BENDEMEER SECONDARY SCHOOL
2024 PRELIMINARY EXAMINATION
SECONDARY FOUR EXPRESS

CANDIDATE NAME

CLASS

INDEX NUMBER

BIOLOGY
Paper 2

6093 / 02

27 August 2024
1 hour 45 mins

Candidates answer on the Question Paper.
No additional materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on the work handed in.
Write in dark blue or black pen.
You may use a 2B pencil for any diagrams or graphs.
Do not use paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

Section A (70 marks)
Answer **all** questions. Write your answers in the spaces provided on the question paper.

Section B (10 marks)
Answer any **one** question.
Write your answers in the spaces provided on the question paper.

The number of marks is given in brackets [ ] at the end of each question or part question.

FOR ASSESSMENT USE
80

This document consists of **22** printed pages.

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Section A [70 marks]

Answer all questions in the spaces provided.

1 Fig. 1.1 is a photomicrograph of a cell from the pancreas. The cell secretes the hormone insulin.

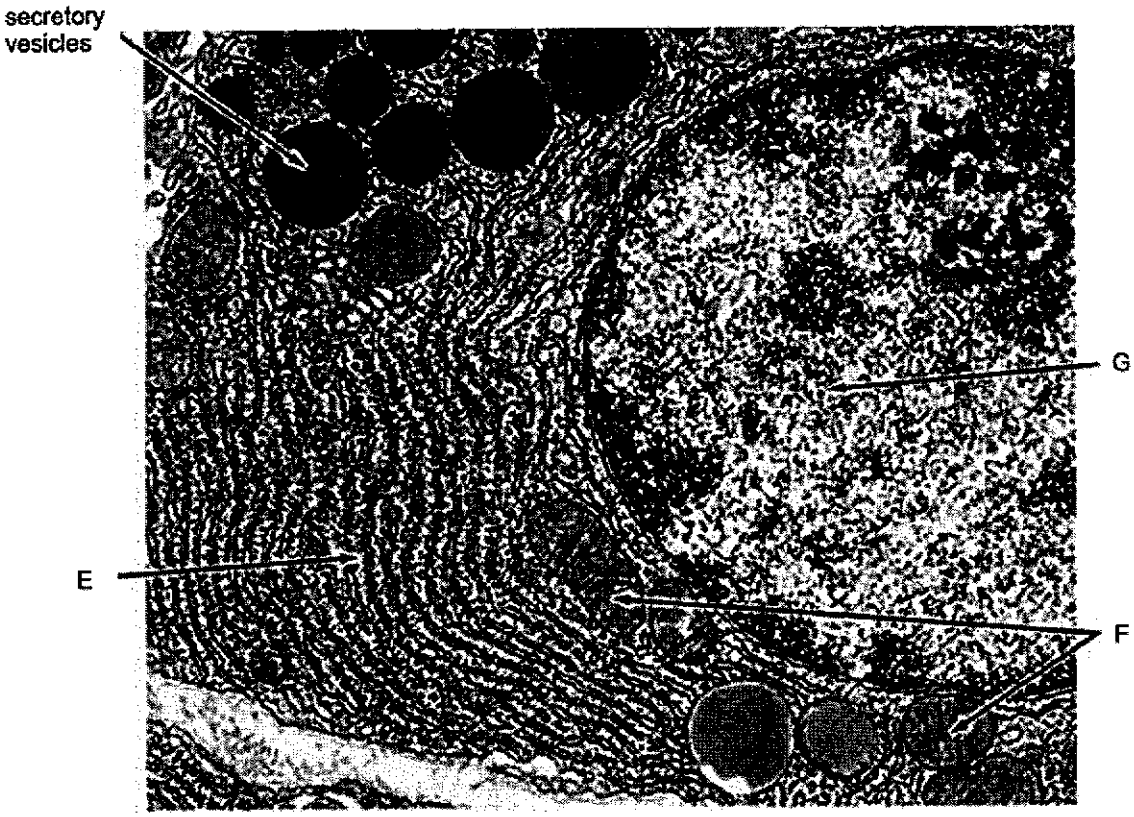


Fig. 1.1

(a) Name organelles E, F and G.

E: ..... F: .....

G: ..... [2]

(b) Define hormone.

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..... [2]

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(c) Explain the role of insulin in the regulation of blood glucose.

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..... [3]

(d) Diabetics can control their blood glucose level by injecting the hormone through the skin. In recent years, intensive research is conducted on the possibility of introducing the hormone into the body through either ingestion of a tablet or inhalation through a nasal spray.

Suggest why using nasal sprays is preferred over using injections and tablets.

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..... [1]

[Total: 8]

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2 Protoplasts are plant cells that have had their cell walls removed by treatment with enzymes. Scientists often use protoplasts when researching ways to improve the yield of crop plants.

Fig. 2.1 is a scanning electron micrograph of protoplasts of cells from the tobacco plant, *Nicotiana tabacum.*

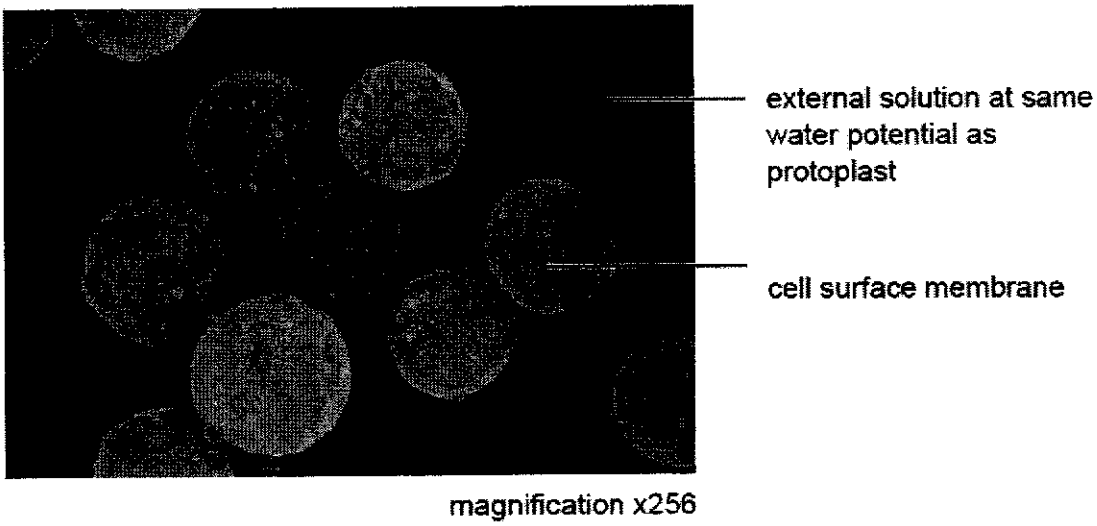


Fig. 2.1

(a) Suggest the name of the enzyme used in the treatment to produce protoplasts.

