

OCR A-LEVEL BIOLOGY B • H422

BIOLOGY



EXAM QUESTION PACK

2.2.3 GAS EXCHANGE IN MAMMALS AND PLANTS

SCORE

/55

PERCENTAGE

%

STEMUP

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- 1 Fig. 3.2 is a photomicrograph of the lower surface of a leaf showing stomata as viewed using a light microscope.

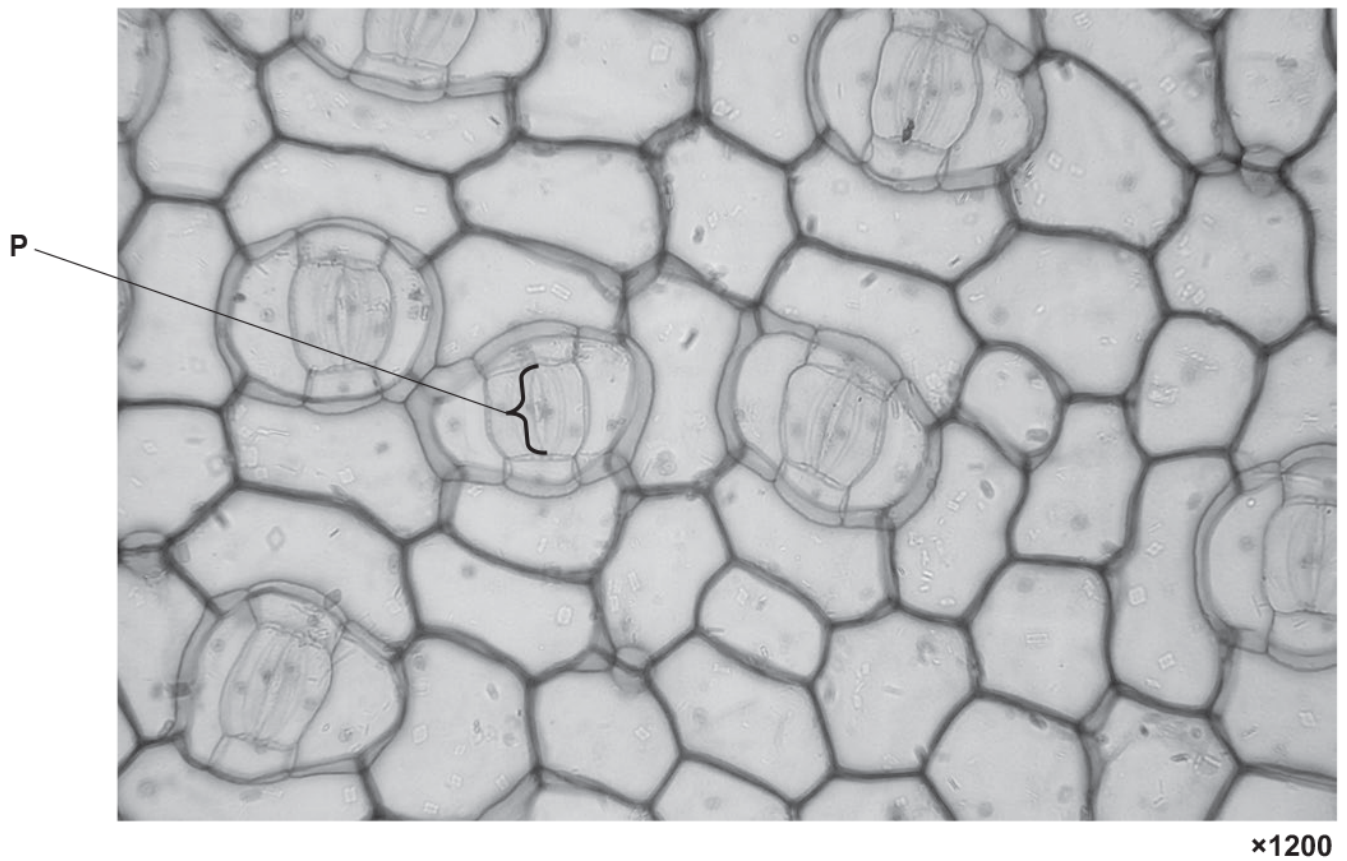


Fig. 3.2

Calculate the actual length of the stoma labelled P on Fig. 3.2.

Actual length = ... μm [2]

2 Which of the plant structures, A to D, has intercellular spaces to allow for the process of gas exchange?

- A sieve tubes
- B lenticels
- C root hairs
- D xylem vessels

Your answer

[1]

3 Gas exchange in the lungs occurs as a function of partial pressure differences in oxygen and carbon dioxide between the alveoli, and blood in the pulmonary capillaries.

Which of the rows, A to D, shows the partial pressure values that would allow efficient gas exchange in a healthy lung?

	Alveoli		Pulmonary capillaries	
	pO ₂ (mmHg)	pCO ₂ (mmHg)	pO ₂ (mmHg)	pCO ₂ (mmHg)
A	104	40	40	45
B	40	40	104	45
C	40	104	45	40
D	104	45	40	40

Your answer

[1]

4 A patient was assessed for pulmonary function.

The volume of air breathed during a normal breath was 0.5 dm³ in and 0.5 dm³ out. The volumes of air breathed in and out during a maximum possible breath were seven times greater.

The estimated total lung volume was 4.5 dm³.

Which of the options, A to D, is an estimate of residual volume in the patient?

- A 1.0 dm³
- B 3.5 dm³
- C 4.0 dm³
- D 5.0 dm³

Your answer

[1]

5(a) Absciscic acid (ABA) is a plant hormone that plays a role in many physiological processes.

