

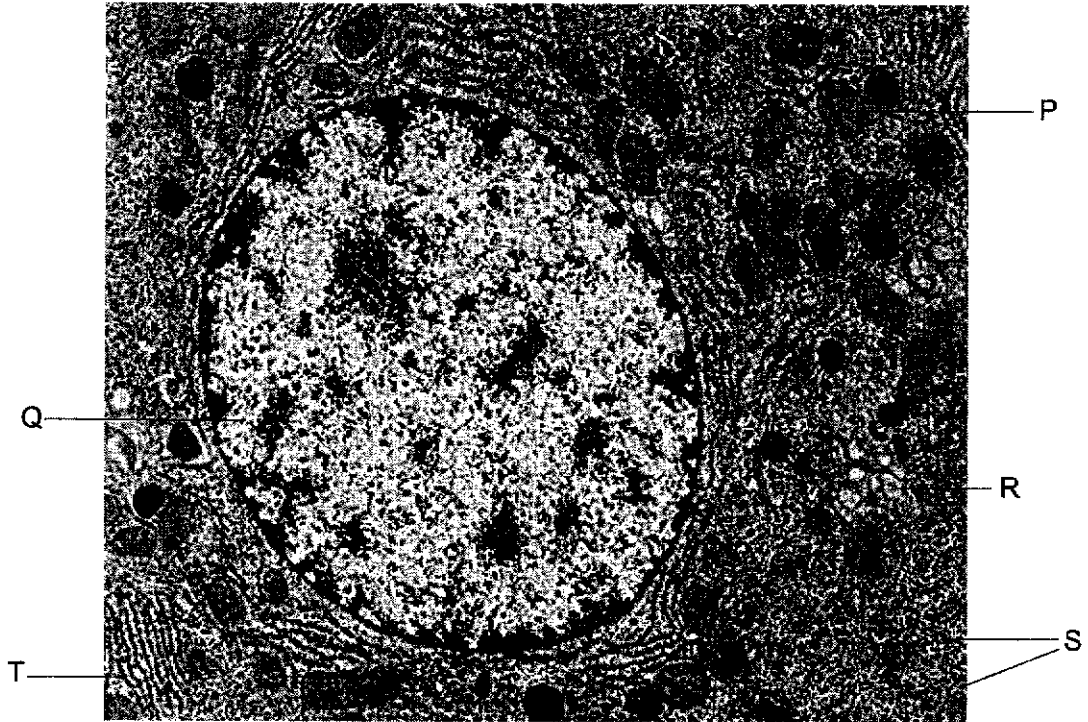




**Multiple-Choice Questions [40 marks]**  
Shade your answers on the OMR sheet provided.

- 1 RNA polymerase is an enzyme that transcribes DNA into mRNA.

The electron micrograph below shows a portion of a cell.



Which of the following about RNA polymerase is correct?

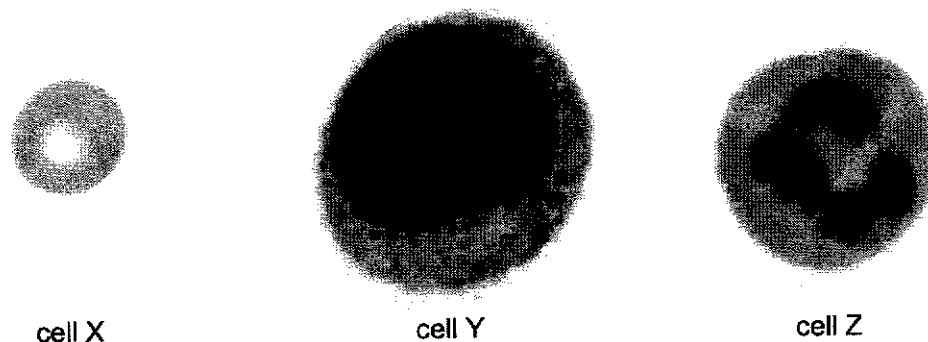
	structure which synthesises RNA polymerase	structure where RNA polymerase functions
A	P	S
B	R	T
C	S	Q
D	T	R

- 2 Viruses are non-living organisms that do not have nucleus or cytoplasm. Some virus strains will have an extra membrane surrounding it to protect the freely floating genetic material within it.

Which of the following statements about viruses is incorrect?

- A Exposure to high temperatures disrupts the viral membrane and kills the virus.
- B No chemical reactions occur within a virus.
- C Viruses are unable to synthesise their own proteins.
- D Viruses can replicate and reproduce on their own in the air, causing widespread infection.

- 3 The diagram below shows some cells that are found in the blood. These cells were viewed under the microscope, at a magnification of  $\times 3512.0$ . (Note:  $1 \text{ cm} = 10\,000 \mu\text{m}$ )



What is the actual size of the cell that produces antibodies against a viral infection?

- A 4.27  $\mu\text{m}$   
 B 6.83  $\mu\text{m}$   
 C 11.4  $\mu\text{m}$   
 D 20.9  $\mu\text{m}$
- 4 Equal sized potato pieces were placed into test-tubes containing equal volumes of different concentrations of sucrose solution and left for 30 minutes. All other variables were controlled. After 30 minutes, the potato piece in one of the sucrose solutions had not changed in size.

What can be concluded from this result?

- I There is no net movement of water into or out of the potato.  
 II The water potential of the cell sap of the potato cell is the same as the water potential of the sucrose solution.  
 III The concentration of sucrose in the cell sap of the potato cell is the same as the concentration of the sucrose solution.

- A I and II                      B I and III                      C I, II and III                      D II only

- 5 Cytochrome oxidase is an enzyme that is found in the mitochondria of plant and animal cells. Cyanide, a toxic compound, binds to the active site of cytochrome oxidase and inhibits oxygen from binding.

Which of the following processes will be affected by the consumption of cyanide?

	gaseous exchange of oxygen at the alveoli	absorption of dissolved mineral ions by root hair cells	ultrafiltration of substances in the glomerulus	selective reabsorption at proximal convoluted tubule
A	affected	not affected	affected	not affected
B	affected	affected	not affected	not affected
C	not affected	affected	affected	affected
D	not affected	affected	not affected	affected

- 6 A human cell contains a length of DNA that carries the code for making substances. Which substance is made from this code?
- A fat  
B glycogen  
C lipase  
D starch
- 7 Which row shows the correct elements and basic unit that are used in the synthesis of the food molecule?

	food molecule	elements	basic unit
A	fats	carbon, hydrogen, oxygen, nitrogen	glucose
B	fats	carbon, hydrogen, oxygen, nitrogen	glycerol
C	maltose	carbon, hydrogen, oxygen	glucose
D	starch	carbon, hydrogen, oxygen	glycogen

- 8 The colour of a positive Benedict's test is due to the formation of copper (I) oxide. The mass of copper (I) oxide is proportional to the mass of reducing sugar present.

Juice extracted from fruits typically contains varying amounts of sucrose and glucose. Samples of fruit juice were tested for the presence of reducing sugars and non-reducing sugars using the Benedict's test.

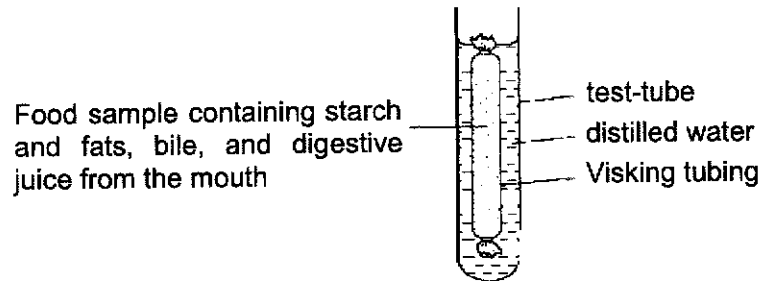
The table shows the mass of copper (I) oxide after two treatments of the fruit juice.

sample of fruit juice	mass of copper oxide / mg	
	after boiling with Benedict's solution	after acid hydrolysis and boiling with Benedict's solution
1	20	20
2	30	45
3	50	55
4	65	75

Which samples contained the highest amount of sucrose, and least amount of glucose?

	highest amount of sucrose	least amount of glucose
A	1	4
B	2	1
C	3	2
D	4	3

- 9 A student extracted some digestive fluid from the mouth and added them into a liquid sample of food substances as shown in the diagram below. A small volume of bile was also added to the liquid sample of food. At the end of 3 hours, some food tests were performed on the distilled water extracted from the test-tube.



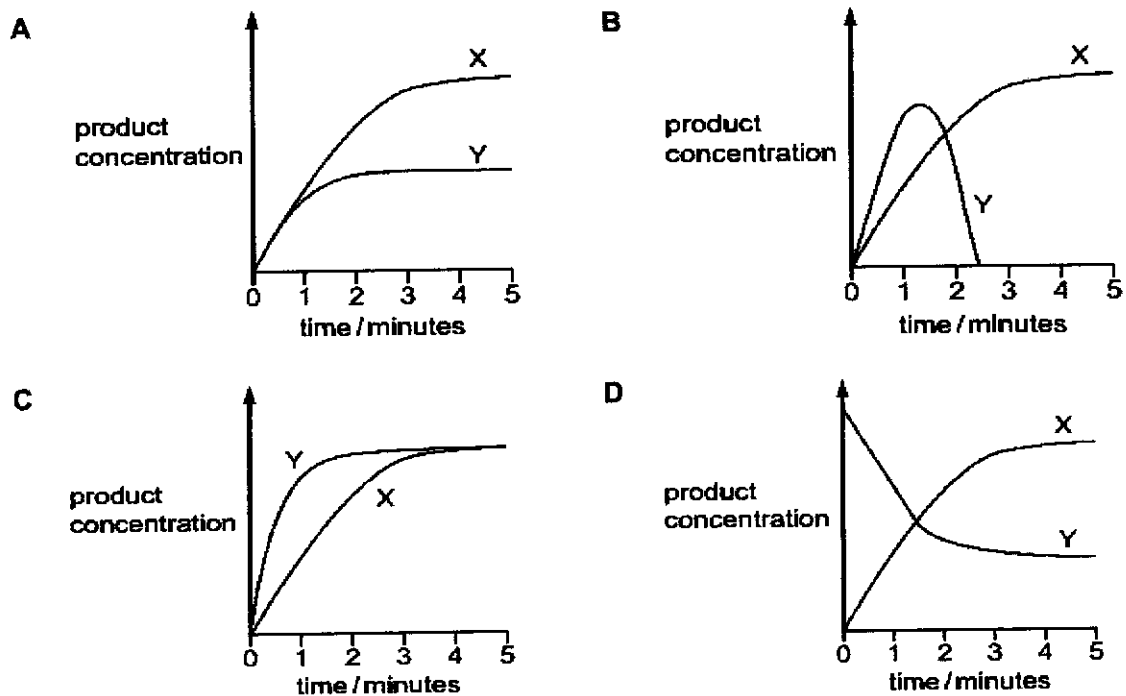
Which of the following correctly reflects the results of the food tests performed at the end of 3 hours?