..... [1]

(b) Explain why scientists keep the protoplasts in a solution that is the same water potential as the cell.

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..... [2]

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(c) An investigation was carried out on a sample of protoplasts to determine the effect of light intensity on photosynthesis. Fig. 2.2 shows the results of the investigation.

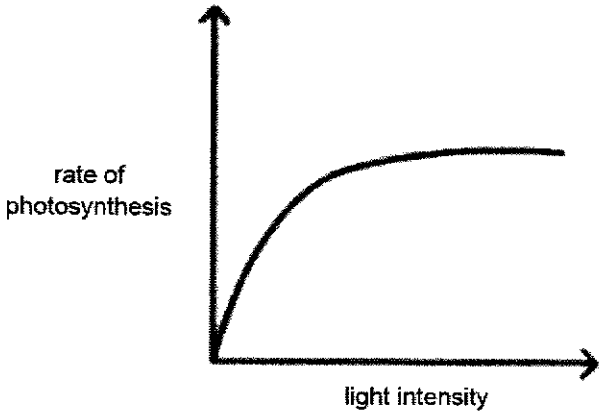


Fig. 2.2

(i) Describe and explain the relationship between light intensity and rate of photosynthesis.

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..... [2]

Farmers often install additional lighting in their glasshouses for their tobacco plants. Table 2.1 summarises some of the factors considered by farmers when choosing the type of lamps to install.

Table 2.1

type of lamp	electrical energy used by the lamp/ J per s	light intensity output/ arbitrary units	notes
sodium	1041	1767	• releases lots of heat • best when used in addition to sunlight
LED	423	378	• releases very little heat • can be used as an alternative to sunlight
metal halide	651	817	• releases some heat • can be used as an alternative to sunlight

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fluorescent	394	374	• releases some heat • best when used in addition to sunlight

(ii) Calculate the percentage increase in the energy used by the metal halide lamp compared to the energy used by the fluorescent lamp.

Give your answer to two significant figures.

.....% [2]

(iii) Some types of lamp release a lot of heat.

Explain the possible effects of excessive heat on the tobacco plants in a glasshouse.

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.....[2]

[Total: 9]

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3 Fig. 3.1 shows part of a capillary and two alveolar cavities.

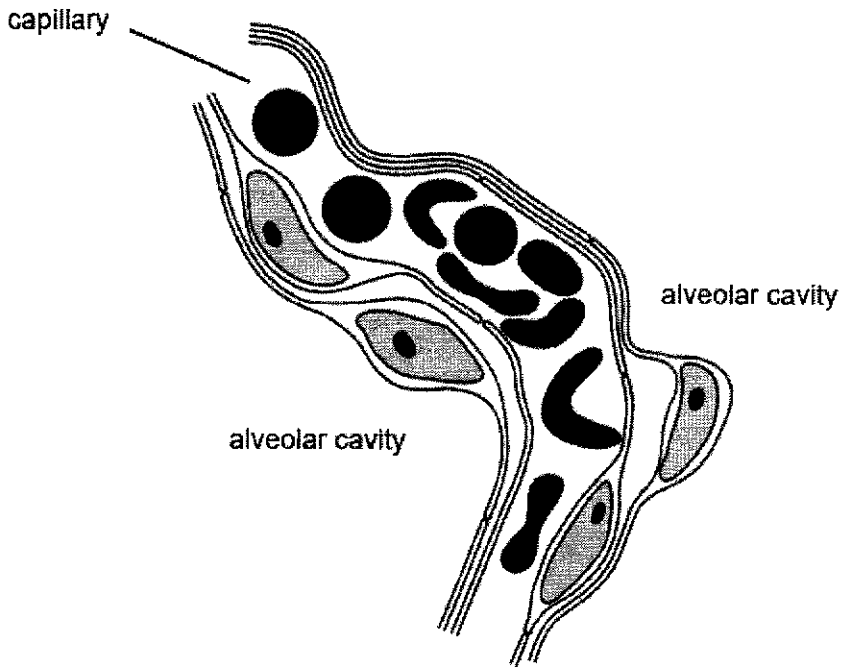


Fig. 3.1

(a) With reference to Fig. 3.1, describe the adaptation(s) of the

(i) alveoli,

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[2]

(ii) red blood cell.

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[2]

(b) Fig. 3.2 shows a section of a bronchiole from the lungs of a person who never smoked cigarettes (non-smoker) and a section of a bronchiole from a person who smoked cigarettes (smoker) for the past five years. The two sections were taken from the same relative position in the lungs and are drawn to the same scale.

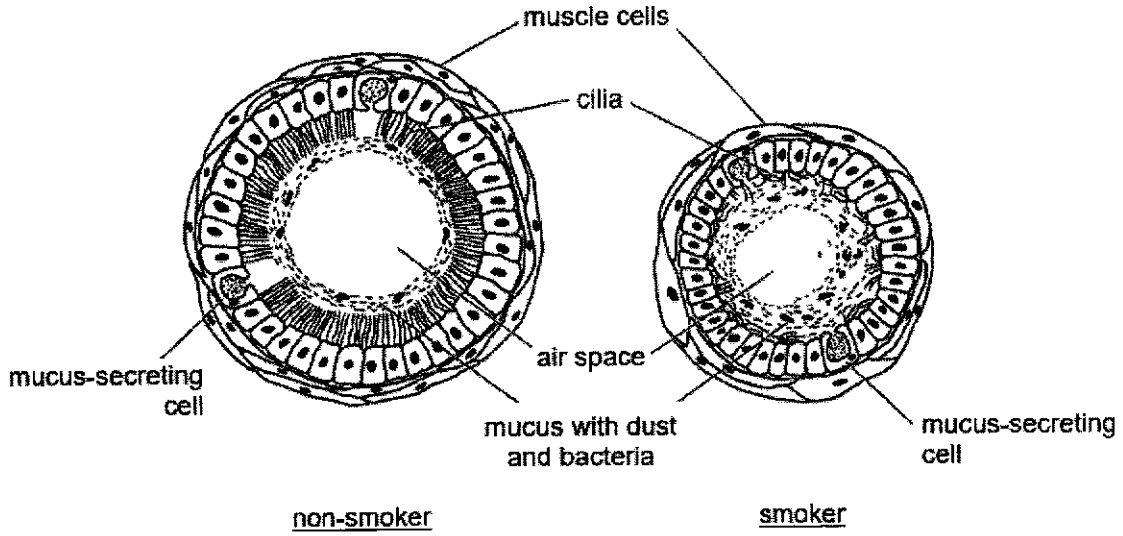


Fig. 3.2

(i) With reference to Fig. 3.2, state two visible changes in the bronchiole of a smoker.