ABA is known to promote the closure of stomata.

Binding of ABA to receptors on the surface of guard cells results in the removal of ions.

Explain how a loss of ions in guard cells causes the stomata to close.

[2]

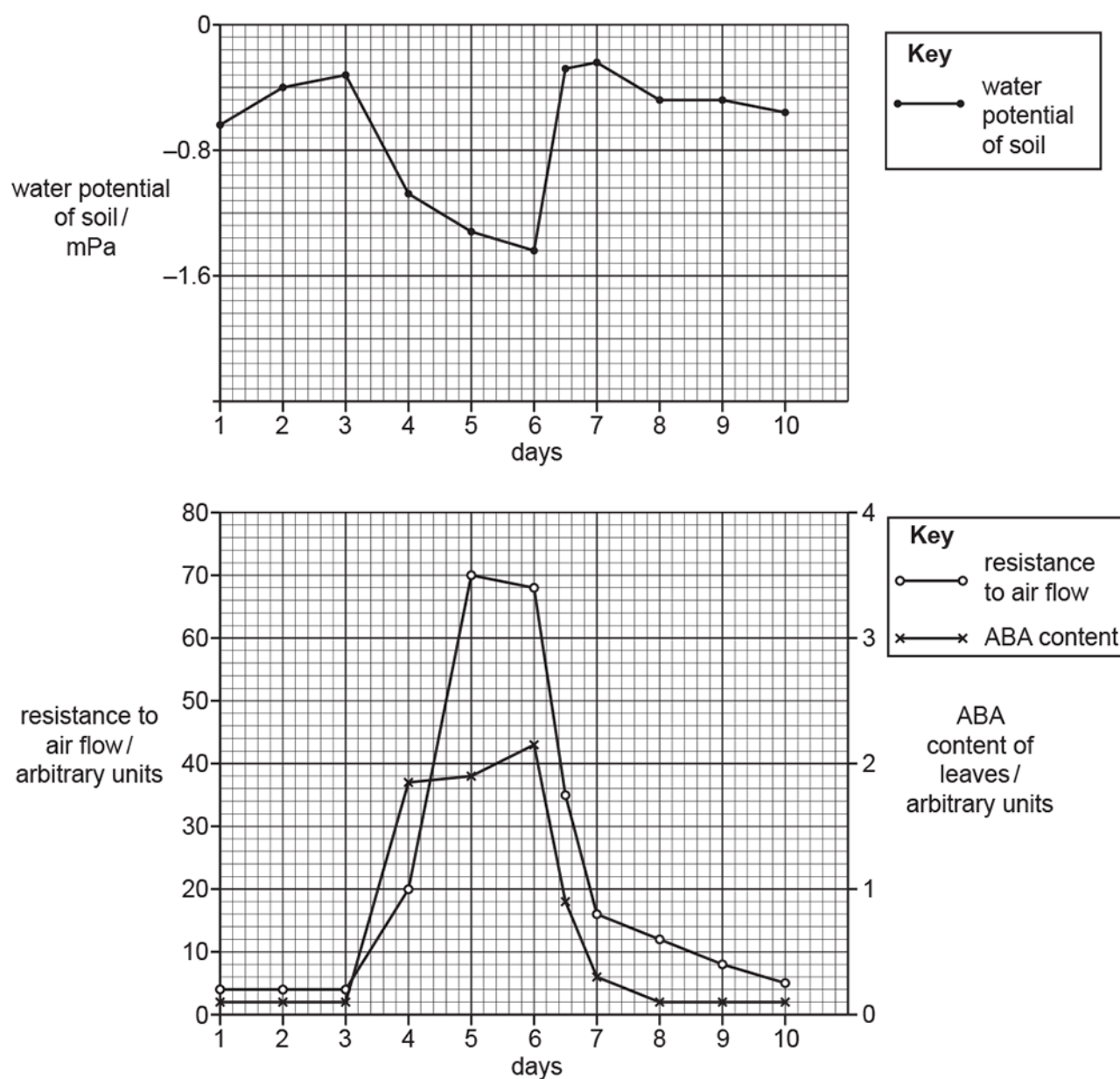
- (b) An experiment was conducted to investigate the effect of soil water potential on the production of ABA in leaves and the resistance to air flow through stomata.

The following parameters were measured daily in a maize plant:

- water potential of soil
- resistance to air flow through stomata
- ABA concentration in leaves.

Before the experiment, the plant was well-watered. The plant was not watered again until day 6 of the experiment.

The results are shown in Fig. 32.2.



The investigator made the following claim:

The data show that dry soil conditions promote the synthesis of ABA in maize plants, causing stomata to close.

Discuss the validity of this claim using **only** the data shown in Fig. 32.2.

[3]

6(a) The process of gas exchange involves several specialised cell types.

Fig. 37.1 shows a human bronchiole and surrounding alveoli under a light microscope. Two cell types are labelled R and S.

