref to the mass change being 0. If the change in mass axis has previously been identified, then ref to that axis value being 0 is equivalent to no change in mass e.g. 'Should draw a graph of sucrose concentration on the x axis and change in mass of potato discs on the y axis. The point where the line of best fit crosses the x axis (when the y axis = 0) is the concentration of sucrose in the potato discs.' will get the mark 'Draw a graph with change in mass of potato discs on the y axis and concentration of sucrose solution on the x axis and draw a line of best fit. Where the line intercepts the x axis is where the change in mass of potato discs is zero.' will get the mark 3 correct units must be stated once Examiner's Comments Most candidates did not read the question carefully enough and just described why the discs gained or lost mass in the various sucrose solutions. Typically they gave statements such as 'when the increase in mass is high then the water potential of the solution is higher than in the potato and when mass is lost the water potential of the solution is lower'. There was no indication they understood that the water potential of the potato tissue could be quantified from the results or the significance of the sucrose concentration where no mass change occurred. Several candidates appreciated that the mass difference changed from positive to negative between two stated sucrose solution concentrations, but did not develop the idea further. Candidates who, presumably, had done this as a

					practical exercise or had analysed similar data, knew that a graph of the results would yield an estimate but most of these said that the water potential could be obtained directly from the point where the line of best fit crossed the zero mass value (rather than the equivalent sucrose concentration).
			Total	5	
2 5	a	i	3.83 ✓✓✓	3	Mark answer on answer line. If no answer on answer line then look for a clear 'final' answer in the working. Correct answer = 3 marks (indicated by 3 ticks) even if no working shown IGNORE minus sign AWARD max 2 for correct answer not to 2dp or for 3 5/6 If answer is incorrect AWARD 1 mark for (calculating difference between means): 0.44 - 0.21 = 0.23 OR 0.21 - 0.44 = - 0.23 AWARD 1 mark for: $\sqrt{\frac{0.06^2}{10} + \frac{0.18^2}{10}}$ OR $\sqrt{\frac{0.0036}{10} + \frac{0.0324}{10}}$ OR $\sqrt{0.00036 + 0.00324}$ Examiner's Comments It was pleasing to see that the majority of candidates could calculate the value for the <i>t</i> test correctly, though as it was an unfamiliar test many ended up with a negative value which still gained credit. Those who gave an incorrect answer but who nevertheless showed working (which candidates should be strongly advised to always include in calculations), frequently picked up one or two marks for correct substitutions in the top or bottom parts of the equation. The most common mistake made by candidates was omitting to square the standard deviation in the given formula for calculating <i>t</i>.

					If no answer for (d)(i), then allow 1 max for correctly stating when to, accept / reject, H_0 ACCEPT H_0 is rejected because 3.83 is greater than 2.10 ACCEPT H_0 is accepted because 't value' is less than 2.10 Examiner's Comments Candidates were often incorrect in their interpretation as to whether to accept or reject the null hypothesis by comparing the calculated value with the critical value. Some failed to realise that if they calculated a negative value of t it would be lower than the critical value and so should accept the null hypothesis. Those who did answer correctly often omitted to go on to comment on whether the difference was significant or not, or just stated whether the value of t meant that the 'results' were significant or not rather than refer to the 'difference' (between the means at the two temperature levels).
	ii	If answer to (d)(i) is greater than 2.10 then rejected because value of t is higher than critical value ✓ (H_0 is rejected so) the difference (between the means), is significant / not due to chance ✓ If answer to (d)(i) is less than 2.10 (including negative numbers) then accepted because value of t is lower than critical value ✓ (H_0 is accepted so) the difference (between the means), is not significant / is due to chance ✓	2		
	b	E1 an increase in pigment (leaking out of cells) increases <u>absorbance</u> ✓ at low(er) temperature D2 there is, little / no, change in <u>absorbance</u> ✓ E2 membrane is, (still) intact / undamaged ✓ at high(er) temperature D3 there is a (steep) increase in <u>absorbance</u> ✓	3 max	Award marks from any D or E statements but max 2 explain marks (E) Put just a tick for D marks and green blob by the tick for E marks to ensure max 2 E marks awarded IGNORE 'as temperature increases' unqualified E1 ACCEPT as clearly linked ideas For D2 and E2 if temperatures are quoted without 'low(er)' then °C must be used at least once any range starting at 0 and ending between 20 and 40°C For D3 and E3 if temperatures are quoted without 'high(er)' then °C must be used at least once above	