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.....

[2]

(ii) State the component of cigarettes that could have caused the changes in the bronchiole of a smoker.

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[1]

(iii) With reference to Fig. 3.2, explain why the smoker has a higher risk of lung infections than a non-smoker.

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[2]

[Total: 9]

4 Fig. 4.1 shows the circulatory system in a fetus developing in the uterus. The foramen ovale is an opening between the right and left atria. The opening naturally closes six to twelve months after birth.

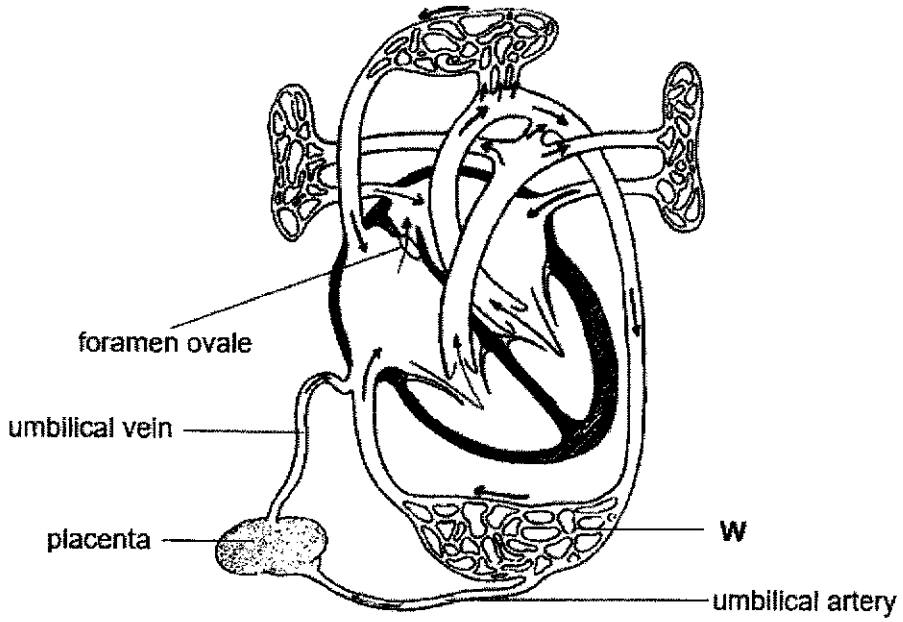


Fig. 4.1

(a) Describe and explain the difference in the composition of blood in the right ventricle of a fetus and a healthy adult.

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[2]

(b) With reference to Fig. 4.1, explain how the structure of W allows it to carry out its function efficiently.

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[2]

(c) A pregnant woman has the blood type B while her growing fetus has blood type A. Explain why it is dangerous if their bloods were to mix.

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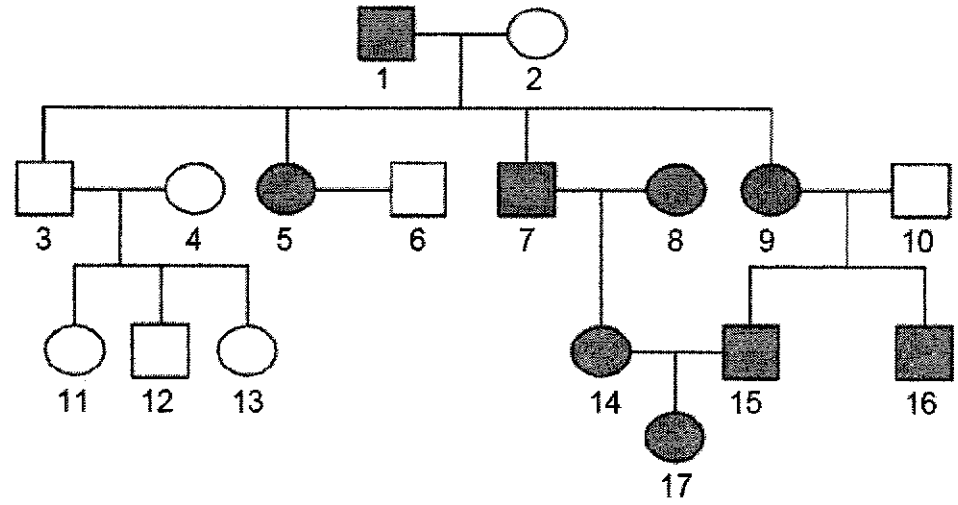
[2]

[Total: 6]

5 Some dogs have different-coloured eyes. This genetic condition is called heterochromia. The allele for heterochromia is dominant.

(a) Fig. 5.1. shows a family of dogs with heterochromia.

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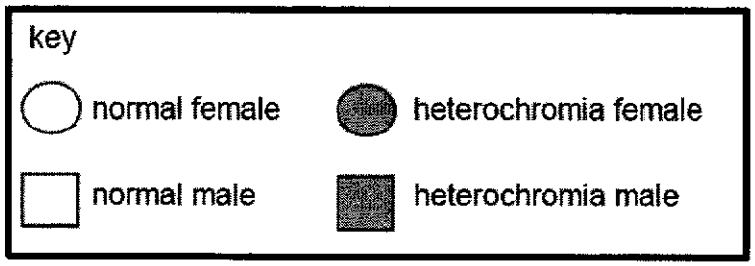


Fig. 5.1

(i) Describe what is an allele.

..... [1]

(ii) Using the numbers 1 to 17, identify the dogs that are heterozygous.

..... [1]

(iii) Dog 13 is crossed with dog 7.

State the expected phenotypic ratio of their offspring. Explain your answer.

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.....[3]

(iv) Explain why the observed ratio of dogs from the cross between dog 9 and dog 10 with heterochromia is different from the expected ratio.

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..... [1]

(b) Table 5.1 shows a comparison of the base sequence from a section of the DNA that controls eye colour in dogs.

Table 5.1

condition	base sequence
dogs not affected by heterochromia	CGT TAA AGA GGC GTA
dogs affected by heterochromia	CGT TAA AGA GCA GTA

(i) Using information from Table 5.1, explain why some dogs display heterochromia while some do not.

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[2]

(ii) State the name of the process that causes changes in DNA sequence.

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[1]

[Total: 9]

6 Fig. 6.1 shows the changes that occur in atmospheric pressure and oxygen concentration as altitude changes. The highest altitude at which people live permanently is 5100 m.