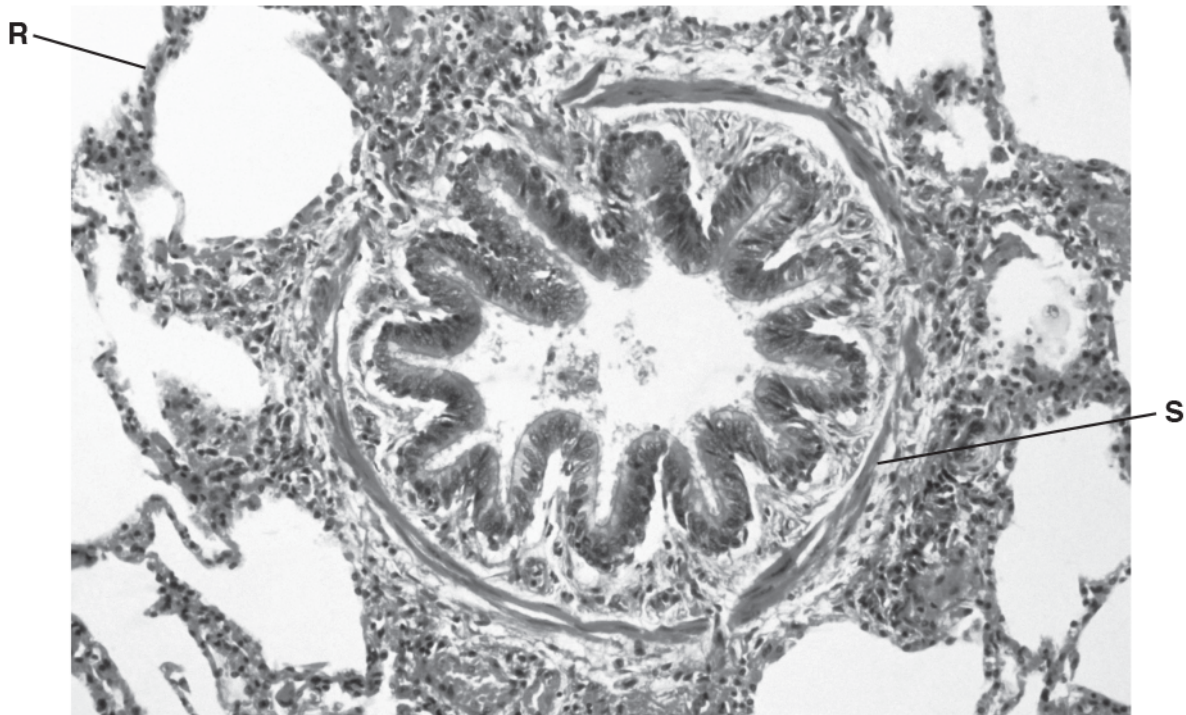


Fig. 37.1

Complete the table below by inserting, for each cell type:

- the **precise** name
- one** role in gas exchange.

Cell type	Name	Role
R		
		
		
S		
		
		

[4]

(b) A health campaign was launched to help people to give up cigarette smoking.

Fig. 37.2 is a graph that featured in the campaign.

Lung function is represented as a percentage of FEV₁ at the age of 25 years.