	Benedict's test	ethanol-emulsion test	iodine test
A	blue	colourless	blue-black
B	brick-red	white	yellowish brown
C	brick-red	colourless	yellowish brown
D	brick-red	white	blue-black

- 10 Two experiments, X and Y, were carried out using an enzyme from humans.

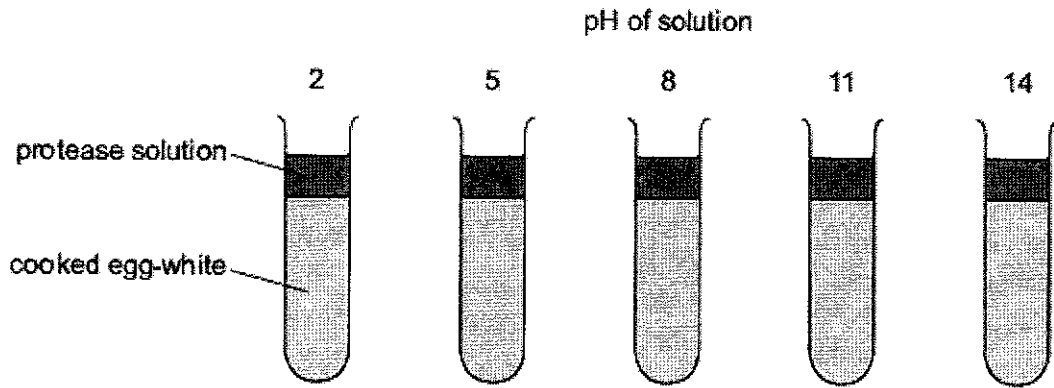
Experiment X was carried out at a constant temperature of 37 °C. During experiment Y, the temperature was increased from 37 °C to 80 °C. All other factors were kept the same.

Which graph shows the results?

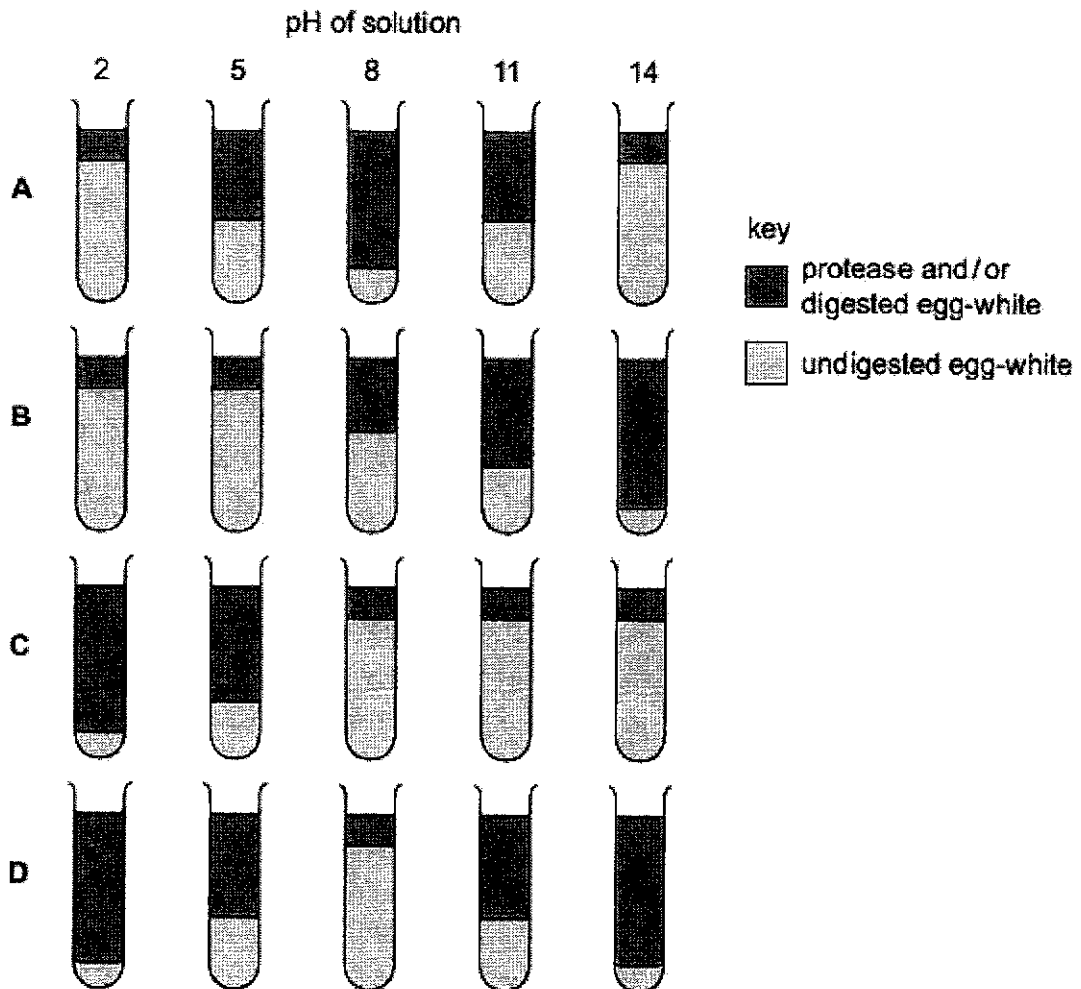


[Turn Over

- 11 Five tubes containing cooked egg-white are set up as shown. Protease solutions of different pH are added to each tube.



Which diagram shows the results of this experiment for a protease from the human stomach?



- 12 Enzymes are commonly added to biological washing powders.

Which of the following statements about the use of enzymes in washing powder is incorrect?

- A Enzymes are biological catalysts and will help to break down food stains quickly.  
 B Enzymes are needed in small quantities and minimal amounts of washing powder are needed in each wash of the same load.  
 C Enzymes are sensitive to temperature and an optimum temperature should be used for each wash.  
 D Enzymes remain unchanged at the end of a reaction, and hence they can be reused in multiple washes.
- 13 Which stage of nutrition takes place when food molecules become part of a body cell?
- A absorption  
 B assimilation  
 C digestion  
 D ingestion

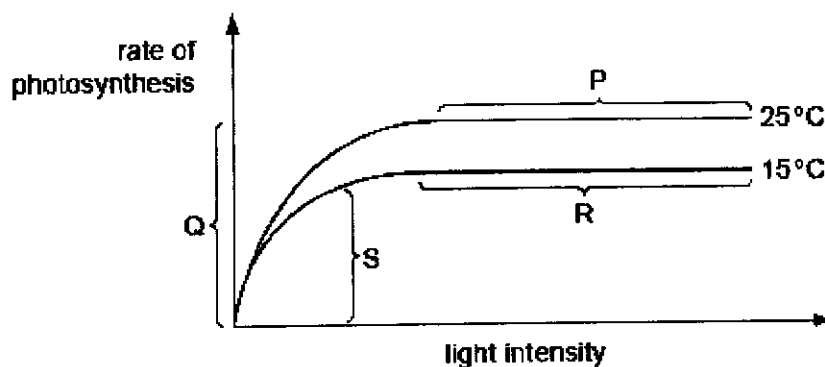
- 14 Prolonged consumption of high levels of alcohol can result in liver failure.

Which of the following are possible results of liver failure?

- I decrease in fat digestion as liver is unable to synthesise bile  
 II increase in blood glucose concentration as liver is unable to secrete insulin  
 III risk of excessive blood loss from a cut due to decrease in the synthesis of fibrinogen  
 IV increase in urea synthesis

- A I and II                      B I and III                      C I, III and IV                      D II and IV

- 15 The graph shows how the rate of photosynthesis varies with light intensity at two different temperatures. Other variables are kept the same.



In which sections of the graph is light intensity limiting the rate of photosynthesis?

- A P and R                      B Q and S                      C R and Q                      D S and P

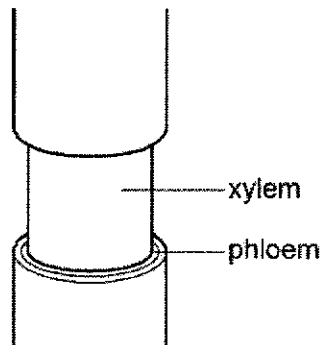


16 Magnesium is important for plants to produce chlorophyll.

Which cell contains the highest concentration of magnesium during the day?

- A companion cell
- B guard cell
- C palisade mesophyll cell
- D spongy mesophyll cell

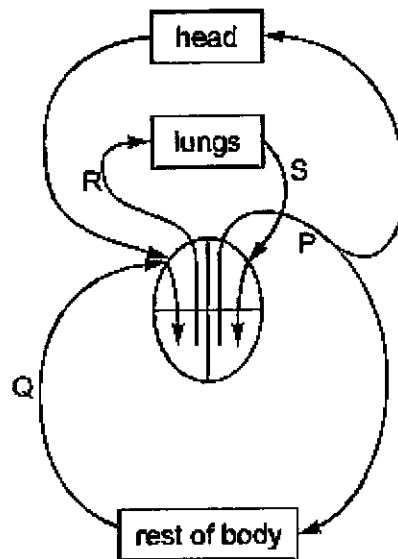
17 The diagram shows the stem of a plant. A strip of the outer tissue including the phloem has been removed.



How is the transport of substances in the plant affected?