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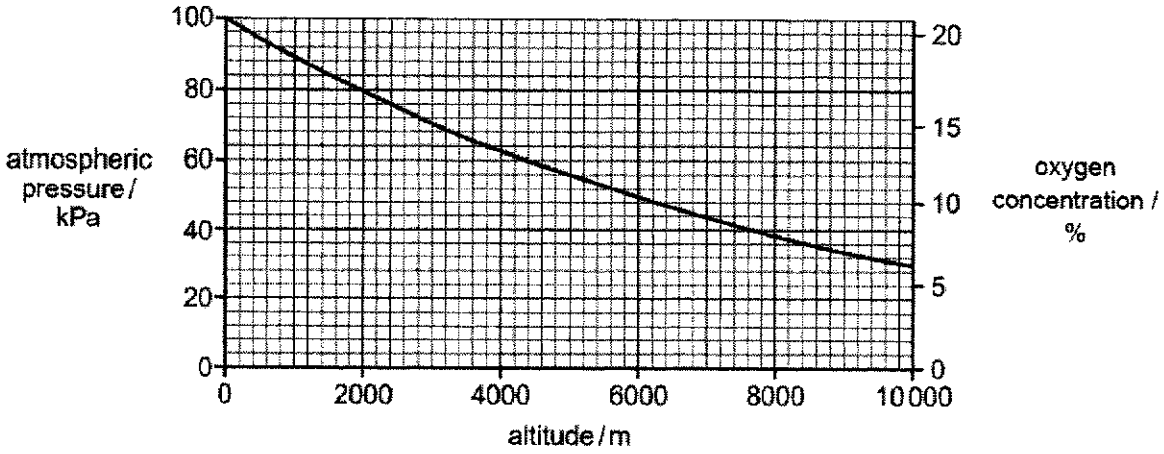


Fig. 6.1

(a) With reference to Fig. 6.1,

(i) describe the effect of increasing altitude on both atmospheric pressure and the oxygen concentration,

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[2]

(ii) calculate the change in atmospheric pressure when a person travels from sea level to an altitude of 3500 m.

Show your working.

..... [2]

(b) When a person travels from 0 m (sea level) to a high altitude, gas exchange in the lungs is affected. A condition known as hypoxia results, where the body tissues do not receive an adequate oxygen supply.

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Explain how hypoxia occurs when a person ascends from sea level to a high altitude.

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[3]

(c) At high altitudes, short-term responses by the body to hypoxia include:

- a decrease in the volume of plasma in the blood
- a decrease in the volume of blood pumped out of the heart per heart beat
- an increase in the heart rate
- an increase in the breathing rate

Explain why an increase in the heart rate occurs in response to hypoxia.

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..... [2]

[Total: 9]

7 During pregnancy, the peptide human chorionic gonadotrophic (hCG) hormone is produced by the embryo. HCG hormone stimulates the ovary to produce

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progesterone. Table 7.1 shows the concentration of hCG hormone in the blood of a woman in the first 18 weeks of pregnancy. Fertilisation occurs in week 3.

Table 7.1

weeks of pregnancy	2	4	6	8	10	12	14	16	18
hCG concentration/ mIUcm^{-3}	0	800	10000	12000	11000	6000	2000	1000	1000

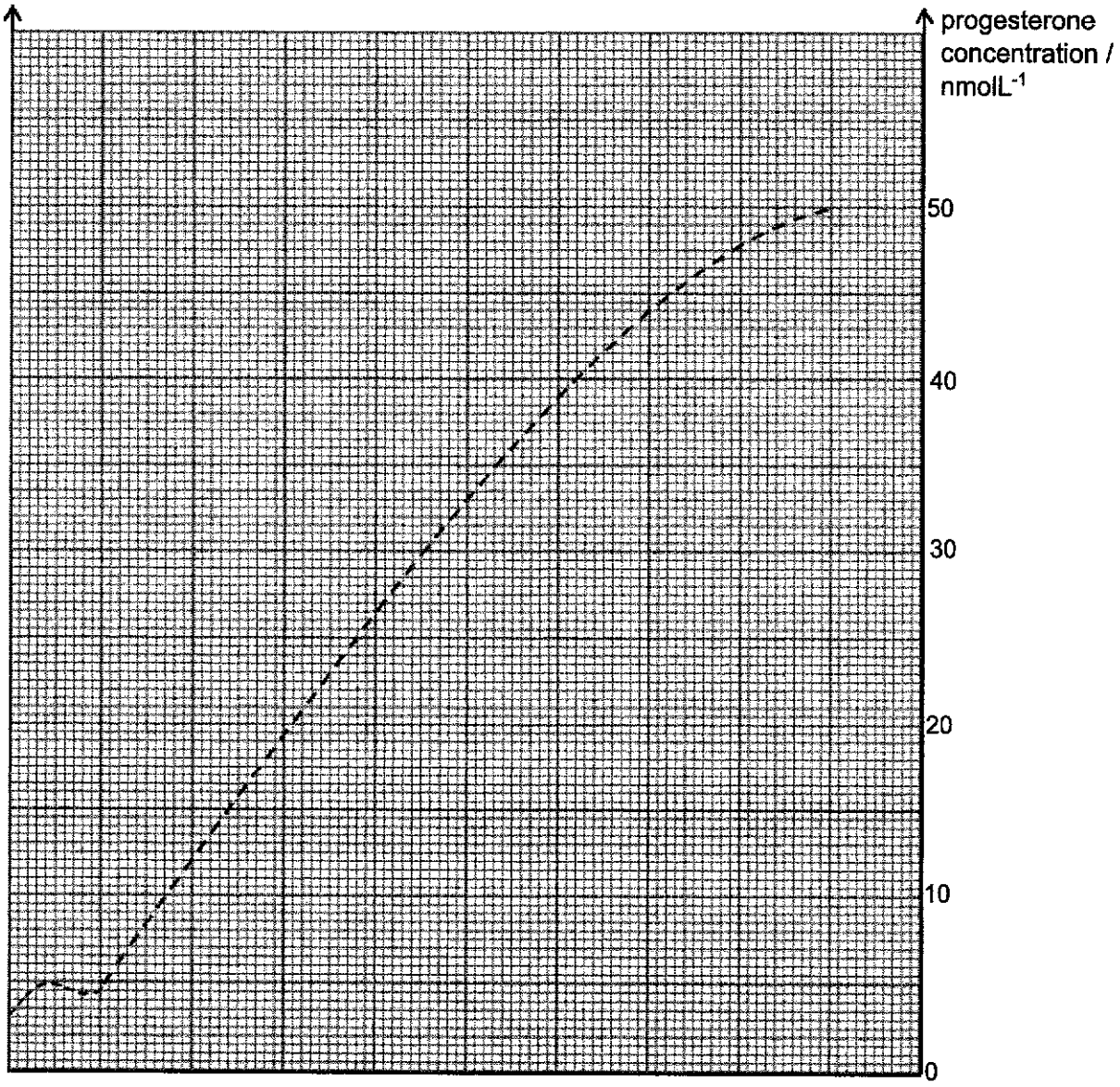


Fig. 7.1

(a) Draw a line of best fit in Fig. 7.1 using the same grid to show the concentration of hCG in the first 18 weeks of pregnancy.
[3]

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(b) Describe the trend in hCG concentration from week 2 to 16 of a pregnancy.