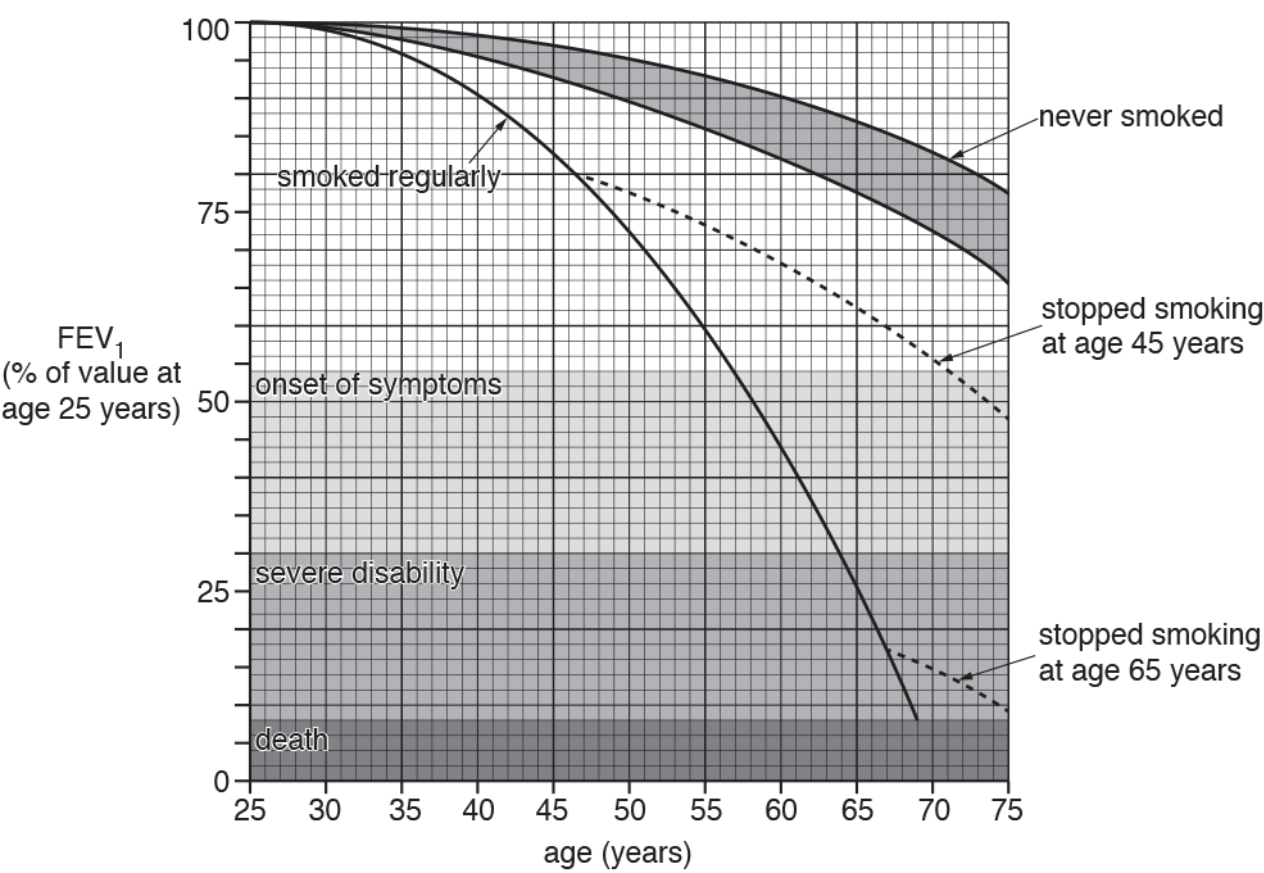


Fig. 37.2

(i) The health campaign claimed that giving up cigarette smoking improves quality of life and prevents smoking-related death.

Evaluate this claim using the data from the graph in Fig. 37.2.

[3]

(ii) During the campaign, doctors warned that the graph in Fig. 37.2 could not accurately predict the lung function of **individual** cigarette smokers over time.

Suggest **two** reasons why.

1 -----

2 -----

[2]

- (c) Cigarette smoking increases an individual's risk of a heart attack.

A heart attack can lead to respiratory arrest.

Describe how expired air resuscitation is performed to manage an adult in respiratory arrest.

[3]

7(a) Researchers were studying the possible association between smoking and the respiratory tract infections, pneumonia and bronchitis.

The study included an analysis of the infection figures for **all** admissions to a hospital.

- Data from 5018 patients were collected.
- 4022 of these patients were **non-smokers**.
- Each patient had only **one** infection.

Some of the data from this study are shown in Table 5.1.

	Number of patients admitted with a respiratory tract infection		Number of patients admitted with other type of infection
	Pneumonia	Bronchitis	
Smokers	335	230	431
Non-smokers	1166	526	2330

Table 5.1

A sample of bacteria from a patient with pneumonia was collected and a pure culture was prepared.

A Kirby-Bauer test was carried out to allow the doctor treating the patient to decide on the correct concentration of antibiotic to use.

Six different concentrations of the antibiotic were used, as shown in Table 5.2.

Kirby-Bauer disc	Concentration of antibiotic (a.u.)
A	0.0001
B	0.0010
C	0.0100
D	0.1000
E	1.0000
F	10.0000

Table 5.2

Describe the apparatus and method necessary to produce the six different concentrations.

You are supplied with an antibiotic solution of 10.0000 a.u. concentration and distilled water.

(b) Fig. 5.2 shows the result of the Kirby-Bauer test.

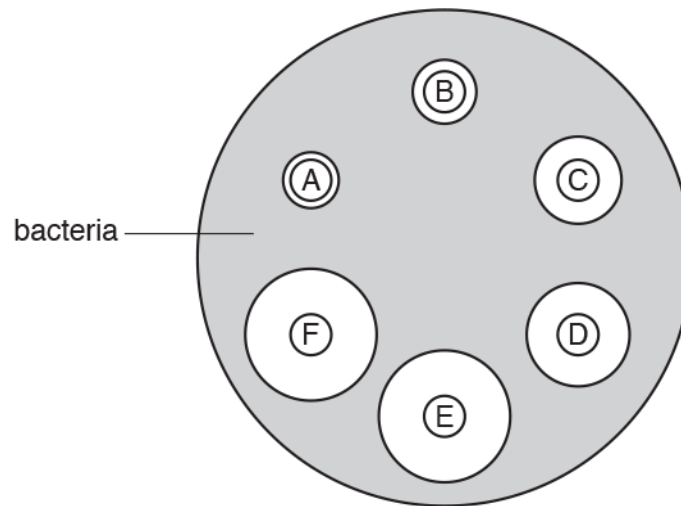


Fig. 5.2

Use the information in Fig. 5.2 to advise the doctor on the most appropriate concentration of antibiotic to use. Explain your choice.

A potometer was used to investigate the effect of wind speed on the rate of transpiration in a leafy shoot.

The investigation was set up as shown in Fig. 33.

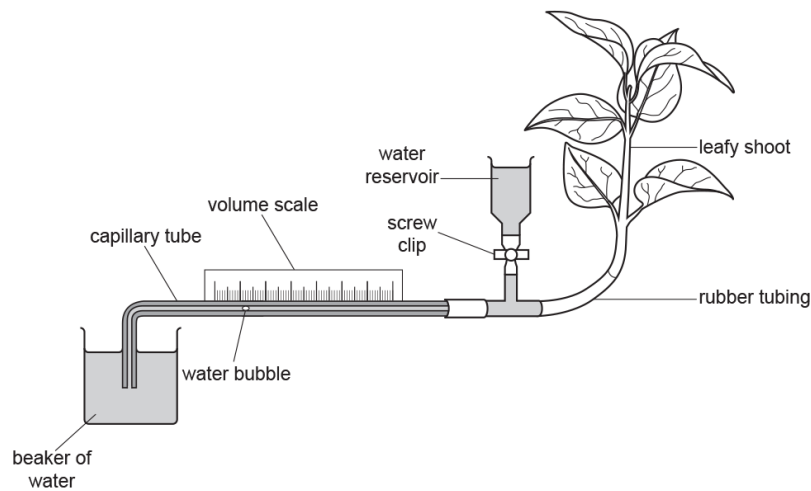


Fig. 33

To vary wind speed, a fan with five different speeds was positioned at a fixed distance from the leafy shoot.

The results of the investigation are shown in Table 33.

