Register No.	Class

Name ______________________________

BENDEMEER SECONDARY SCHOOL
2022 PRELIMINARY EXAMINATION
SECONDARY 4 EXPRESS
BIOLOGY
6093/01

DATE : 30 August 2022

DURATION : 1 hour

Write in 2B pencil.
Write your name, class and register number on the work you hand in.
Do not use paper clips, glue or correction fluid.

There are **forty** questions on this paper. Answer **all** questions.
For each question, there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in 2B pencil on the Answer sheet.

Read the instructions on the Answer sheet very carefully.

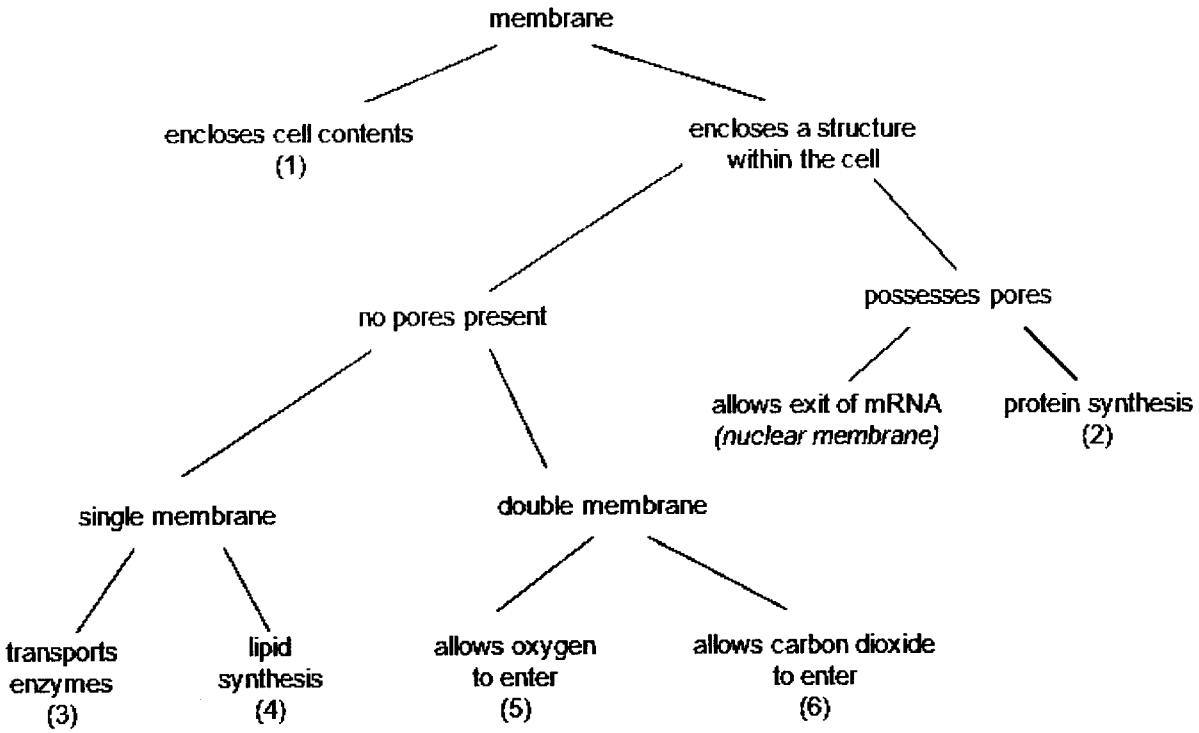
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done on the question paper.

The use of approved scientific calculator is expected, where appropriate.

This document consists of **24** printed pages.

[Turn over

1 Membranes within and at the surface of cells have different roles. The diagram shows the identification of the various organelles by describing the membrane structure and function.



Which row is correct?