- A Amino acids and sucrose cannot pass to the roots.
- B Dissolved salts cannot pass to the leaves.
- C Water cannot pass to the leaves.
- D Water cannot pass to the roots.

18 The diagram represents the heart and some major blood vessels.



What are the possible blood pressures (in kPa) for the vessels shown on the diagram?

	P	Q	R	S
A	1	4	2	16
B	4	16	2	1
C	16	2	4	1
D	16	4	1	2

19 The table below shows the agglutination test results when Alfred receives different components of blood from a donor.

donor's blood type	what Alfred received from donor	results
O	blood plasma	agglutination of Alfred's red blood cells
A	red blood cells	agglutination of donor's red blood cell

Based on the table above, which of the following is likely to be Alfred's blood type?

- A A
- B B
- C AB
- D O

- 20** If the left atrioventricular valve in the heart does not close completely, blood can flow back into the atrium during ventricular systole.

What would be the immediate effect of this backflow?

- A** blood flowing from the heart carries less oxygen because less blood enters the lungs
  - B** diastolic pressure in the left ventricle falls because less blood enters the pulmonary artery
  - C** lower systolic pressure in the left atrium and less blood enters the pulmonary artery
  - D** raised pressure in the left atrium and less blood enters the aorta
- 21** Which of the following pairs acts as mechanical barriers to pathogens?
- A** mucus in the trachea and stomach acid
  - B** mucus in the trachea and phagocytosis in the blood
  - C** skin and hairs in the nose
  - D** skin and stomach acid
- 22** Chronic obstructive pulmonary disease (COPD) includes emphysema.

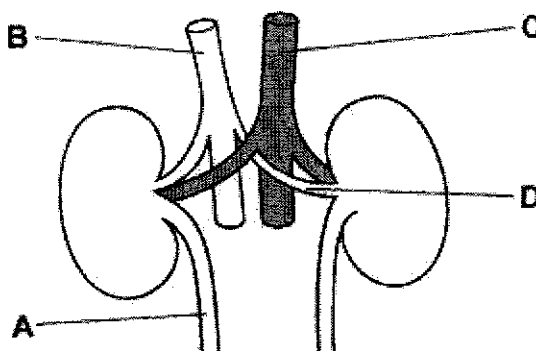
What effects does emphysema have on gaseous exchange?

- I surface area to volume ratio of lungs decreases
  - II distance of the diffusion pathway decreases
  - III volume of oxygen diffused per unit time decreases
- A** I and II                      **B** I and III                      **C** I, II and III                      **D** II and III

- 23 The table shows the composition of a liquid found in the human body.

component	concentration / arbitrary units
amino acids	0.00
glucose	0.00
proteins	0.00
salts	1.50
urea	2.00

In a healthy person, which structure contains this liquid?


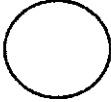

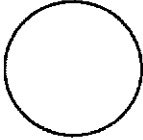
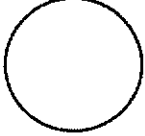


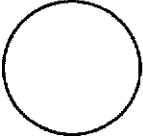


- 24 Which set of conditions would result in the greatest decrease in the percentage of water in urine?

	conditions	
	temperature of surroundings	amount of activity
A	low	low
B	low	high
C	high	low
D	high	high

25 The circles represent the diameter of the shunt vessels in the surface of the skin as the body temperature changes.

Which shows the diameter of the shunt vessels after a decrease and after an increase in body temperature?

	diameter of shunt vessels	
	after a decrease in body temperature	after an increase in body temperature
<b>A</b>		
<b>B</b>		
<b>C</b>		
<b>D</b>		

26 What causes blood glucose level to increase when a person is frightened?

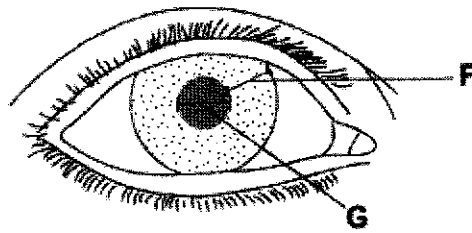
- A less insulin secreted
- B more adrenaline secreted
- C more glucagon secreted
- D more glycogen secreted

27 Which of the following is/are true of all neurones?

	carry information within the brain	stimulate muscles or glands	transmit electrical impulses
<b>A</b>	✓	✓	x
<b>B</b>	✓	x	✓
<b>C</b>	x	✓	x
<b>D</b>	x	x	✓

key:  
 ✓ - true  
 x - not true

- 28 The diagram shows the eye of a person in a dimly lit room.

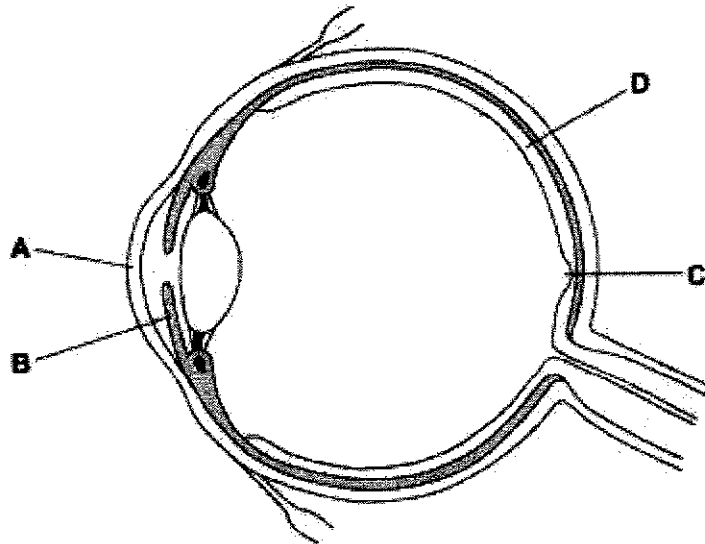


What happens to distance F and distance G when this person moves into a brightly lit room?

	distance F	distance G
A	becomes larger	becomes smaller
B	becomes smaller	stays the same
C	becomes smaller	becomes larger
D	stays the same	becomes smaller

- 29 The diagram shows a section through a human eye.

Which structure refracts light?



- 30 Some viruses have single-stranded DNA as their genetic material. This DNA molecule has to be folded.

Which statements about single-stranded DNA are correct?

- I Single-stranded DNA cannot replicate semi-conservatively.
- II If only the percentage of cytosine is known, then the percentage of guanine can be calculated, but the percentage of adenine and thymine cannot be calculated.
- III Hydrogen bonds may be present within the DNA molecule.

A I and II

B I and III

C I, II and III

D II and III

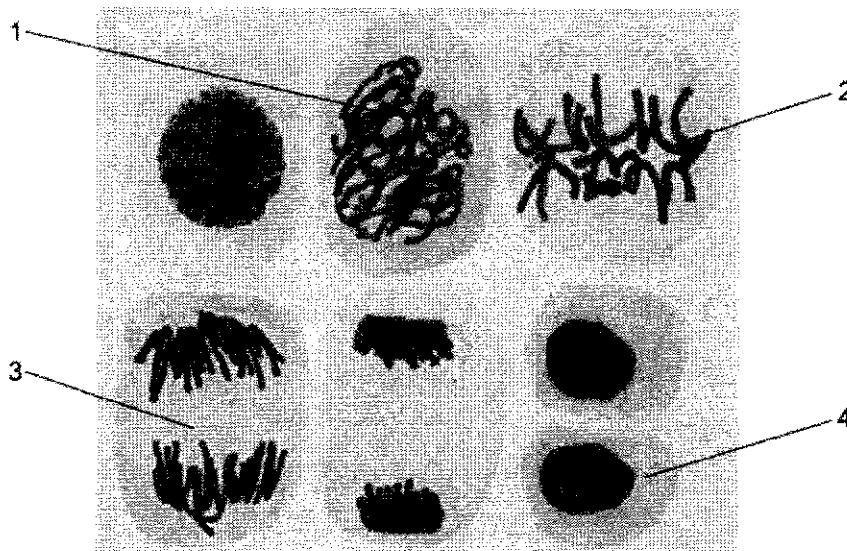
[Turn Over

- 31 Insulin can be commercially synthesised using bacterium in a fermenter.

What is the name of the process used to produced synthetic insulin, and the enzyme used to cut the insulin gene from human chromosome?

	name of process	enzyme used to cut insulin gene
<b>A</b>	artificial selection	DNA ligase
<b>B</b>	artificial selection	restriction enzyme
<b>C</b>	genetic engineering	DNA ligase
<b>D</b>	genetic engineering	restriction enzyme

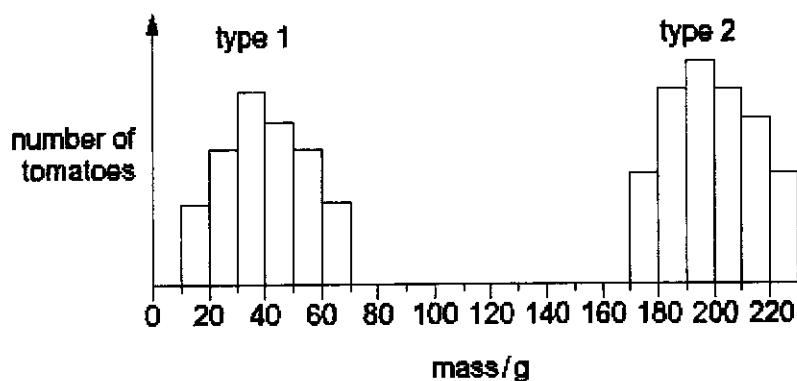
- 32 A drug has been developed to treat certain types of cancer. It prevents mitosis by binding to the spindle and preventing sister chromatids from being separated and moving to opposite poles of the cell. The photomicrograph shows cells in different phases of mitosis.



Which stage(s) of mitosis will be able to occur in a cell which is entering prophase when treated with this drug?

- A** 1 and 2                      **B** 2 only                      **C** 2 and 3                      **D** 3 and 4

- 33 The graph shows the masses of two different types of tomato.



What can be concluded from the graph?

- A Genes do not affect the mass of tomatoes.
  - B Type 1 tomatoes show continuous variation.
  - C Type 2 tomatoes are sometimes smaller than type 1 tomatoes.
  - D Type 2 tomatoes show discontinuous variation.
- 34 In cats, the allele for short hair is dominant to the allele for long hair. A short-haired cat gives birth to five kittens. Two of them have long hair.