	Wind speed (ms ⁻¹)	Rate of water uptake (mm min ⁻¹)				
		Replicate 1	Replicate 2	Replicate 3	Mean	Standard deviation
1	0	0.3	0.3	0.3	0.30	0.00
2	2	2.6	2.5	2.5	2.53	0.06
3	4	5.0	4.8	4.9	4.90	0.10
4	6	7.0	7.0	7.2	7.07	
5	8	9.4	9.5	9.4	9.43	0.06

Table 33

- (i) Give **one** piece of advice when setting up the potometer to ensure a continuous stream of water between the capillary tube and the shoot.

-----[1]

- (ii) Using information in Table 33, calculate the standard deviation for the data from **row 4** (wind speed of 6 ms^{-1}).

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$

standard deviation = _____ [2]

- (iii) Describe **and** explain the data trend in Table 33.

----- [3]

- (iv) State **two** environmental variables that should have been controlled during this investigation.

1

2

----- [2]

(v) Explain why the potometer only gives an estimate of the rate of transpiration.

----- [2]

- has high levels of biodiversity
- is an arid area receiving very little rainfall per year
- has maximum summer temperatures of 40 °C and winter minima of >4 °C.

Fig. 5.1 shows the results of an experiment conducted on a plant species from the Succulent Karoo. It shows the stomatal conductance of the leaves of the plants over a 24-hour period under conditions as found in the Succulent Karoo. Stomatal conductance is a measure of the rate of movement of carbon dioxide (CO₂) entering, or water vapour exiting a leaf.

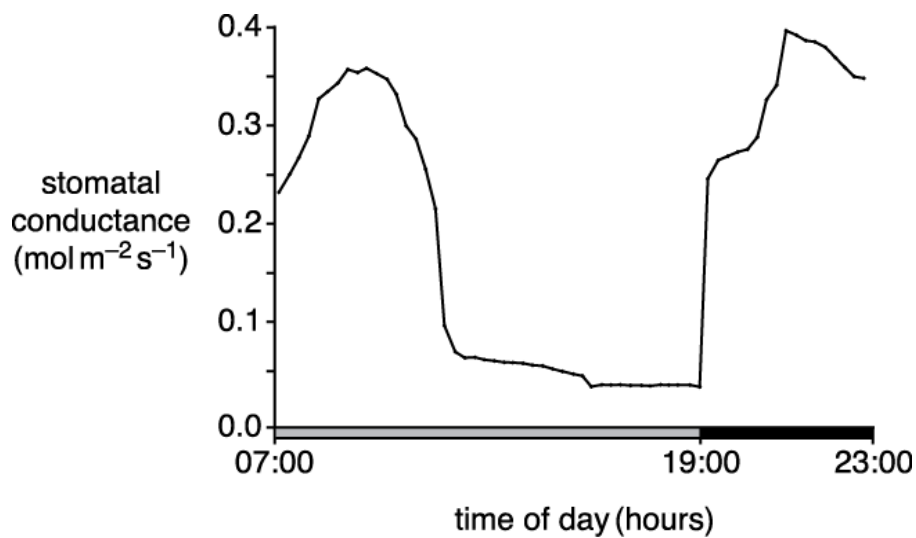


Fig. 5.1

*Using your own knowledge and the patterns shown in Fig. 5.1, explain how the plant species has an evolutionary advantage for living in the Succulent Karoo.

[6]

10 Fig. 2.1 shows oxygen dissociation curves for both haemoglobin and myoglobin.

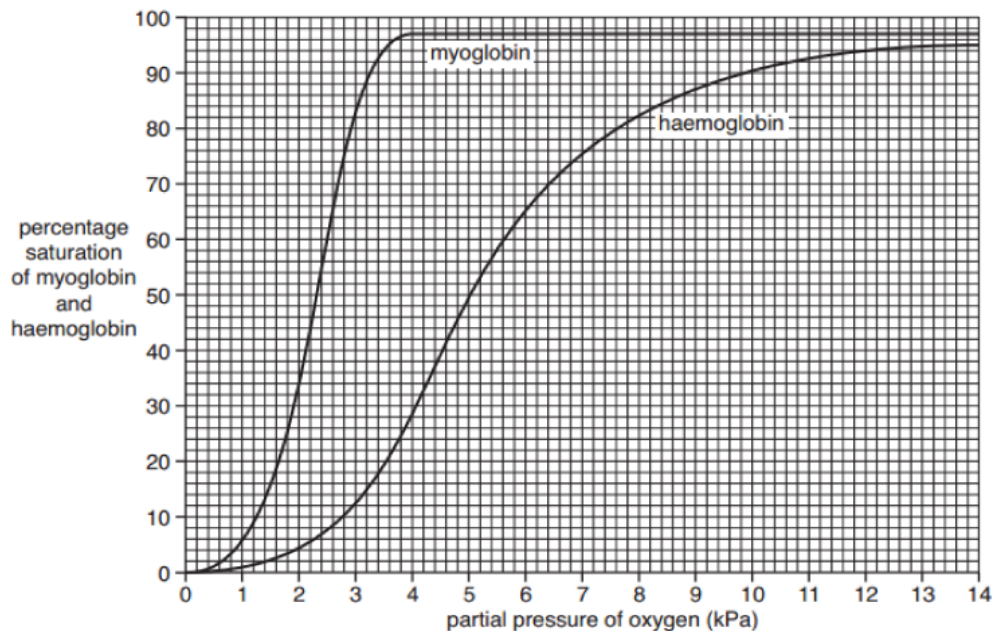


Fig. 2.1

The saturation of haemoglobin with oxygen increases as the partial pressure of oxygen is increased.