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[2]

(c) Suggest why progesterone concentration continues to increase even when hCG concentration decreases.

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[2]

(d) Home pregnancy test kits commonly test for the presence of hCG in urine.
Suggest why hCG can be found in the urine of pregnant women even though it is a protein.

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[1]

(e) Oligohydramnios is a condition in pregnancy characterised by low quantities of amniotic fluid.
Explain how this condition can be dangerous for a developing fetus.

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[2]

[Total: 10]

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8 Two subspecies of reindeer, *Rangifer tarandus*, live in North America. Members of the different subspecies belong to the same species but have some physical differences and are found in different geographical locations. Fig. 8.1 shows a reindeer.



Fig. 8.1

Table 8.1 compares the features of the two reindeer subspecies.

Table 8.1

feature	woodland subspecies, *R. tarandus caribou*	barren-ground subspecies, *R. tarandus groenlandicus*
habitat	warmer, southern woodland	snowy, northern tundra
colour of fur	dark	light
type of food	tree leaves, grass	lichen, moss

(a) During the last ice age, an ice sheet separated the southern and northern populations of *R. tarandus* in North America.

Using your understanding of natural selection and Table 8.1, explain how the ice sheet resulted in the evolution of two subspecies of *R. tarandus*.

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..... [4]

(b) A scientist studied the effects on kidney function of reindeer fed either with a low-protein diet or supplemented with salt (sodium chloride).

(i) When fed with a low-protein diet, there was a significant decrease in glomerular filtration rate (GFR) in the reindeer. The GFR can change when the afferent arteriole carrying blood to the glomerulus constricts.

Explain why the lumen of the afferent arteriole needs to be wider than the lumen of the efferent arteriole.

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[2]

(ii) State one adaptation of the afferent arteriole that allows it to change its lumen size.

..... [1]

(iii) Explain why a smaller volume of concentrated urine was produced in reindeer whose diet was supplemented with salt.

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[3]

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[Total: 10]

Section B [10 marks]

Answer only **one** of the questions in the space provided.

9 Some pollutants are not broken down easily and remain in the environment for a long time. These are described as persistent pollutants. PCBs are a waste material from the manufacturing of electrical insulation. PCBs are one of the most persistent pollutants in the environment.

Between 1947 and 1976, factories dumped large quantities of PCBs into the Hudson River in the USA. Studies measured the concentrations of PCBs in the tissues of organisms in a food chain in the sea near Hudson River, as shown in Fig. 9.1.

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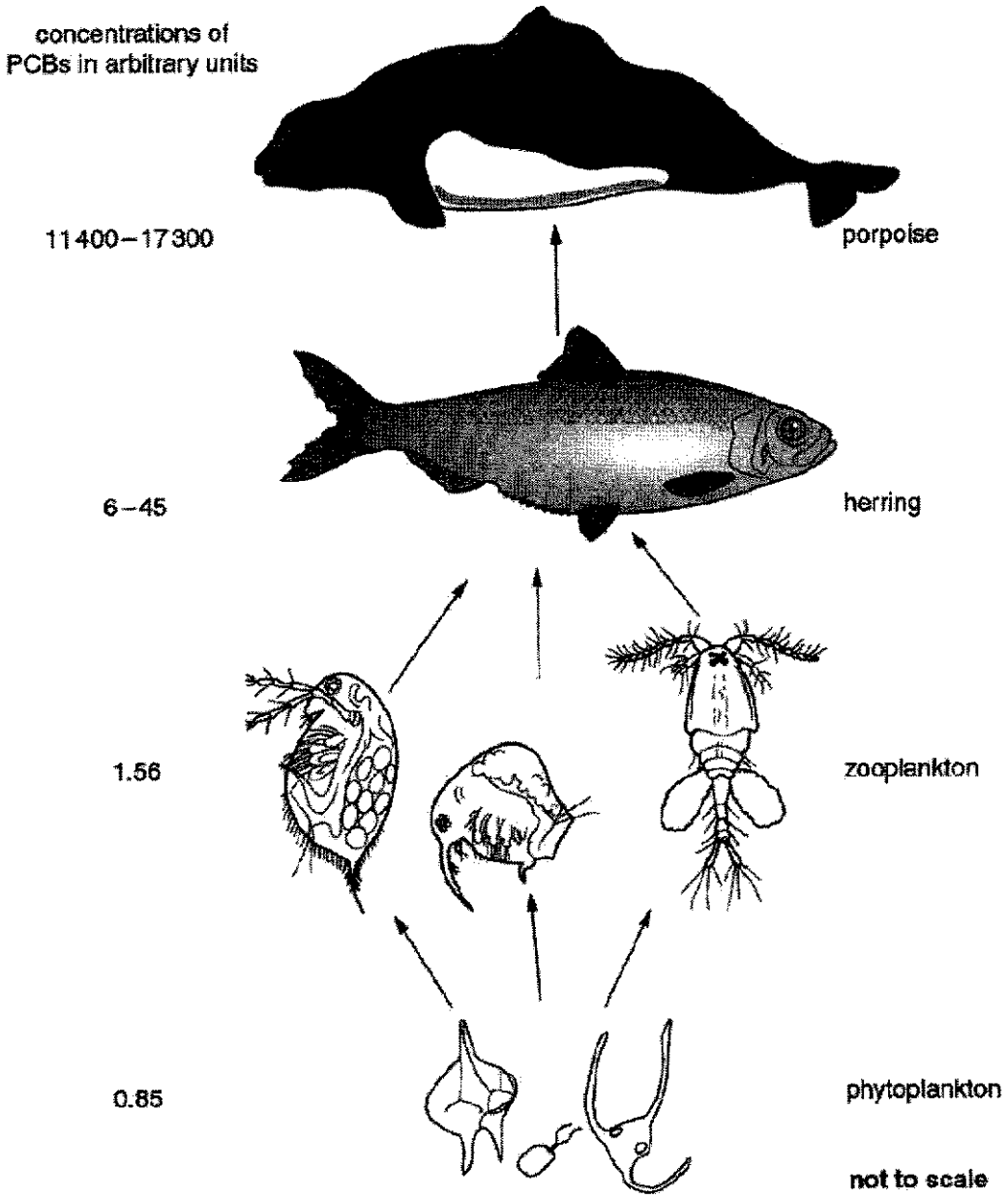


Fig. 9.1

(a) (i) Describe the results shown in Fig. 9.1.