	(1)	(2)	(3)	(4)	(5)	(6)
A	chloroplast	vesicle	smooth ER	rough ER	cell membrane	mitochondrion
B	cell membrane	rough ER	vesicle	smooth ER	chloroplast	mitochondrion
C	cell membrane	rough ER	vesicle	smooth ER	mitochondrion	chloroplast
D	cell membrane	smooth ER	mitochondrion	rough ER	vesicle	chloroplast

2 Which option shows how xylem is structurally adapted for its function?

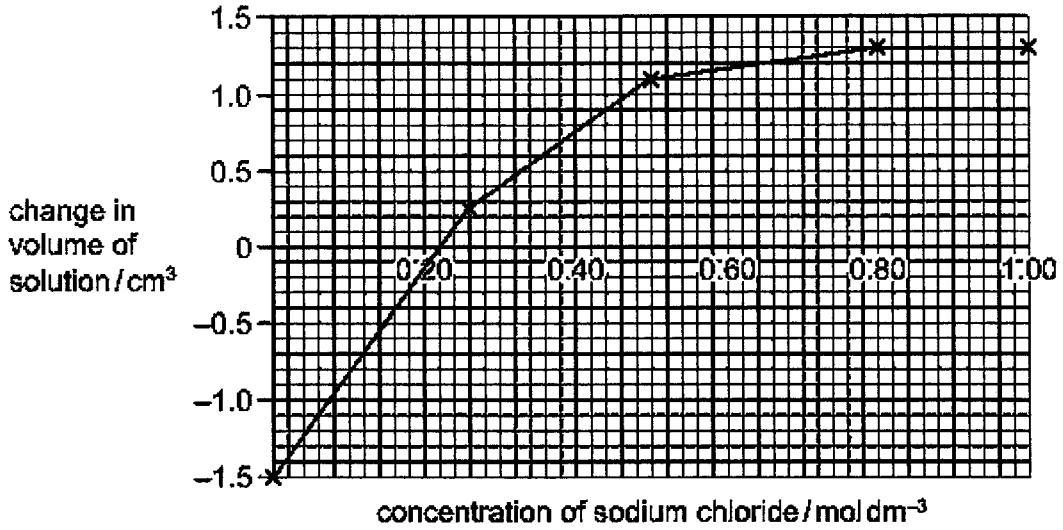
I lacks protoplasm
II lacks cross walls between adjacent cells
III contains cell walls strengthen with lignin
IV contains cell walls strengthen with cellulose

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

[Turn over

3 Equal volumes of five different concentrations of sodium chloride solution were placed into five similar containers. An identical piece of plant tissue was placed in each container and left for 48 hours.

The plant tissues were removed after 48 hours and the change in volume of solution was accurately measured for each container. The results are shown below.



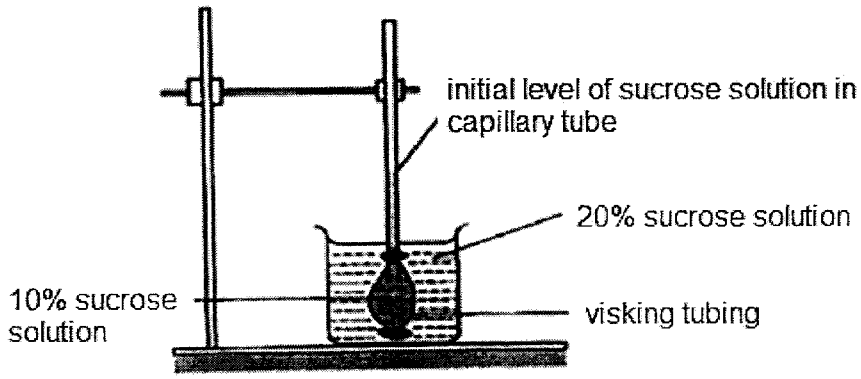
Which statement(s) explain/s the results from 0.80 to 1.00 mol dm^{-3} sodium chloride?

1 There was no movement of water molecules out of the plant tissues.
2 The plant tissues had a water potential of zero.
3 The plant tissues were fully plasmolysed.