- (i) Use Fig. 2.1 to calculate the fastest rate of change in haemoglobin saturation as oxygen partial pressure increases. Determine the units for your answer.

answer _____ units _____ [3]

- (ii) Suggest where in the body a partial pressure of oxygen of 13 kPa would be found.

_____ [1]

- (iii) On Fig. 2.1, sketch the oxygen dissociation curve for human fetal haemoglobin.

_____ [1]

- (iv) Explain the biological significance of the different oxygen dissociation curves of myoglobin and adult haemoglobin.

- 11 Ventilation is increased during exercise to meet the increased oxygen demand of the body.

One way of increasing ventilation is to exchange a larger volume of air with each breath.

Which of the options, **A** to **D**, is a respiratory measurement that could detect this increase?

- A forced expiratory volume
- B residual volume
- C tidal volume
- D vital capacity

Your answer

[1]

- 12 Plants exchange gases through stomata. The opening and closing of stomata is controlled by guard cells.

Which of the sequences, **A** to **D**, would result in **open** stomata?

- A K^+ enters guard cells. The water potential of the cells is decreased. The cells take in water.
- B K^+ leaves guard cells. The water potential of the cells is increased. Water leaves the cells.
- C K^+ enters guard cells. The water potential of the cells is increased. The cells take in water.
- D K^+ leaves guard cells. The water potential of the cells is decreased. Water leaves the cells.

Your answer

[1]

- 13 The statements below refer to the location of cells **S** and **T** and the effect of the pollutants in tobacco smoke on these cells.

Fig. 9.1 shows a photomicrograph of a tissue found in the human gas exchange system. This tissue will be exposed to any pollutants present in inhaled air.

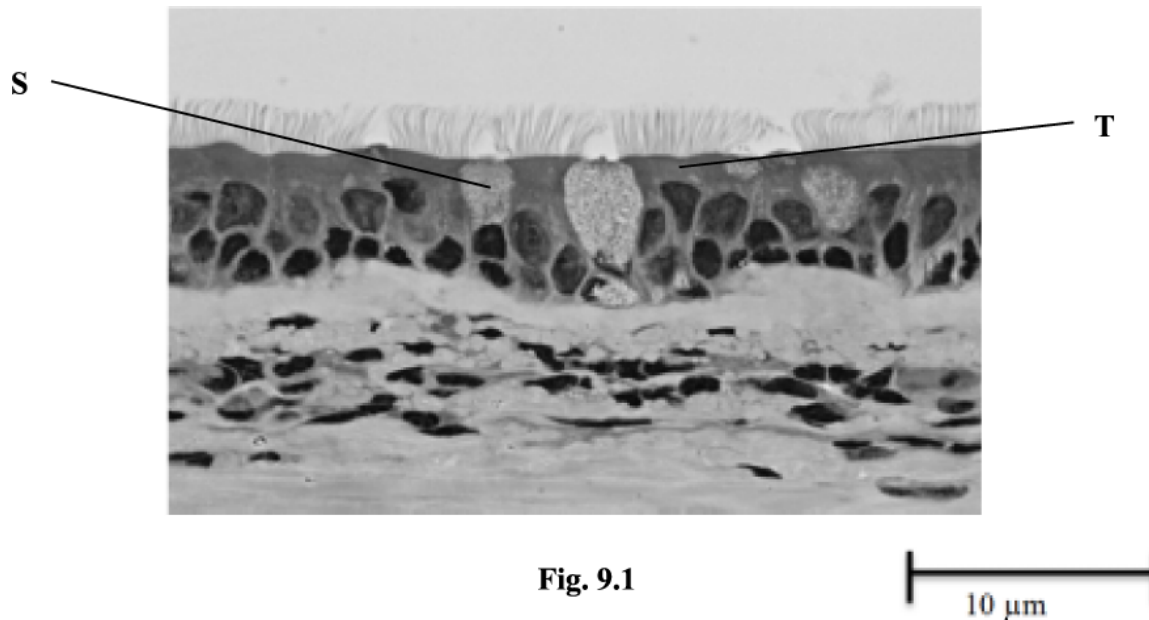


Fig. 9.1

10 μm

Which of the following statements are correct?

- Statement 1:** Cell S is a goblet cell and is stimulated by pollutants.
Statement 2: Cell T is a ciliated cell and is damaged by pollutants.
Statement 3: Cell S and T are found in the bronchi, bronchioles and alveoli.

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

Your answer

☐

[1]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 10 (μm) ✓✓ 12mm $\div$ 1200 OR 1.2cm $\div$ 1200 ✓	2(AO2.4)	
			Total	2	
2			B	1(AO1.1)	
			Total	1	
3			A	1 AO2.6	
			Total	1	
4			A	1 AO2.4	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
5	a		increase in water potential of guard cells ✓ water leaves by osmosis ✓ guard cells, become plasmolysed / flaccid ✓	max 2 AO2.5	ORA ALLOW Ψ for water potential ALLOW guard cells lose turgidity <u>Examiner's Comments</u> When discussing movement by osmosis in relation to water potential candidates need to be very clear to explain which regions contain the highest water potential and in which direction water moves. Exemplar 2 <i>Loss of potassium ions in the guard cells lowers the water potential. Water no longer diffuses by osmosis down its water potential gradient. Guard cells become flaccid. Stomata close (because they rely on the turgidity of guard cells to be open).</i> The candidate has stated that a loss of ions lowers the water potential. In this context it would lower the water potential of the tissue it is moving into but raise the water potential of the guard cells. This would cause water to move out of the guard cells. The lack of clarity has restricted the mark to 1.
	b		claim is valid because: ABA rises, as water potential of soil decreases / as soil dries out / during water stress ✓ resistance to air flow increases as water potential of soil decreases / as soil dries out / during water stress ✓ correlation / positive relationship between ABA and resistance ✓ claim not valid because: correlation does not prove causal link ✓ only one plant is used/there are no repeats ✓	max 3 AO3.1 3.2	<u>Examiner's Comments</u> The question asked about dry soil and the synthesis of ABA. Thus, candidates who only referred to the ABA levels decreasing when the soil was watered were not given credit. The principle here is that there is a correlation between soil drying and ABA increasing (and resistance to air flow) but a correlation between variables does not necessarily mean there is causation.
			Total	5	