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..... [3]

(ii) Suggest an explanation for the different concentrations of PCBs in the organisms of the food chain.

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(b) Explain why there are no more than four trophic levels in the ecosystem shown in Fig. 9.1.

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..... [3]

(c) Humans play a significant role in ecosystems.

Suggest possible conservation programmes that have helped to prevent the extinction of endangered species.

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[1]

[Total: 10]

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10 Fig. 10.1 shows a strawberry plant.

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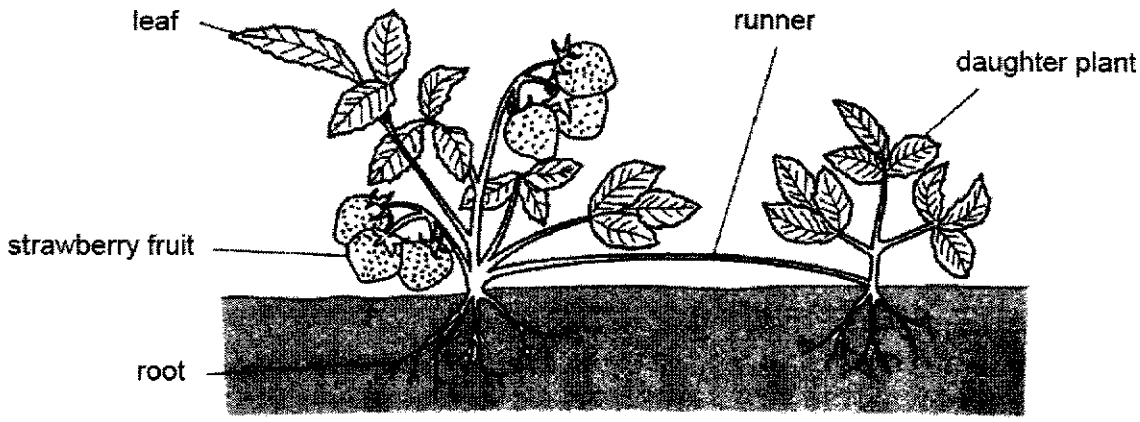


Fig. 10.1

(a) With the aid of Fig. 10.1, explain how the strawberry plants reproduce and state reasons for it.

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[4]

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(b) Three strawberry plants of the same species were placed in different greenhouses A, B and C. The conditions of each greenhouse are shown in Table 10.1.

Table 10.1

conditions	greenhouse A	greenhouse B	greenhouse C
humidity/ %	0.2	0.5	
Light intensity/ arbitrary unit	50	30	

(i) It was found that the plant in greenhouse C shown the highest rate of water loss. Complete Table 10.1 by predicting the humidity and light intensity in greenhouse C.

[1]

(ii) Explain how humidity and light intensity affect the rate of water loss in the strawberry plant in greenhouse C.

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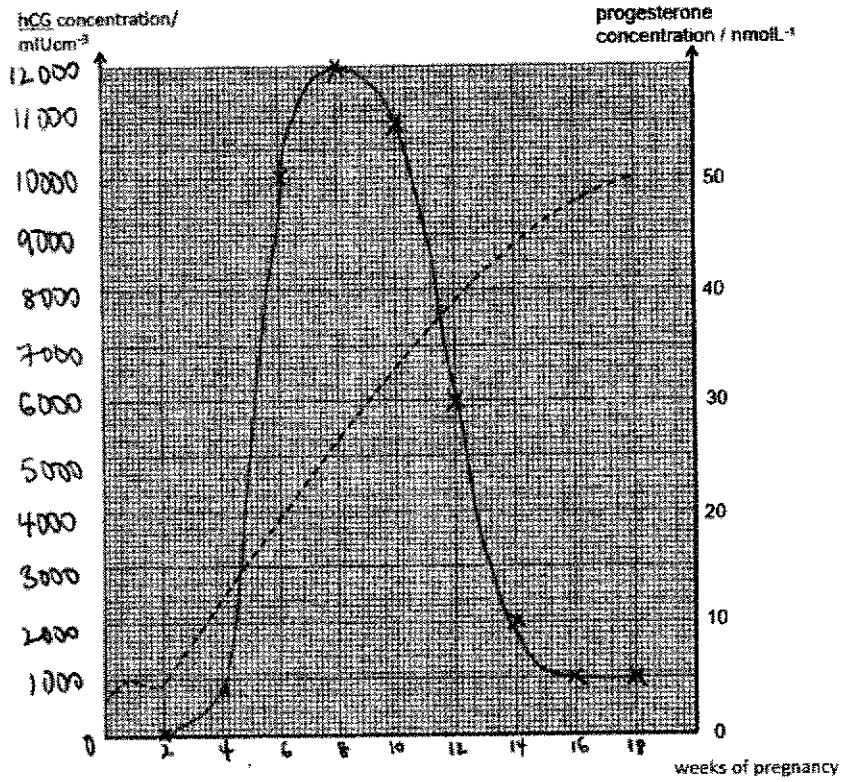
..... [5]

[Total: 10]