A 1 only
B 1 and 2
C 2 and 3
D 3 only

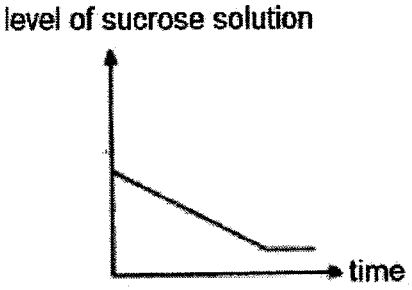
[Turn over

4 The diagram shows the initial level of 10% sucrose solution in a capillary tube before an experiment.

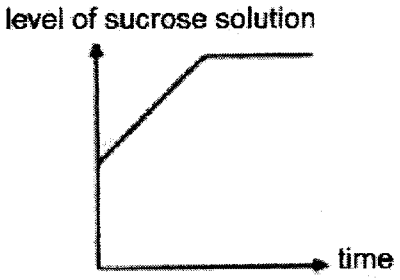


Which graph shows the changes in the level of sucrose solution in the capillary tube changes during the experiment?

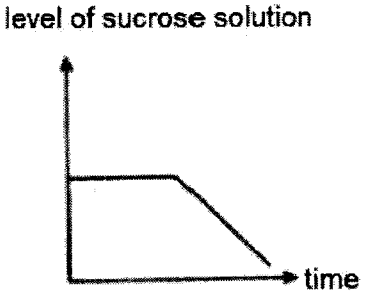
A



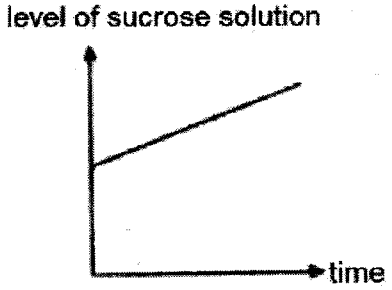
B



C

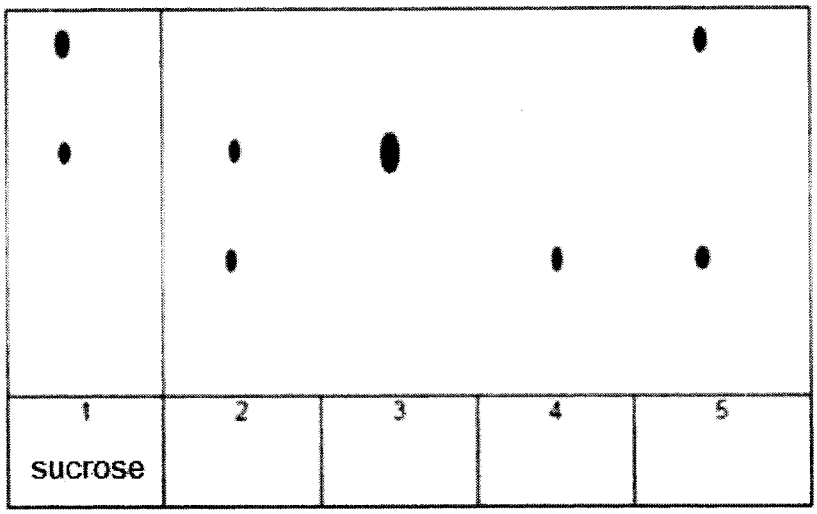


D



[Turn over

5 Five disaccharides were each hydrolysed with dilute acid, and the final products were separated by chromatography. The final chromatogram is shown in the diagram.



If 1 represents the products obtained from the hydrolysis of sucrose, which option indicates the results obtained from the hydrolysis of lactose and maltose respectively?

	lactose	maltose
A	2	3
B	2	4
C	3	2
D	3	5

6 The following statements describe the characteristics of water.

1 water cools a surface from which it evaporates
2 water is used as a solvent for many chemicals
3 water is involved in many metabolic reactions

Which statement(s) make water suitable to use in a blood transport system?