Which statement must be correct?

- A Neither of the parents is heterozygous.
  - B One parent is homozygous.
  - C The female cat is heterozygous.
  - D The male cat is heterozygous.
- 35 A plant has flowers whose anthers mature and fall off before the stigma is fully developed.

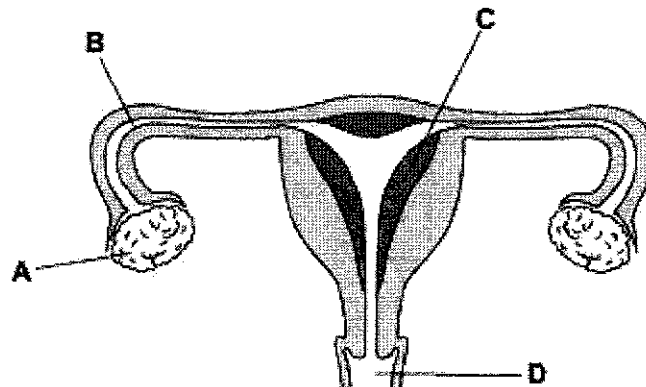
What will this prevent?

- A cross-pollination
- B insect-pollination
- C self-pollination
- D wind-pollination

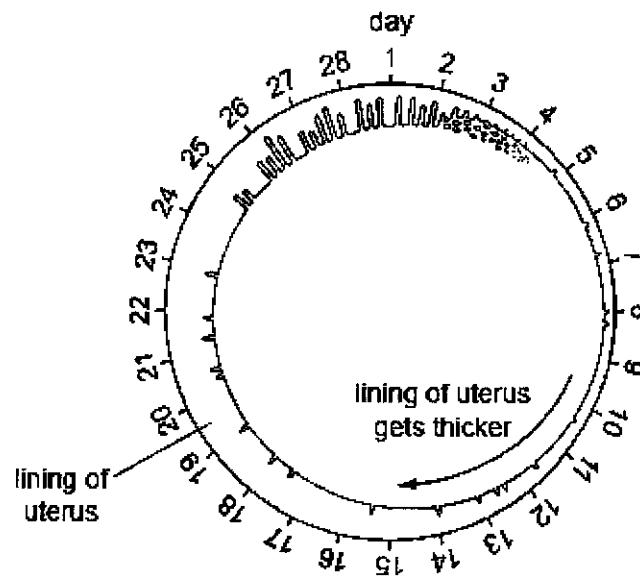


36 The diagram shows the female reproductive system.

Where does fertilisation normally occur?



37 The diagram shows the changes that occur to the uterus lining during the menstrual cycle.



Which of the following shows the concentration of hormones, oestrogen and progesterone, throughout the menstrual cycle?

	days 1-4	days 6-14	days 26-27
<b>A</b>	low oestrogen and low progesterone	high oestrogen and low progesterone	low oestrogen and low progesterone
<b>B</b>	low oestrogen and low progesterone	low oestrogen and high progesterone	high oestrogen and low progesterone
<b>C</b>	high oestrogen and low progesterone	high oestrogen and high progesterone	high oestrogen and high progesterone
<b>D</b>	high oestrogen and high progesterone	low oestrogen and high progesterone	low oestrogen and high progesterone

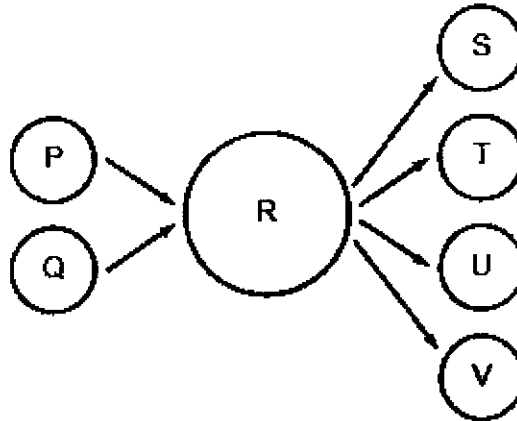
38 A food chain is shown below.

trophic level:      1            →            2            →            3            →            4

If the organisms in trophic level 3 suddenly die out as a result of disease, in which trophic level(s) will the number of organisms be likely to decrease?

- A 1 and 2                      B 1 and 4                      C 2 and 4                      D 4 only

39 The diagram represents gametes P and Q fusing to give cell R. Cell R then produces gametes S, T, U and V.



Which statement about the numbers of chromosomes in the cells and gametes is correct?

- A The numbers of chromosomes in P and Q are different.  
 B The numbers of chromosomes in P and S are the same.  
 C The numbers of chromosomes in S is one quarter of the number of chromosomes in R.  
 D The numbers of chromosomes in T is half the number of chromosomes in Q.

40 A condom is a thin rubber sheath worn over a man's penis during sexual intercourse.

How do condoms reduce the risk of HIV infection?

- A They prevent sperm from entering the vagina.  
 B They prevent virus particles from crossing the placenta.  
 C They prevent the formation of seminal fluid.  
 D They prevent seminal fluid from coming into contact with the vaginal wall.

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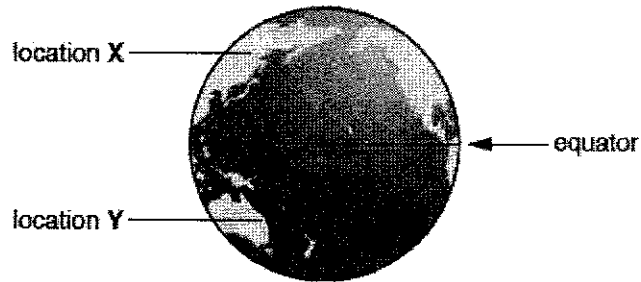
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**Section A: Structured Questions [50 marks]**

Answer all the questions in this section in the spaces provided.

- 1 Fig. 1.1 shows two locations, X and Y, on the Earth.



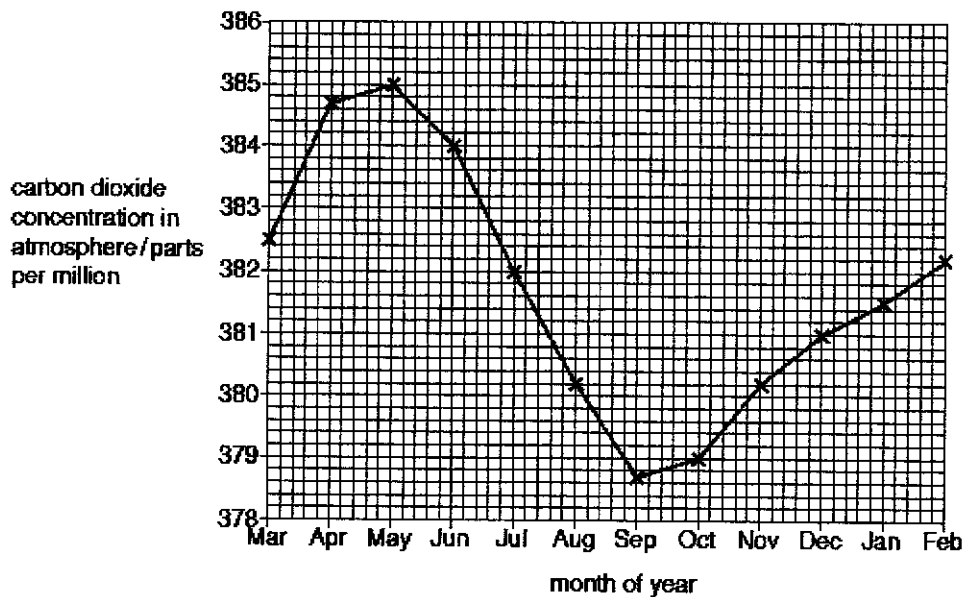
**Fig. 1.1**

Table 1.1 shows the length of daylight at each location from March to Feb the next year.

**Table 1.1**

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
length of daylight at location X	medium			long			medium			short		
length of daylight at location Y	medium			short			medium			long		

Fig. 1.2 shows the change in carbon dioxide concentration in the atmosphere measured during one year at location X.



**Fig. 1.2**

- (a) (i) Describe the pattern of changes in the concentration of carbon dioxide in the atmosphere shown in Fig. 1.2, from June to February the next year.

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[2]

- (ii) Using the information from Table 1.1, suggest an explanation for the pattern of changes in the concentration of carbon dioxide in the atmosphere shown in Fig. 1.2, from September to November.

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[3]

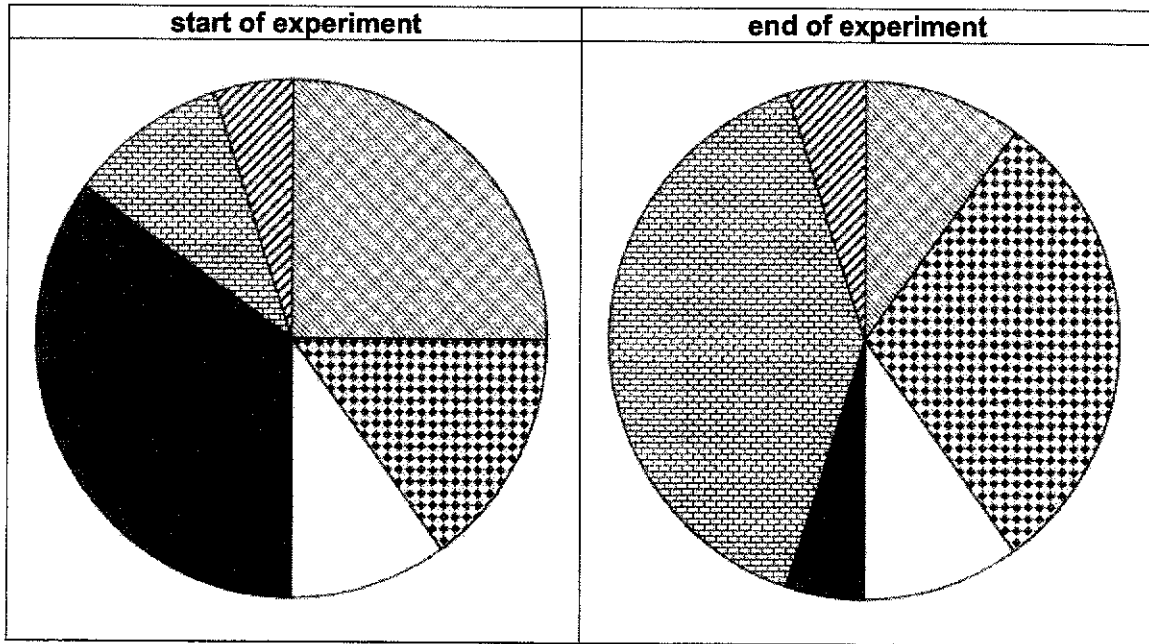
- (b) Draw a line on the graph to suggest the change in carbon dioxide concentration in the atmosphere during the same 12 months at location Y. [1]

[Total: 6]



- 2 A group of scientists were interested in the digestive system in humans. They conducted some tests. In the first test, they extracted a digestive juice, X, from the body and added it to some food.