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4a	The right ventricle in the fetus contains mixed blood/blood has a higher concentration of oxygen while the right ventricle in an adult contains deoxygenated blood; The foramen ovale allows oxygenated blood from the umbilical vein to mix with the deoxygenated blood from the vena cava;	1 1
4b	As the cross-sectional area of the vessel increases/when branching occurs, the blood pressure in the vessel decreases, slowing blood flow through the body tissues; There is more time/longer duration for the blood to flow through the tissue, increasing the efficiency of exchange of substances such as oxygen and nutrients between the capillaries and the tissues;	1 1
4c	The mothers blood plasma contains antibodies a while the surface of the red blood cells of the fetus has antigen A. When antibodies a comes into contact with antigen A, agglutination/clumping occurs;	1 1
5ai	Allele is an alternative form of the gene. Heterochromia is an alternative form for the eye colour gene.	1
5aii	1, 5, 7, 9, 15, 16;	1
5aiii	1 heterochromia : 1 no heterochromia; (rej: 50%) 13 is homozygous recessive / 13 has no dominant allele for heterochromia / 13 has only recessive alleles; 7 is heterozygous / 7 has 1 dominant and 1 recessive allele;	1 1 1
5aiv	the expected ratio is a mathematically calculated value that is true for large sample sizes only. Since dog 9 and 10 only has 2 children (small sample size) the observed ratio does not have to be the same as the expected ratio	1
5bi	Codon for heterochromia is GCA different to GGC in normal dogs; Different amino acid formed + different protein formed in eye colour;	1 1
5bii	Mutation;	1
6ai	As altitude increases, both atmospheric pressure and oxygen concentration decrease; Correct comparative data quote of altitude and atmospheric pressure or oxygen concentration, with units; Non-linear decrease; Decrease in oxygen concentration proportionate to decrease in atmospheric pressure;	1 1 1 1 (max 2)
6aii	-34kPa	2
6b	Lower atmospheric pressure/ oxygen concentration • Lower concentration of / less/ oxygen in, alveolar/ inspired/inhaled air; • Decreased, diffusion/ concentration gradient; • Between alveolus and capillary (ref to concentration gradient); • Less oxygen enters capillaries/ the blood; • So fewer molecules of oxygen combining with haemoglobin;	 1 1 1 1 1 (max 3)
6ci	Greater concentration of red blood cells (through pulmonary capillaries per unit time) Increases the percentage of red blood cells to the total blood volume; Increases carbon dioxide/ bicarbonate ions concentration (to increase heart and breathing rates);	1 1 1 (max 1)
6cii	More red blood cells flowing to the lungs (per unit time); To maximise oxygen uptake from alveoli/ takes in more oxygen/ compensates for lack of oxygen; More blood pumped through the systemic circulation to the rest of the body;	1 1 1 (max 2)

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	Compensates for the lowered plasma volume	
7a	Scale + Axes (unit); Line; Point;  	3
7b	From week 2 to 8, hCG concentration increased sharply from 0mIUcm^{-3} to 12000 mIUcm^{-3} From week 8 to 16, hCG concentration decreased sharply from 12000mIUcm^{-3} to 1000 mIUcm^{-3}	1 1
7c	Placenta is formed; Take over the role of secreting progesterone;	1 1
7d	hCG is small enough to pass through the basement membrane hCG is degraded into smaller subunits in the kidney	1 1 (max 1)
7e	Insufficient amniotic fluid - to provide the developing fetus with support and cushioning before birth, making the developing fetus susceptible to physcial injury; - act as a shock absorber making the developing fetus suspectible to physcial injury; - to fucntion as an incompressible layer surrounding the developing fetus, causing the fetus to be susceptible to physical injury; - insufficient space to move about resulting in underdeveloped muscles;	
8a	- random/**spontaneous mutations resulted in variation** between the population of reindeers in the North and South; - **selection pressure**: due to difference in habitat / availability of food + provide ref. from table; - reindeer that is darker/lighter / ability to forage for food are at **selective advantage** in North/South; - able to **survive and reproduce** to pass down beneficial genes to offspring;	1 1 1 1 1

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	- **over time/many generations the populations evolved into the 2 subspecies separately;** - **geographical separation due to ice sheet;**	1 (max 4)
8bi	generate **high hydrostatic pressure** within the glomerulus; to force plasma/ small molecules/ fluid out of the Bowman's capsule during **ultrafiltration**;	1 1
8bii	presence of thick muscular walls;	1
8biii	salt lowers/decreases blood water potential, causing **more anti-diuretic hormone (ADH)** to be secreted by hypothalamus / released by pituitary gland; **cells of walls of collecting duct become more permeable;** more water is reabsorbed back into the blood capillaries surrounding the nephron;	1 1 1
9ai	- concentration of PCBs increases up the food chain; - concentration is much higher in larger organisms; - great increase between herring and porpoise; - herring/ porpoise at the top of food chain have a range of concentrations; - use data to make comparison between two trophic levels;	1 1 1 1 1 (max 5)
9aii	- animals at higher trophic levels live longer; - eat many of the animals below them in the food chain; - non-biodegradable, unable to be broken down and store and build up in the fatty tissues of the organisms - bioaccumulation	1 1 1
9b	- 90% of energy is lost through heat during respiration, excretory products - Only 10% is transferred to the next trophic level - Too little energy left in the last trophic level to support another trophic level	1 1 1
9c	- Monitoring and protecting the species/ habitat; - Education; - Captive breeding programme; - Zoos/ wildlife parks; - Law to ban hunting	Any 1
9a	Parent plant produces runners which allow a new daughter plant to grow close by. (genetic composition) Daughter plants are genetically identical to parent plant. Sexual reproduction allows genetically different / genetically dissimilar offspring to be produced. This is advantageous as it allows a larger proportion of offspring to survive in a range of environments / prevents a single disease from wiping out the whole population.	1 1 1 1
9b	Humidity – less than 0.2%, light intensity more than 50 AU	1
9c	The lower the humidity, the steeper the concentration gradient of water vapour between the intercellular air spaces and the surrounding air. Water vapour diffuses out of the stomata faster so there is a higher rate of water loss. The higher the light intensity, the higher the rate of photosynthesis in the guard cells. The higher rate of photosynthesis causes faster accumulation of glucose within the guard cells, lowering their water potential. Water molecules enters the guard cells by osmosis causing them to be turgid. This results in the stomata opening wider and hence, the rate of water loss will be higher.	1 1 1 1 1

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Paper 3

<table>
<tr><th>No</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1ai</td><td>50.0, 50.0</td><td>1</td></tr>
<tr><td>aii</td><td>Prediction :
1. As concentration of sodium chloride solution increases, the angle of bend of the potato increases.

Reason :
2. As the concentration of sodium chloride solution increases, the water potential of the sodium chloride solution decreases as compared to the potato cells.