Mark Scheme

Question			Answer/Indicative content			Marks	Guidance
6	a		Cell type	Name	Role	1	ALLOW septal cells DO NOT ALLOW contraction of bronchiole <u>Examiner's Comments</u> Many candidates were able to identify the squamous epithelial cell and describe the role. The smooth muscle cell proved more difficult to identify and for those who could there was some confusion about the role of this cell type. Some candidates incorrectly linked the contraction of smooth muscle to the regular ventilation process.
		R	<u>squamous</u> epithelial (cell) ✓	surface for gas exchange ✓ secretion of (pulmonary) surfactant ✓			
		S	<u>smooth</u> muscle (cell) ✓	control of airflow / constriction / dilation, of lumen (of bronchiole) ✓			

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b	i	delays onset of, symptoms / disability ✓ comparison of data to illustrate mp1✓ giving up at 65 years does not improve quality of life (already severe disability) ✓ cannot prove any influence on smoking-related death since cause of death not recorded ✓	3	ALLOW the earlier the age when giving up, the better the quality of life ALLOW those already disabled do not recover Examiner's Comments Although candidates were asked to evaluate a claim made about giving up smoking, many candidates wrote at length about non-smokers and regular smokers. This made their answers too long and often caused them to miss out on marks. Candidates should remember to quote data to support their answer in an evaluation question. Exemplar 11 (i) The health campaign claimed that giving up cigarette smoking improves quality of life and prevents smoking-related death. Evaluate this claim using the data from the graph in Fig. 37.2. For people that stopped smoking aged 45 ✓ there onset of symptoms reduced from age 57 to 71 ✓ which is a big increase, however people that stopped age 65, have already gone past symptoms disability so it just gives them around 7 years more to live ✓ The earlier you stop the more it improves quality of life. This candidate starts their answer clearly by referring to the two different ages that smokers could give up and gains the full marks in just six lines of text.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	any 2 from: person may not begin smoking at age 25 ✓ number of cigarettes per day not recorded ✓ graph does not exceed age 75 ✓ other respiratory conditions / named example e.g. asthma or COPD, affect FEV1 , not accounted for ✓ smokers may, lie / forget to report symptoms ✓ data based on mean values ✓	max 2	ACCEPT any reference to variation in <u>individuals</u>. <u>Examiner's Comments</u> Most candidates scored at least one mark here. Candidates stated correctly that individuals would have different starting FEV values but did not appreciate that the graph shows the change in FEV as a % of the FEV at 25 and so this would have been taken into account. Exemplar 12 This response demonstrates the error described above as well as one correct response.
	c		any 3 from: tilt head back (to open airway) ✓ check airway for / remove, obstructions ✓ pinch nose and seal mouth ✓ blow (gently) into mouth until chest rises ✓ wait for chest to fall and then repeat ✓ check pulse after two breaths ✓ repeat if pulse present / if not present, perform cardiopulmonary resuscitation / CPR ✓	max 3	<u>Examiner's Comments</u> Several candidates described CPR rather than expired air resuscitation.
			Total	12	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
7	a		states apparatus, to hold solution AND measure volumes ✓ 'F' is, stock / initial, solution used in the (serial) dilution ✓ correct volumes ✓ correct sequence ✓	4	<i>Apparatus could include</i> • suitable vessels for holding solutions, e.g. test tubes • volumetric apparatus, e.g. measuring cylinder, syringe, (graduated) pipette, burette ALLOW 10.0000AU in place of 'F' ALLOW description (serial) dilution of 'F' e.g. • measurement of one aliquot (antibiotic solution) and, adding to / mixing with, water • removal of one aliquot of new solution and, adding to / mixing with, water (repeated five times) <i>Volumes</i> one tenth of each solution forms the aliquot and is mixed with nine aliquots of water ALLOW 'parts' in place of absolute volumes IGNORE scale of volumes <i>Sequence</i> must result in correct dilutions being produced, i.e. start with stock solution and proceed in order Examiner's Comments Q5(d) was well answered in the main. Some candidates however were unable to provide appropriate apparatus and/or give even the most basic of descriptions of serial dilutions. Some candidates described serial dilutions but did not give appropriate volumes to generate the concentrations of the antibiotic required e.g. gave dilutions of 50%, 25% etc. rather than by diluting by factors of 10 in each case.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b		E and F have same sized, zone of inhibition ✓ most appropriate (concentration) is, 1.0000 a.u. / E ✓ reason given for not choosing, 10.0000 a.u. / solution F OR reason given for choosing, 1.0000 a.u. / solution E ✓	3	DO NOT ALLOW E is optimum concentration ALLOW • 10.0000 a.u./ solution F, is not optimal because it is wasteful / expensive • may cause (worse) side-effects • greater % of antibiotic isn't absorbed in gut / AW • greater % is egested OWTTE • <i>idea that</i> it is good practice to prescribe the lowest effective dose Examiner's Comments In Q5(e) to obtain full credit candidates needed to work through all three steps of identifying E and F as equally effective in this test, a reason for preferring E over F and a clear statement that E was the most appropriate.
			Total	7	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
8		i	any 1 from: cut shoot under water ✓ connect shoot to rubber tubing under water ✓ ensure tight fit between shoot and rubber tubing ✓ seal with Vaseline ✓ set up the potometer under water ✓	max 1	Examiner's Comments (a)(i) and (b) tested AO1, with most of the remainder testing AO2 criteria. In (a)(i) the question addressed practical procedures and it was encouraging to see that most candidates were familiar with the setting up of the potometer.
		ii	0.12 ✓ ✓	2	ALLOW unrounded answer (0.115758...) for 1 mark Examiner's Comments The calculation of the standard deviation in (a)(ii) caused a few problems, although more than 50% achieved the full 2 marks. The most common mistake was candidates who thought that $n - 1 = 4$ (the number of treatments minus 1) rather than $n - 1 = 2$ (the number of replicates minus 1). Candidates should remember that the standard deviation is a measure of variation around the mean and n is the number of values that make up the mean.
		iii	<i>Description:</i> faster the wind speed, faster the (rate of) water uptake ✓ <i>Explanation:</i> wind <u>increases</u> water (vapour) potential gradient (between airspaces in leaf and air in environment) ✓ faster diffusion of water <u>vapour</u> / increased transpiration rate ✓	3	ORA ALLOW wind <u>increases</u> concentration / diffusion gradient Examiner's Comments (a)(iii) required a description of the data which was done well, followed by an explanation which they found more difficult. Few candidates could give a clear and succinct explanation. To achieve full marks candidates needed to give a clear link to increasing air movement reducing the water (vapour) potential around the stomata so that there was a steeper water (vapour) potential gradient. Too many candidates referred to water being blown off the leaf, some even describing droplets being blown away or water moving out of the leaf by osmosis.
		iv	humidity ✓ light intensity ✓ temperature ✓	max 2	Examiner's Comments (a)(iv) was answered well and only a few candidates did not achieve these marks.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		v	water used in photosynthesis / hydrolysis ✓ water produced in respiration / condensation reactions ✓ water used to maintain turgor pressure ✓	max 2	Examiner's Comments There was a poor understanding of what was required by (a)(v). Although many candidates seemed to appreciate that water uptake was not the same as transpiration, fewer were able to explain that water was used (and produced) in the plant. The most common correct answer was that water was used in photosynthesis but it was disappointing to see that few candidates appreciated that water is essential to maintain the turgor of a plant.
			Total	10	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
9			<i>Summary of instructions to markers:</i> <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)</i> <i>Using a ‘best-fit’ approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.</i> <i>Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics):</i> <i>award the higher mark where the Communication Statement has been met.</i> <i>award the lower mark where aspects of the Communication Statement have been missed.</i> <i>The science content determines the level.</i> <i>The Communication Statement determines the mark within a level.</i>		