Fig. 2.1 shows the changes in the percentage of carbohydrates, proteins and fats after the addition of digestive juice, X.



Legend:

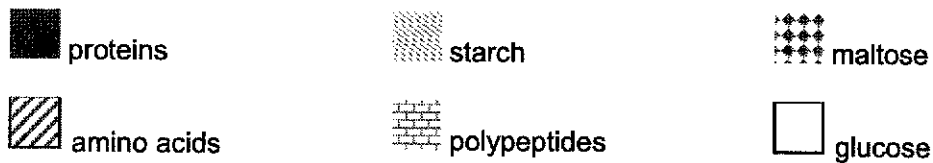


Fig. 2.1

- (a) (i) Using the information given in Fig. 2.1, identify the enzymes present in digestive juice, X.

..... [1]

- (ii) Suggest where digestive juice, X, is produced.

..... [1]

- (b) The scientists also ran some food tests on digestive juice, X. State and explain the observation made when biuret solution was added to digestive juice, X.

..... [2]

In another test, the scientists had two groups of people (E and F) with each group of people following a different type of diet. Fig. 2.2 shows the average time taken for food to pass through the alimentary canal for these two groups.

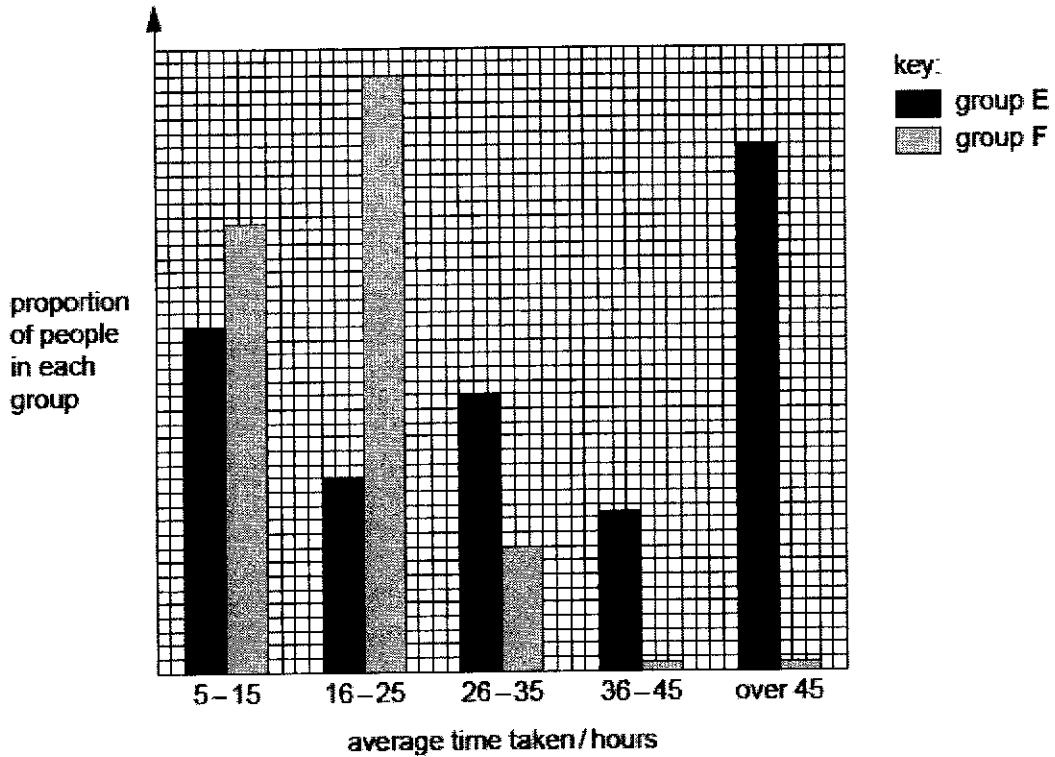


Fig. 2.2

(c) (i) Name the process that causes food to pass through the alimentary canal.

[1]

(ii) Suggest how the diets of the two groups of people may be different and give reasons for your answer.

[2]

[Total: 7]

- 3 The electrical activity of the heart can be recorded on an electrocardiogram (ECG). Fig. 3.1 shows an ECG of one heartbeat.

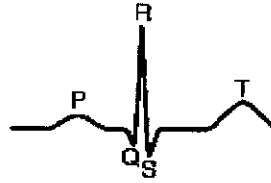


Fig. 3.1

Table 3.1 shows how the electrical activity, during one heartbeat, corresponds to the opening and closing of the valves in the heart.

Table 3.1

part of the ECG shown in Fig. 3.1	result of electrical activity	tricuspid valve	semilunar valve
P	muscles in atria contract		
QRS	muscles in ventricles contract		
T	muscles in atria and ventricles relax		

- (a) (i) Complete Table 3.1 using the words 'open' and 'closed'. [3]

- (ii) State the function of the tricuspid valve.

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[1]

- (b) Fig. 3.2 shows the ECG of an athlete before and during exercise.

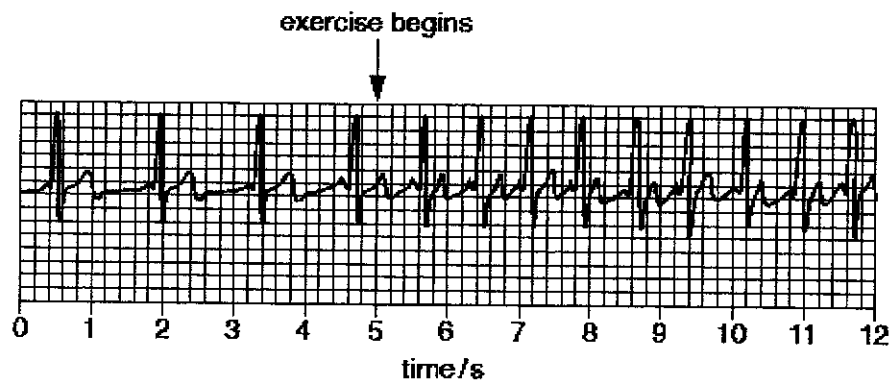


Fig. 3.2

- (i) Calculate the heart rate, in beats per minute, **before** exercise begins. Show your working and give your answer to the nearest whole number.

\_\_\_\_\_ beats per minute [2]

- (ii) Using Fig. 3.2, describe how the electrical activity of the heart during exercise differs from the electrical activity before exercise begins.

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[2]

- (iii) Suggest and explain what will happen to the electrical activity of the heart immediately after the end of an intensive exercise.

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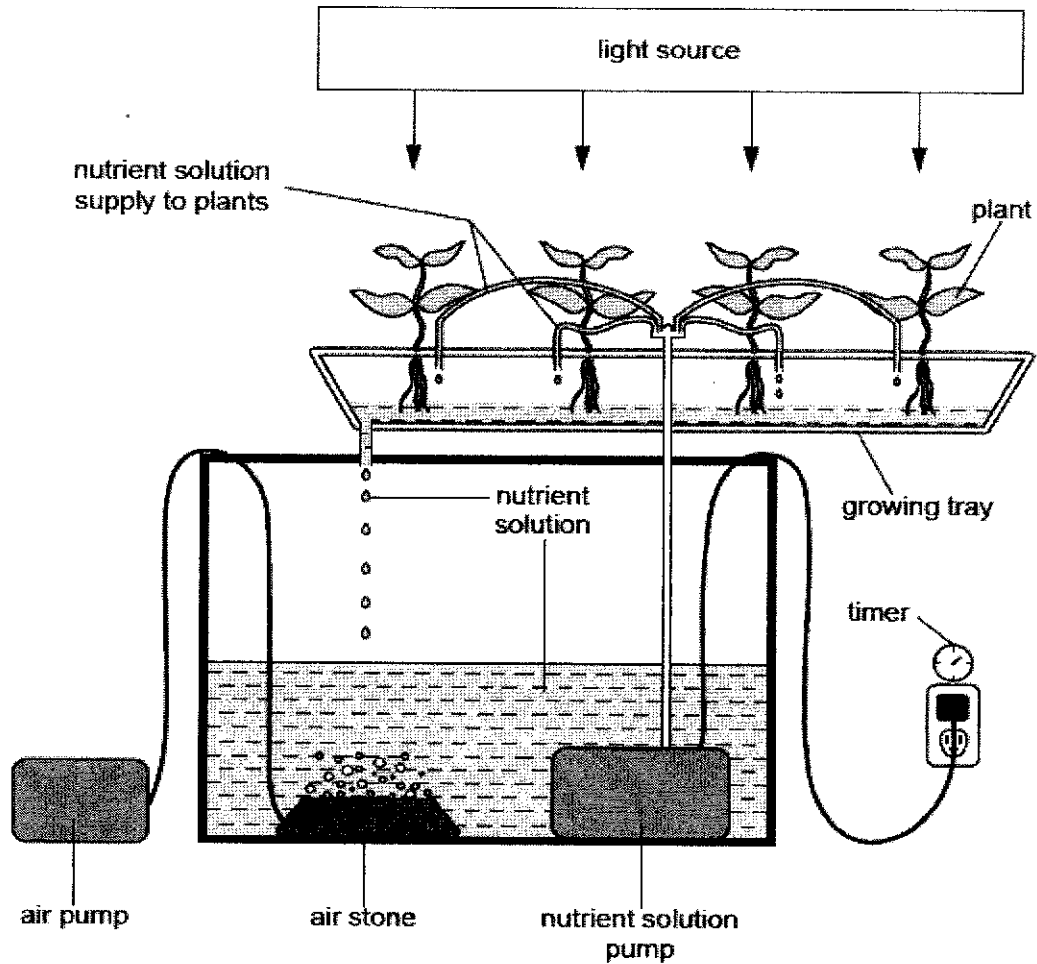
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[3]

[Total: 11]

- 4 Hydroponics is a technique used to grow plants without soil.  
Fig. 4.1 shows plants being grown using hydroponics.