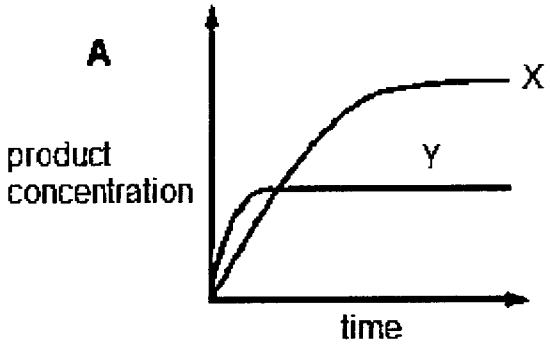
A 1 and 2
B 1 and 3
C 2 only
D 3 only

[Turn over

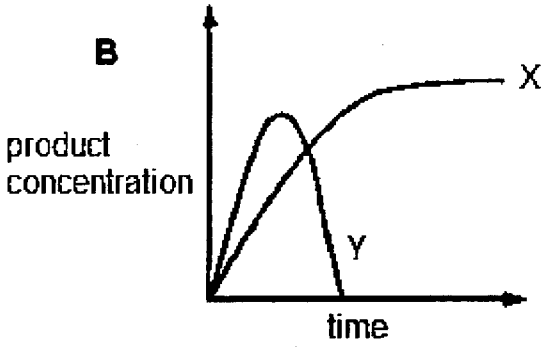
7 Two enzyme-controlled experiments were carried out one after another. Experiment X was carried out at a constant temperature of 37°C. In experiment Y, the temperature was initially 37°C. It was gradually raised to 80°C. No products were removed throughout both experiments.

Which graph shows the results?