			E3 (pigment, leaves cells / leaks out when) membrane becomes more permeable / membrane is damaged / membrane disrupted / phospholipids melt / phospholipids move further apart / proteins denature (or described) ✓		30/40°C IGNORE enzymes denature Examiner's Comments This question proved to be a good discriminator. Many candidates scored poorly on this question, mainly due to a lack of precision in describing the graph and a lack of understanding of the experimental technique involved. A general description of an increase in absorbance as temperature increased was incorrect and failed to gain credit. This was very often all that lower ability candidates offered. Some candidates correctly gained credit for describing that there was no change in absorbance between 0 - 20°C, but fewer correctly noted that the absorbance did not start to increase until above 30°C. Few candidates understood that the membrane remained intact at these low temperatures. Students should be encouraged to describe data in as much detail as possible and at all relevant points, in order to gain full marks in such questions. Some candidates omitted to use full units (degrees 'C') for temperature quotes and thereby failed to gain credit for otherwise correct answers. Several candidates correctly described the increase in absorption at high temperatures and most went on to link this to an increase in membrane permeability or membrane disruption. However, few linked this to more betalain pigment leaking out and causing the increased absorbance. Marks for explanations were less common than for descriptions. There seemed to be misunderstanding of the term 'absorbance' at times with candidates believing that higher temperatures led to more pigment being 'absorbed by the cells'. These candidates may well have never used colorimeters. Candidates who had carried out this or a similar experiment were at an advantage.
			Total	8	
2 6	i		(the charged particles are) hydrogen ions / H ⁺ / protons ;	2	IGNORE descriptions of observations 2 and / or 3 IGNORE ref to OH⁻ / alkaline substances Note do not need to refer to hydrogen ions for mp 2 Note that 'hydrogen ions move out of the cell' = 2 marks

			(ions are) moved out of the cells / move into surrounding (solution) ;		Examiner's Comments Candidates were provided with the results of an investigation and asked to draw conclusions from the evidence. Most candidates correctly identified the charged particles as hydrogen ions and many appreciated that these ions were moved out of the companion cells. Other candidates seemed confused and referred to acidic substances or alkaline substances rather than to ions. Many candidates tried to describe the process of active loading rather than focus their response on the specific question asked. It is important to train candidates to read the question carefully and restrict their response to answering only that question.
		ii	active transport involved / cyanide prevents active transport / (mechanism) is active / (mechanism) needs energy / (mechanism) needs ATP ;	1	IGNORE descriptions of observation 4 e.g. no ATP is made IGNORE 'mechanism / active loading, does not work in presence of cyanide' as too vague Examiner's Comments Many candidates appreciated that the evidence suggested a need for ATP and an active process to ensure that the hydrogen ion concentration gradient is set up. However, many candidates simply stated that respiration must occur for the process to go ahead.
			Total	3	
27	a	i	two from units on axes (1) plotted points (1) title (1)	2	
		ii	= 5.25 (mm min ⁻¹) (1)(1)	2	ALLOW answer in range 5.0 to 6.0 (mm min ⁻¹) ALLOW one mark for correct working if final answer incorrect e.g. $\frac{21-0}{4}$
	b		evaporation (1) from upper leaf surfaces (1)	2	
	c		two from not all lower leaf surface covered (1) leaks in apparatus (1) shoot not cut under water (1) error in reading position of meniscus (1)	2	e.g. seal around the plant is not airtight.
			Total	8	
28		i	A B	2	
		ii	five cells drawn adjacent to each other AND clear continuous lines (1)	5	DO NOT ALLOW cells separated by gaps DO NOT ALLOW more than five cells DO NOT ALLOW ragged lines / any shading

			correct proportions (1) uses $\geq 50\%$ of area provided (1) <i>annotations:</i> label lines drawn with a ruler to correct feature (1) cell membrane AND nucleus AND cytoplasm labelled (1) comparative colour of any of above mentioned (1)	ALLOW if it is clear which cells the candidate has attempted to draw IGNORE any annotations not mentioned here DO NOT ALLOW arrow heads ALLOW implied comparison from different colours NOTE:  = 3 marks (MP2, 3 and 6)
			Total	2