**Fig. 4.1**

The roots of the plants are provided with a nutrient solution. The nutrient solution contains mineral ions that are necessary for plant growth. Air is pumped through the nutrient solution using an air stone that contains many very small holes.

- (a) Explain the advantage to the cells of the plant roots of pumping air through the nutrient solution using the air stone.

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[3]

- (b) Fig. 4.2 shows the rate of water loss for three plants, D, E, and F, that were grown using hydroponics, in different environmental conditions.

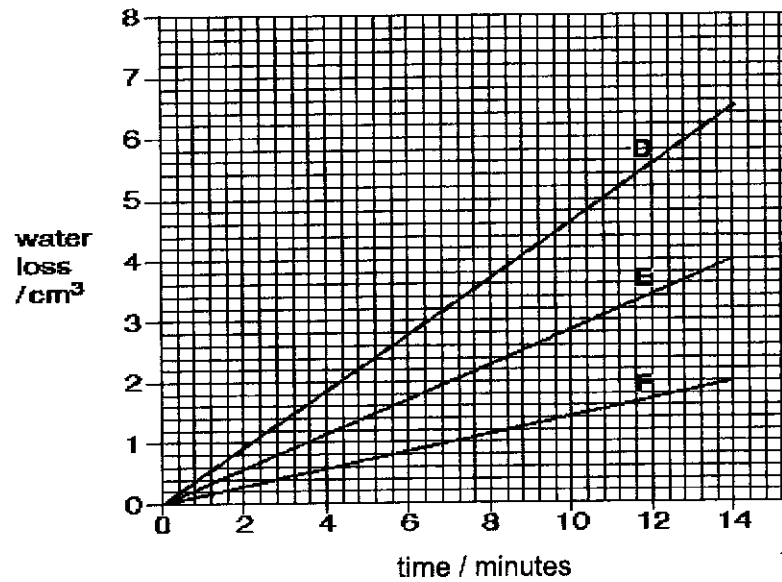


Fig. 4.2

- (i) Name the process by which plants lose water to the atmosphere.

[1]

Table 4.1 shows the different environmental conditions that the plants were grown in.

Table 4.1

plant	light intensity	carbon dioxide concentration / %	wind	temperature / °C
	high	1.00	absent	47
	low	0.03	absent	20
	high	0.03	present	45

- (ii) Identify the environmental conditions that the plants, D, E, and F, were grown in, and complete Table 4.1. [2]

(iii) Give a reason for your choice of environmental conditions for plant F.

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[2]

[Total: 8]

5 Fig. 5.1 shows some stages of the cell cycle in the root tip of a plant. Two of these stages are identified in Table 5.1.

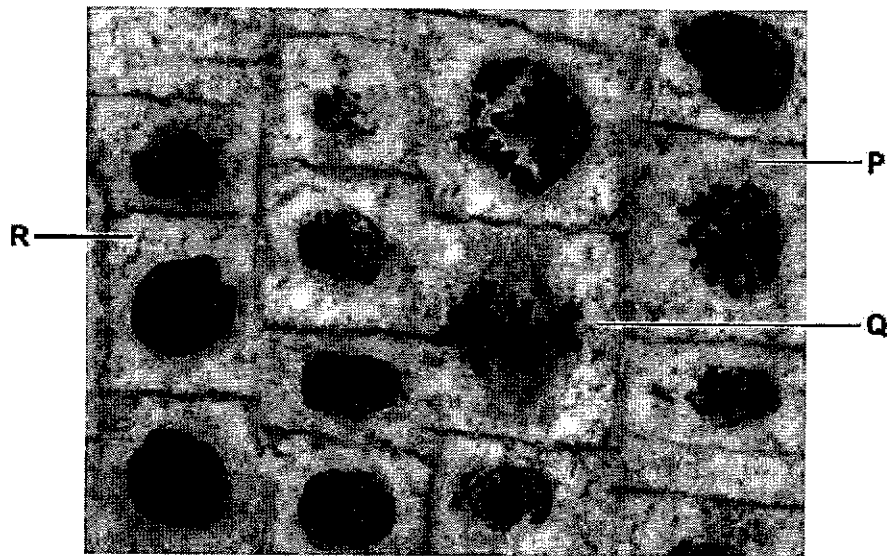


Fig. 5.1

(a) (i) Complete Table 5.1 by stating one feature, visible in Fig. 5.1, that is used to identify each stage.

Table 5.1

cell	stage of cell cycle	reason
P	prophase	
Q	metaphase	

[2]

- (ii) At stage **R**, centrioles doubled.  
Describe one other event that happened during stage **R** of the cell cycle.

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[1]

- (b) Describe how the spindle fibres are involved in the different stages of the cell cycle in the root tip of a plant.

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[2]

- (c) The number of chromosomes present in stage **P** is 24.  
State the number of chromosomes present in the ovum of a plant of the same species.

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[1]

[Total: 6]

6 Fig. 6.1 shows a diagram of the male reproductive system.

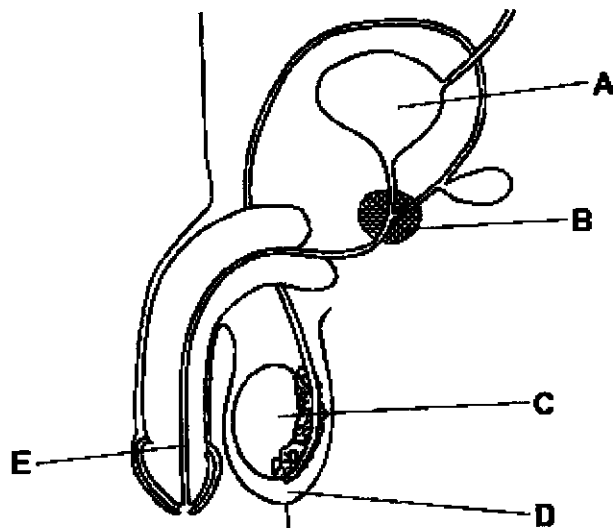


Fig. 6.1



(a) Spermatogenesis is a process where sperms are made. This process gives off significant heat.

(i) State the letter on Fig. 6.1 and name the structure which helps to provide an optimum temperature for the development of sperm.

letter on Fig. 6.1	name of structure

[1]

(ii) Research have shown that there are more sweat glands present in the structure mentioned in (a)(i).

Using your understanding of homeostasis, explain how the structure helps to dispel the excess heat that is given off by spermatogenesis.

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[2]

(b) Artificial insemination is a method of breeding farm animals in which semen from a selected male animal is sent to a farmer to fertilise females of the same species.

(i) State the letter on Fig. 6.1 that identifies where the seminal fluid found in the semen is made.

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[1]

(ii) Suggest two possible advantages of this method over natural methods of breeding farm animals.

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[2]

[Total: 6]

- 7 Fig. 7.1 shows part of a newspaper article about a new variety of maize.

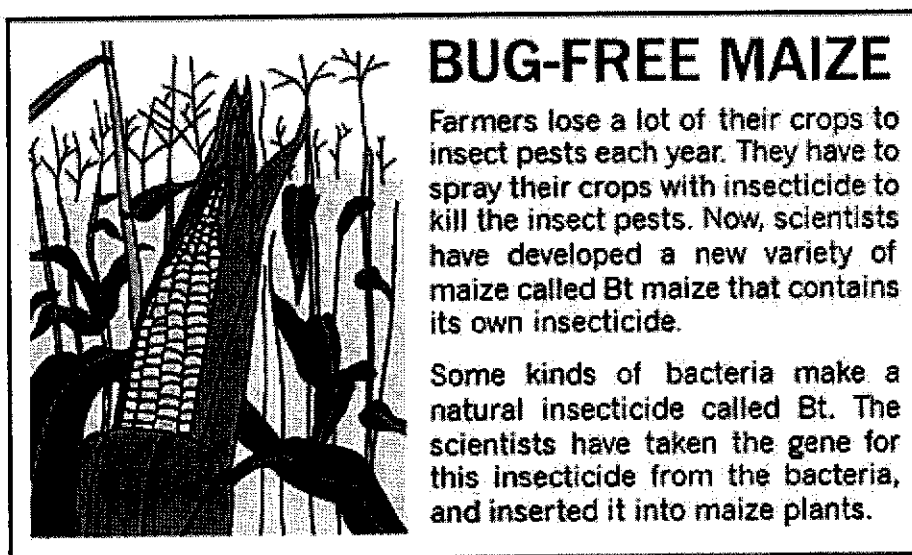


Fig. 7.1

- (a) The new Bt maize is a transgenic organism.

With reference to the information in Fig. 7.1, explain the term 'transgenic organism'.

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[2]

- (b) (i) Use the information in Fig. 7.1 to explain how the addition of the Bt gene could benefit the farmers economically.

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[3]

(ii) Fruit trees are pollinated by insects.

Suggest why growing Bt maize near to apple trees might reduce the yield of the fruit crop.