3. Increase in net movement of water molecules from potato cells outwards into the sodium chloride solution

4. via osmosis
Reject: diffuse

5. Increased plasmolysis of potato cells causing potato to be more flaccid (aw)</td><td>1

Max 2</td></tr>
<tr><td>aiii</td><td>6. CH (column heading) - Column heading <u>with UNITS</u>
7. D (data) - Different angle of bend each conc of sodium chloride
(Angle of bend cannot be more than 90°)
8. T (trend) – 10% is the highest angle of bend & 0% (distilled water) is the lowest angle of bend
9. P – angle of bend to whole number

Example:
<table><tr><th>concentration of sodium chloride solution / %</th><th>angle of bend / °</th></tr><tr><td>10.0</td><td>30</td></tr><tr><td>7.5</td><td>25</td></tr><tr><td>5.0</td><td>20</td></tr><tr><td>2.5</td><td>10</td></tr><tr><td>0.0</td><td>6</td></tr></table></td><td>1
1
1
1</td></tr>
<tr><td>a iv</td><td>Based on student results
(tally with angle of bend for 7.5% sodium chloride solution)</td><td>1</td></tr>
<tr><td>a v</td><td>7.5% ;
Accept range between known values</td><td>1</td></tr>
</table>

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a vi	10. When placed against the protractor, pressure exerted on each piece of potato tissue may be different / inconsistent. 11. The potato tissue is difficult to hold and measure. 12. Potato pieces were NOT immersed in sodium chloride for the same duration / inconsistent incubation time. 13. Containers not covered and evaporation may have affected the concentration of the NaCl that the potato were immersed in. 14. The widths / cross sectional area of the potato tissue varies slightly when cutting 15. Measuring cylinder which was used for measuring volume of distilled water and sodium chloride is imprecise. **R.** fluctuations in temperature	Max 2.
a vii	16. Increase the number of concentrations of sodium chloride ; 17. Use a stabiliser or support for bottom of potato to reduce movement ; 18. Measure the change in mass rather than angle of bend ; 19. Carry out the test for each potato piece separately ; 20. Carry out repeat or replicate and calculate the mean ;	Max 2
a viii	Take precaution when handling the knife when cutting the potato.	1
b	Independent variable : Temperature (5 different temp with regular intervals) ; Dependent variable : Angle of bend / % of mass difference ; List at least 2 Control variable : • same concentration of (sodium chloride) solution ; • volume of solution used for each replicate ; • length / volume / surface area of potato tissue ; • time taken for each potato tissue to be immersed ; Method : • describe method of maintaining the temperature described (eg. using a thermostatically regulated water bath) ; • (if measuring mass) take mass of potato tissues using an electronic balance ; • place potato tissues in equal volume of solution for equal duration ; • dry off the potato cylinder with a paper towel before taking the angle of bend / mass ; • At least two repeats for each temperature, taking the mean ;	1 1 1 1 1

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<table>
<tr><td>ci</td><td>Solution : iodine solution;

Positive test result : iodine solution turns from yellow / brown to blue black;</td><td>1

1</td></tr>
<tr><td>cii</td><td>Lines : clear, continuous, unbroken link with no shading ;
Size: at least half the space provided ;
Detail : double line showing cell wall + minimum of five starch grains around perimeter of cell ;
Label : one starch grain labelled ;</td><td>1
1
1

1</td></tr>
<tr><td>ciii</td><td>*Check after printing Length of AB = ~10mm ;

Actual length = 100 / 800 = 0.125

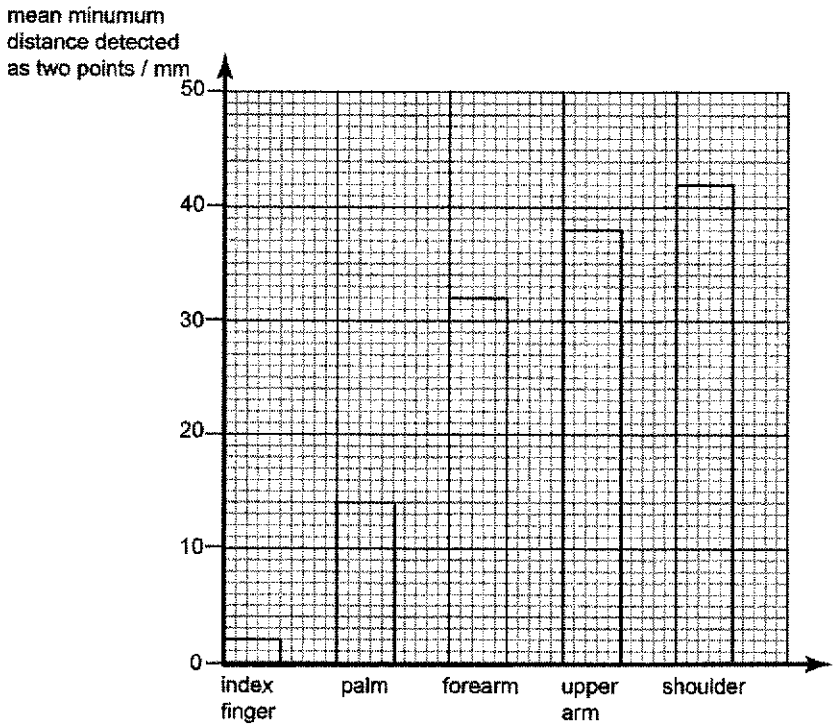
Round off to 2 sf → 0.013 (0.011 – 0.014) mm ;</td><td>1

1

1</td></tr>
<tr><td>2ai</td><td>index finger and thumb same number of ticks (±1) must follow trend [1]
palm less sensitive than finger [0.5]
wrist less sensitive than finger [0.5]

<table><tr><th rowspan="2">Distance between two points</th><th colspan="4">area tested</th></tr><tr><th>end of index finger</th><th>end of thumb</th><th>palm</th><th>wrist</th></tr><tr><td>20</td><td>✓</td><td>✓</td><td>✓</td><td>✓/×</td></tr><tr><td>15</td><td>✓</td><td>✓</td><td>✓</td><td>×</td></tr><tr><td>10</td><td>✓</td><td>✓</td><td>✓</td><td>×</td></tr><tr><td>5</td><td>✓</td><td>✓</td><td>×</td><td>×</td></tr></table></td><td>2</td></tr>
<tr><td>2aii</td><td>Index finger/ thumb
answer is consistent with candidate's results</td><td>1</td></tr>
</table>

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2bi	1. Scale: linear scale with 0 at origin for mean minimum distance graph and at least half of grid is used [1] **2.** Axes: both axes fully labelled with units on distance axis [1] **3.** Plotting of data: all data correctly plotted ±1 mm [1] 4. Graph: all drawn bars are of equal width with gaps between the bars [1] 	4
2bii	to make results more reliable / improve reliability [1] if student mentions accuracy, mark will not be awarded.	1
2biii	prevent seeing / knowing how many points being tested [1] so that touch is the only sense being tested [1]	Max 1
2biv	ensure same area of each section of arm / shoulder tested [1] same pressure / force exerted on skin / time points in contact with skin [1] toothpicks of equal sharpness / same surface area [1]	Max 1

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2bv	different areas of skin have <u>different numbers of receptors</u> [1] (touch) receptors <u>closer together</u> in more sensitive areas / hands [1] fingers / hand involved in manipulating / handling objects [1] reject: - different number of sensory neurone, - different thickness of skin (receptors are in all layers of skin – epidermis, dermis to differentiate light vs deep pressure)	2

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