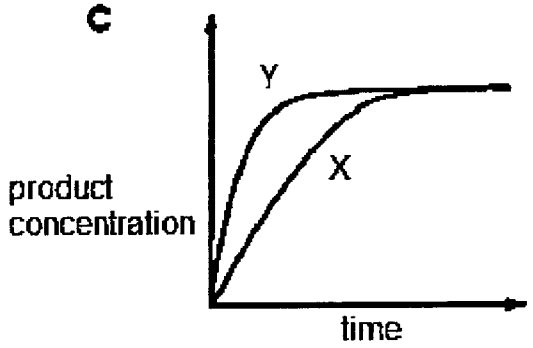
A



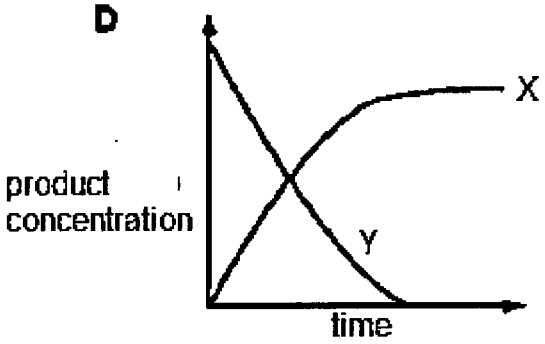
B



C



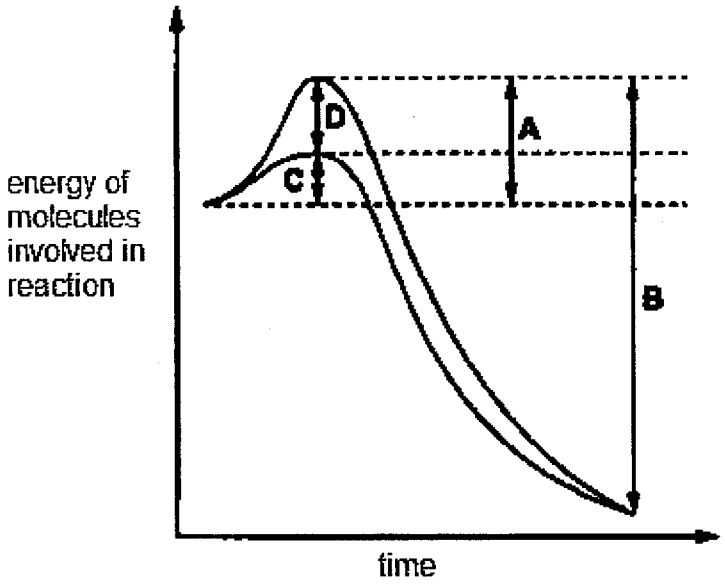
D



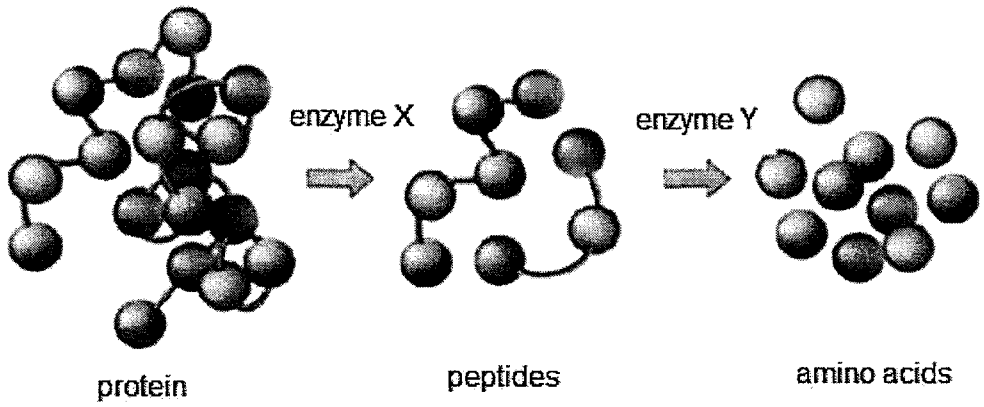
[Turn over

8 The two curves in the diagram represent energy levels as a chemical reaction progresses, with and without the presence of the enzyme specific to this reaction.

Which arrow represents the total activation energy of the reaction without the enzyme?



9 The diagram shows the digestion of protein.



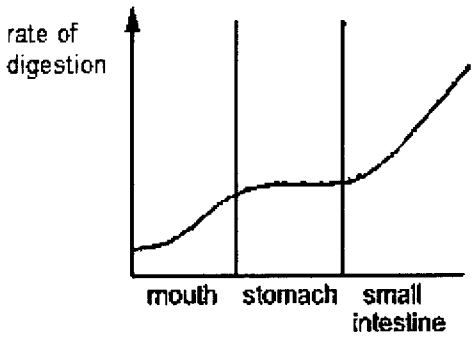
What is enzyme Y and where is it released from?

	enzyme Y	released from
A	lipase	intestinal wall
B	pepsin	stomach wall
C	peptidase	intestinal wall
D	trypsin	pancreas