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[1]

[Total: 6]

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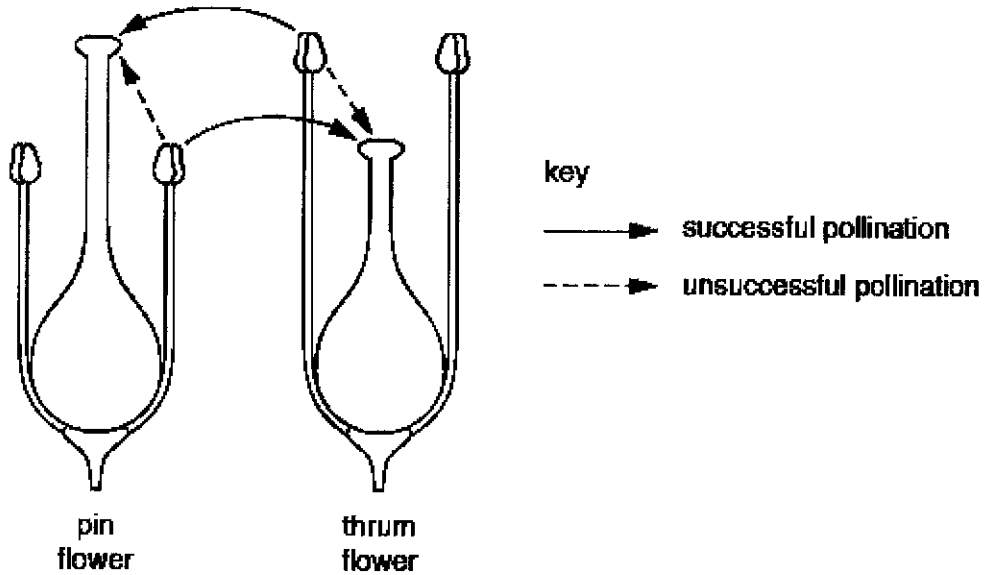
**Section B: Free-Response Questions [30 marks]**

Answer **three** questions in this section in the spaces provided.

Question 10 is in the form of **Either/ Or**. Only one part should be answered.

- 8 A species of flowering plant has two types of flowers. Some plants of this species have flowers called pin and some plants have flowers called thrum. Pollination in this species of plant is not always successful in leading to fertilisation.

Examples of successful pollination and of unsuccessful pollination are shown in Fig. 8.1.



**Fig. 8.1**

- (a) With reference to Fig. 8.1, name the type of pollination that is successful and suggest the advantage of this type of pollination to the species.

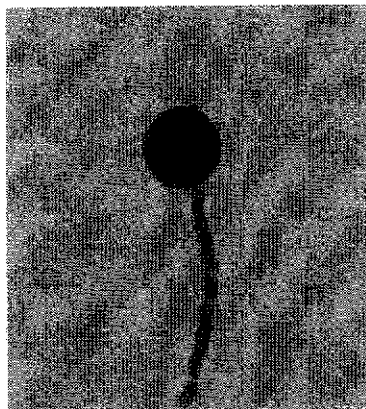
type of pollination \_\_\_\_\_

advantage \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ [2]

Germination of pollen grains occurs after successful pollination has taken place. Fig. 8.2 shows a pollen grain with a pollen tube growing from it.



**Fig. 8.2**

Pollen grains from the same type of plant were placed in sucrose solutions of different concentrations for a fixed period of time. After this time, the pollen grains and tubes were examined using a microscope. The following observations were made for each sucrose concentration:

- number of pollen grains that had germinated to produce a pollen tube,
- length of each pollen tube

The results of the investigation is shown in Table 8.1.

**Table 8.1**

percentage of sucrose concentration / %	percentage of of pollen grains germinated / %	mean pollen tube length / mm
1	6	0.005
2	13	0.008
4	25	0.012
8	56	0.040
10	31	0.030
20	25	0.018
40	13	0.006

- (b) (i) A total of 12 pollen grains were placed in the 20 % sucrose solution.

Use the information in Table 8.1 to calculate the number of pollen grains that germinated to produce a pollen tube in the 20 % sucrose solution.

..... [1]

- (ii) Use the information in the table to suggest the optimum (best) concentration of sucrose solution for pollen tube germination and growth.

..... %

Explain how you arrived at your answer.

.....  
.....  
..... [2]

- (iii) The germination of a pollen grain to form a pollen tube requires the movement of water into the pollen grain from its surroundings.

Suggest why placing a pollen grain in a solution with a higher sucrose concentration than in your answer to (b)(ii) may result in a lower percentage of germination.

.....  
.....  
.....  
..... [3]

- (c) Explain the importance of a growing pollen tube in plant reproduction.

.....  
..... [1]

[Total: 9]

9 In 1931 a scientist was pouring the powdered form of a chemical called PTC into a bottle. A small amount of the powder accidentally blew into the air. A short time later another scientist working in the same room said that she had a bitter taste in her mouth from the powder in the air.

- (a) (i) Describe, with reference to named components of the nervous system, the nervous pathway that led to the scientist detecting that the powder tasted bitter.

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[3]

- (ii) Besides coordinating our ability to taste, the nervous system also coordinates other body functions such as spitting of extremely hot food from the mouth.

Suggest why these changes that take place in the mouth are controlled by the nervous system, rather than by a hormone.

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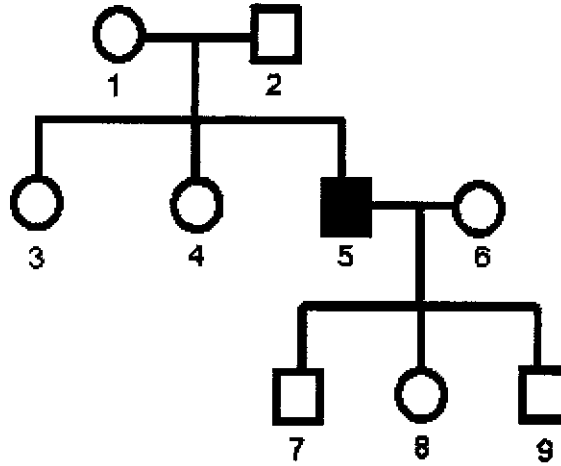
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[3]



(b) The scientist pouring the powder did not detect any bitter taste.

It was later found that the inheritance of two forms of the same gene determines if a person is able to detect a bitter taste from PTC or not. Fig. 9.1 shows the inheritance pattern in one family.



Legend:





- |   |   |
|---|---|
|  unable to detect bitter taste from PTC (female) |  unable to detect bitter taste from PTC (male) |
|  able to detect bitter taste from PTC (female)   |  able to detect bitter taste from PTC (male)   |

Fig. 9.1

Using the information given in Fig. 9.1, deduce and explain whether the allele which gives the ability to detect a bitter taste from PTC is dominant or recessive.

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[3]

- (c) Chemicals similar to PTC with a bitter taste are produced by some plants to prevent them from being eaten.

Suggest why animals that eat only plants have fewer genes that enable them to detect chemicals that taste bitter than animals that eat both plants and animals.

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[2]

[Total: 11]

**10 EITHER**

- (a) Outline how plants make the carbon in the molecules of carbon dioxide in the atmosphere into a food substance.

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[4]

- (b) Describe how the carbon in the food substance is eventually excreted out of the human body. Details of digestion are not required.

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[6]

[Total: 10]

**10 OR**

**(a)** Outline how plants make the nitrogen in the molecules of nitrates in the soil solution into a food substance.

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[4]

**(b)** Describe how the nitrogen in the food substance is eventually excreted out of the human body. Details of digestion are not required.

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[6]

[Total: 10]

[Turn Over

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**Preliminary Examination 2021**  
**6093 Biology Paper 1**  
**Mark Scheme**

<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>
C	D	C	A	D	C	C	B	B	A
<b>11</b>	<b>12</b>	<b>13</b>	<b>14</b>	<b>15</b>	<b>16</b>	<b>17</b>	<b>18</b>	<b>19</b>	<b>20</b>
C	D	B	B	B	C	A	C	B	D
<b>21</b>	<b>22</b>	<b>23</b>	<b>24</b>	<b>25</b>	<b>26</b>	<b>27</b>	<b>28</b>	<b>29</b>	<b>30</b>
C	B	A	D	C	B	D	A	A	B
<b>31</b>	<b>32</b>	<b>33</b>	<b>34</b>	<b>35</b>	<b>36</b>	<b>37</b>	<b>38</b>	<b>39</b>	<b>40</b>
D	A	B	C	C	B	A	B	B	D

**Preliminary Examination 2021**  
**6093 Biology Paper 2**  
**Mark Scheme**

**Section A**

Qn	Mark Scheme	Remarks
1ai	<ul style="list-style-type: none"> <li>Carbon dioxide concentration in atmosphere decreased from 384 parts per million to 378.3 parts per million from June to September [1]</li> <li>Carbon dioxide concentration in atmosphere increased from 384 378.3 parts per million to 382.2 parts per million from September to February [1]</li> </ul>	
aii	<p>Increase in carbon dioxide concentration in atmosphere</p> <ul style="list-style-type: none"> <li>Length of daylight shortens = less light energy available for photosynthesis [1]</li> <li>Decrease rate of photosynthesis → less carbon dioxide taken in by plants from the atmosphere [1]</li> <li>More respiration than photosynthesis → more carbon dioxide produced than removed [1]</li> </ul>	Reject: light intensity decreases since it is about duration of exposure to sunlight
b	<p>carbon dioxide concentration in atmosphere / parts per million</p> <p>month of year</p> <p>Idea: may to sept increase in carbon dioxide concentration, from sept to feb decrease in carbon dioxide concentration [1]</p>	*marking based on trend
2ai	<ul style="list-style-type: none"> <li>Protease / trypsin (R: pepsin) + Amylase [1]</li> </ul>	
aii	Pancreas [1]	
b	<ul style="list-style-type: none"> <li>Biuret solution turns violet [1]</li> <li>Enzymes are protein in nature [1]</li> </ul>	
ci	Peristalsis [1]	
cii	<ul style="list-style-type: none"> <li>Group E food takes longer to pass through the gut [1]</li> <li>Food might contain more meat / less fibre/ vegetables [1]</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>Group F food takes shorter time to pass through the gut [1]</li> <li>food contains more fibre/ vegetables/ more moist and softer food [1]</li> </ul>	