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Level 3 (5-6 marks) There is a comprehensive consideration of regions of the graph which are accurately explained in relation to stomatal aperture size. The adaptive significance of the conductance pattern is discussed in relation to transpiration and photosynthesis. <i>There is a well-developed line of reasoning which is clear and logically structured and uses scientific terminology at an appropriate level. All the information presented is relevant and forms a continuous narrative.</i> Level 2 (3-4 marks) There is some consideration of regions of the graph which are correctly linked to stomatal aperture size. A discussion of the adaptive significance of the conductance pattern is attempted and may consider transpiration or photosynthesis. <i>There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.</i> Level 1 (1-2 marks) Stomata are identified as the structures which will alter conductance values. An attempt is made to link stomatal opening with the correct times of day. There is little consideration of the adaptive significance of the patterns of conductance. <i>The information is communicated with only a little structure. Communication is hampered by the inappropriate use of technical terms.</i> 0 marks No response or no response worthy of credit.	6	Indicative scientific points may include Changes in the leaf • stomatal aperture open/wider when conductance is high • stomatal aperture narrower when conductance is low DO NOT ALLOW stomata are closed as no conductance / value is zero • stomata are wider during the morning • stomata narrow from 09:00 • stomata narrowest from 16:00 to 19:00 • gap between guard cells forms stoma(ta) Adaptive significance • stomata open to allow gaseous exchange • gaseous exchange permits aerobic respiration and photosynthesis • wider stomata increase transpiration • stomatal aperture reduced during hottest parts of the day ensuring water loss is minimised • stomatal aperture increased at night when it is cooler but there is no light for photosynthesis • stomata open when evaporation is slower Technical terms • stomata • xerophyte • transpiration • photosynthesis • guard cells
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
10		i	Answer (in a range between) = 20 – 22 Units = % kPa ⁻¹	3	1 mark can be awarded if there is evidence that the candidate has identified the steepest part of the slope as (any value between) 3.6–4.6 kPa ALLOW % per kPa
		ii	lungs / alveoli	1	
		iii	curve placed anywhere between the myoglobin and haemoglobin curves	1	The fetal haemoglobin curve can merge with either of the other two lines after 10 kPa
		iv	myoglobin has, greater affinity / AW, for oxygen (at the same kPa) <i>idea that</i> oxygen will be transferred to myoglobin / muscle, from (adult) haemoglobin	2	
			Total	7	
11			C	1	
			Total	1	
12			A	1	
			Total	1	
13			B	1	
			Total	1	