3ai	part of the ECG shown in Fig. 3.1	result of electrical activity	tricuspid valve	semilunar valve	
	P	atria contract	open	closed	
	QRS	ventricles contract	closed	open	
	T	atria and ventricles relax	open	closed	
1 mark per row					
aii	<ul style="list-style-type: none"> <li>Prevent backflow of blood + from right ventricle to right atrium [1]</li> </ul>				
bi	<ul style="list-style-type: none"> <li>Working <math>-\frac{60}{5} \times 4</math></li> <li>Answer = 48</li> </ul> <p>Or</p> <ul style="list-style-type: none"> <li>Working: 1 heartbeat = 3.4s – 2s = 1.4s</li> <li>Total number of heartbeat per minute = 60 ÷ 1.4 [1]</li> <li>Answer: 42.8 = 43 (nearest whole number) [1]</li> </ul>				*ECF for working awarded i.e. calculation of number of heartbeat during exercise [1]
bii	<ul style="list-style-type: none"> <li>Electrical activity increase during exercise [1]</li> <li>Waves/ peaks/ R-R intervals are closer together during exercise / S-T interval is shorter [1]</li> <li>Data: 1 peak per 1.4s (before exercise) to 1 peak per 0.6s (after exercise) [1]</li> </ul>				*max. 2 marks
biii	<ul style="list-style-type: none"> <li>Electrical activity of the heart <u>remains high</u> [1]</li> <li>the heart continues to pump fast to <u>bring more oxygen to the muscles</u> [1]</li> <li>to <u>repay the oxygen debt</u> incurred during period of intensive exercise [1]</li> </ul>				
4a	<ul style="list-style-type: none"> <li>More* oxygen present/ dissolved in the nutrient solution + diffuse into root hair cells [1]</li> <li>Used for increased* rate of aerobic respiration + release more* energy [1]</li> <li>For <u>active transport</u> of more* mineral ions into plants [1]</li> <li>Take up mineral ions against concentration gradient for growth [1]</li> </ul>				*mark idea for more once; penalised only once'  **max. 3 marks
bi	<ul style="list-style-type: none"> <li>Transpiration</li> </ul>				

bii	<b>plant</b>	<b>light intensity</b>	<b>carbon dioxide concentration/ %</b>	<b>wind</b>	<b>temperature/ °c</b>	
	E	high	1.00	absent	47	
	F	low	0.03	absent	20	
	D	high	0.03	present	45	
	<ul style="list-style-type: none"> <li>All 3 correct [2]</li> <li>1-2 correct [1]; otherwise zero</li> </ul>					
biii	<ul style="list-style-type: none"> <li>At low light intensity, less photosynthesis [1]</li> <li>Guard cells become flaccid + stomata remains close [1] OR</li> <li>Absence of wind, water vapour concentration [1] surrounding stomata remains high / idea of saturation</li> <li>Gentler water vapour concentration gradient between intercellular air spaces and surrounding air + less diffusion of water vapour out [1] OR</li> <li>Low temperature, lower rate of evaporation, less water vapour [1]</li> <li>Gentler water vapour concentration gradient between intercellular air spaces and surrounding air + less diffusion of water vapour out [1]</li> </ul>					*max. 2 marks
5ai	<b>cell</b>	<b>reason</b>				
	P	Chromosomes visible/ chromatin threads condensed into chromosomes/ chromosomes arranged randomly [1]				
	Q	Chromosomes aligned along the equator [1]				
aii	<ul style="list-style-type: none"> <li>DNA is replicated [1]</li> </ul>					
b	<ul style="list-style-type: none"> <li>Spindle fibre attached to the centromere of each chromosome during prophase [1]</li> <li>Spindle fibre helps to arrange chromosomes to align to the equator plate during metaphase [1]</li> <li>Spindle fibre shortens and pull sister chromatids apart to separate poles during anaphase [1]</li> </ul>					*max. 2 marks.
c	<ul style="list-style-type: none"> <li>12</li> </ul>					
6ai	<b>Letter on fig. 6.1</b>		<b>name of structure</b>			
	D		Scrotum			
1 mark						

a	<ul style="list-style-type: none"> <li>• Increase sweat production [1]</li> <li>• <u>More</u> water in sweat evaporates + remove latent heat of vaporisation from the scrotum [1]</li> </ul>	
b	<ul style="list-style-type: none"> <li>• B [1]</li> </ul>	
bii	<ul style="list-style-type: none"> <li>• Desirable features can be selected for [1]</li> <li>• Sperms can be transported to locations far away for breeding (ease of transport of sperms vs male animals) [1]</li> <li>• Greater chance of successful fertilisation [1]</li> <li>• Faster/ more convenient [1]</li> <li>• Promotes cross-breeding/ prevent inbreeding [1]</li> </ul>	*max. 2 marks
7a	<ul style="list-style-type: none"> <li>• Genetic characteristic altered due to human intervention [1]</li> <li>• with <u>insertion of Bt gene</u> from another organism <u>of a different species / bacteria</u> [1]</li> </ul>	
7bi	<ul style="list-style-type: none"> <li>• Transcription and translation of Bt gene would result in the production of the natural insecticide Bt in plants. [1]</li> <li>• Insecticide in leaves/ plant will kill insects + less plants eaten OR Less leaves eaten [1]</li> <li>• More leaves/ plants photosynthesise/ grow + larger yield of crop [1]</li> <li>• No need to use commercial insecticides, hence save cost [1]</li> </ul>	*max. 3 marks
7bi	<ul style="list-style-type: none"> <li>• Fewer insect-pollinators (as insects are killed by natural insecticide, Bt) + decrease pollination of apples</li> </ul>	*max. 1 marks

## Section B

Qn	Mark Scheme	Remarks
8a	<ul style="list-style-type: none"> <li>Cross pollination [1]</li> <li>Exchange of genetic material between two plants/ parents + increase in genetic variation/ more likely to survive/ adapt to changes in environment [1]</li> </ul>	
bi	<ul style="list-style-type: none"> <li><math>25\% \times 12 = 3</math> [1]</li> </ul>	*working not required
bii	<ul style="list-style-type: none"> <li>8 % [1]</li> <li><u>highest</u> % pollen grains germinated of <u>56%</u> + <u>longest</u> mean pollen tube length <u>0.040mm</u> [1]</li> </ul>	
biii	<ul style="list-style-type: none"> <li>increase sucrose concentration = <u>decrease in water potential of sucrose solution</u> [1]</li> <li>water potential gradient between sucrose solution and pollen grain becomes <u>gentler</u>* [1]</li> <li>less water molecules move in + by osmosis [1]</li> </ul> <p>*accept also if candidates write that water potential of sucrose solution may be lower than/ same as pollen grain, hence water molecules leave the pollen grain/ no water molecules enter pollen grain</p>	
c	<ul style="list-style-type: none"> <li>Delivers male gamete to female gamete in the ovule + for fertilisation to occur [1]</li> </ul>	
9ai	<ul style="list-style-type: none"> <li><u>Receptor on the tongue detect</u> PTC powder + <u>generate nerve impulse</u> [1]</li> <li>Nerve impulse is <u>transmitted by sensory neurone</u> to the <u>relay neurone in the brain</u> [1]</li> <li><u>Across the synapse + with the help of neurotransmitters</u> [1]</li> </ul>	
aii	<ul style="list-style-type: none"> <li>Faster response/ shorter response time by nervous system (ORA) [1]</li> <li>Due to transmission via nerve impulse (nervous system) vs [1]</li> <li>by chemical means (hormone) which <u>must be carried by the blood</u> (hence slower) [1]</li> <li>helps to prevent mouth from burning/ allows us to quickly respond to food that may be harmful to the body (ref to taste) [1]</li> </ul>	*max. 3 marks
b	<ul style="list-style-type: none"> <li>recessive [1]</li> <li>5 inherits 2 copies of recessive allele that allows him to detect a bitter taste from his parents [1]</li> <li>1 &amp; 2 are both unable to detect a bitter taste and are carriers of the recessive allele/ must have one copy of recessive allele and a copy of a dominant allele [1]</li> </ul>	

c	<ul style="list-style-type: none"> <li>• <u>Herbivores</u> obtain all energy/ nutrients only from plants [1]</li> <li>• Plants taste less bitter + able to <u>eat more</u>/ eat more variety [1]</li> <li>• Hence able to survive better, reproduce and pass down their favourable alleles/ genes (i.e. ref. to survival of fitness/ natural selection) [1]</li> </ul>	*max. 2 marks
10E a	<ul style="list-style-type: none"> <li>• Carbon dioxide in the atmosphere <u>diffuses into the intercellular air spaces</u> in the leaf [1]</li> <li>• down the concentration gradient [1]</li> <li>• Into the (palisade/ spongy) mesophyll cells + into chloroplast [1]</li> <li>• Chlorophyll traps light energy [1]</li> <li>• Carbon dioxide reacts with water + form glucose [1]</li> <li>• Photosynthesis [1]</li> </ul>	*max. 4 marks
b	<ul style="list-style-type: none"> <li>• Glucose is used in aerobic respiration + release carbon dioxide [1]</li> <li>• Carbon dioxide diffuses from tissue cells into the blood plasma and into red blood cells [1]</li> <li>• Water + carbon dioxide -&gt; carbonic acid + catalysed by carbonic anhydrase [1]</li> <li>• Carbonic acid dissociates to form hydrogen carbonate ions [1]</li> <li>• Hydrogen carbonate ions dissolve + carried in blood plasma to the lungs [1]</li> <li>• Ref. to reverse reaction by carbonic anhydrase [1]</li> <li>• Carbon dioxide molecules diffuse into alveoli and removed during exhalation [1]</li> </ul>	*max. 6 marks
10O a	<ul style="list-style-type: none"> <li>• Nitrate ions in the soil solution taken <u>into the root hair cells by active transport</u> [1]</li> <li>• against concentration gradient[1]</li> <li>• Dissolve in water (in cell sap) [1]</li> <li>• move through root cortex + osmosis [1]</li> <li>• Move up xylem by transpiration pull to leaf [1]</li> <li>• Combines with glucose to form amino acids [1]</li> </ul>	*max. 4 marks
b	<ul style="list-style-type: none"> <li>• Amino acids is transported from ileum to liver via hepatic portal vein</li> <li>• Excess amino acid is deaminated in the liver + to form urea</li> <li>• Urea is carried by blood plasma to the kidney</li> <li>• via renal artery</li> <li>• urea is pushed into the Bowman's capsule across the glomerular and basement membrane + during ultrafiltration</li> <li>• urea is transported to the PCT collecting duct and finally out of the DCT</li> <li>• excreted as urine through the urethra</li> </ul>	*max. 6 marks