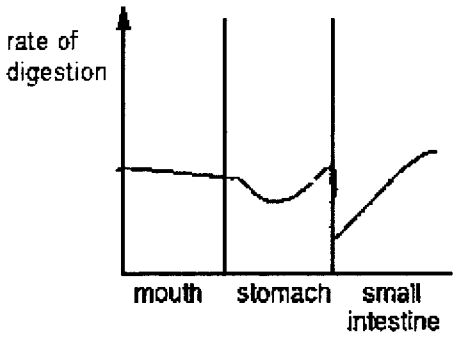
[Turn over

10 What graph below shows the rate of digestion of starch in the three parts of the alimentary canal?

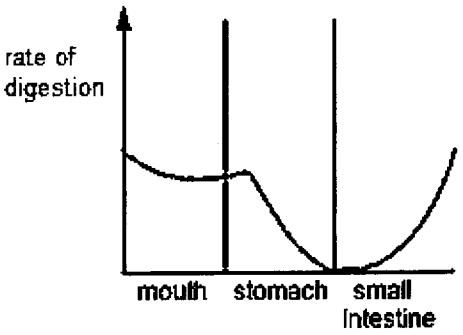
A



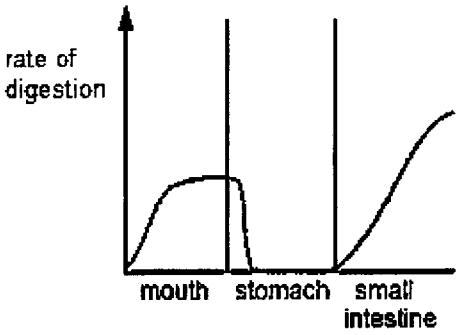
B



C



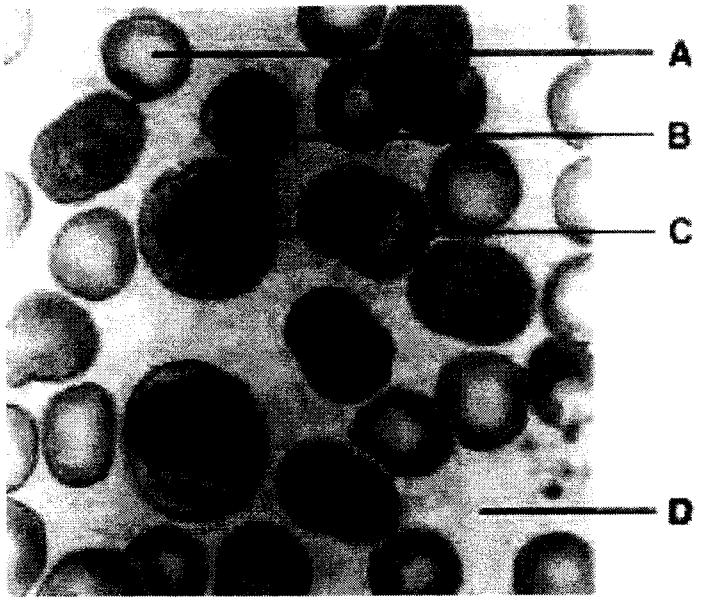
D



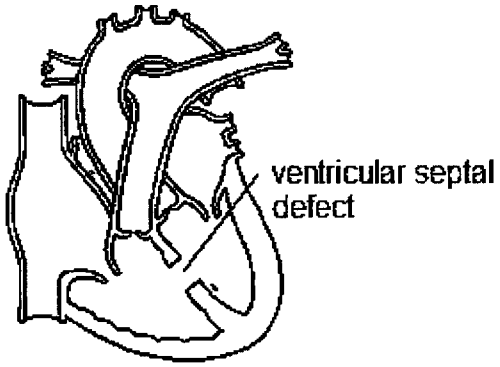
[Turn over

11 The diagram shows a photograph of blood smear seen under a light microscope.

Which part shows the structure that carry out phagocytosis?



12 The diagram shows a congenital defect (ventricular septal defect) in which the median septum of the heart fails to form fully, resulting in 'a hole in the heart'.



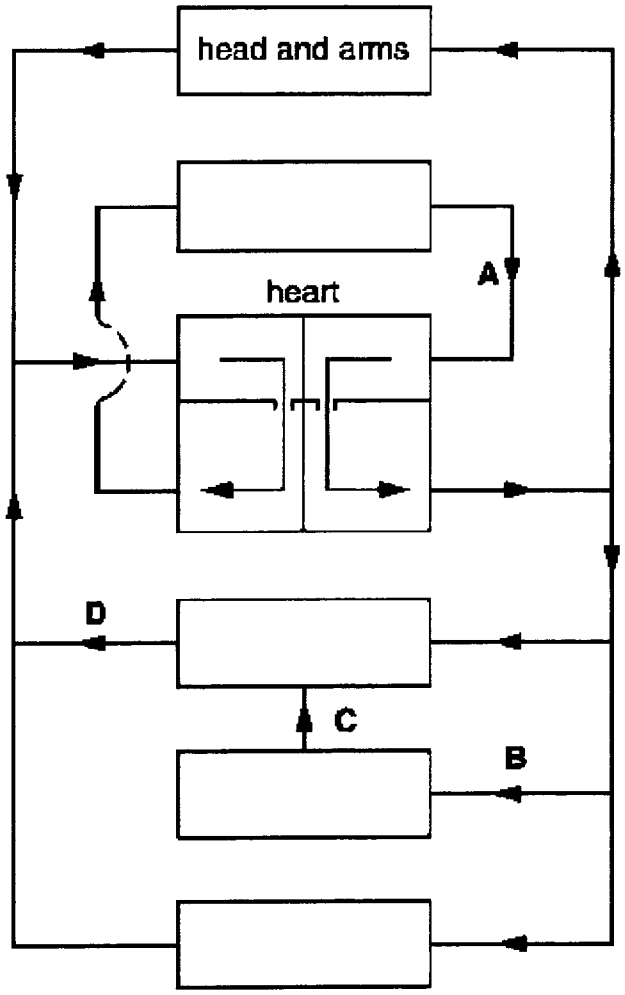
Which of the following would not be a likely consequence of this disease?

A a reduction in the pressure of blood leaving the aorta
B a reduction in the percentage of oxygen brought to body cells
C mixing of oxygenated and deoxygenated blood
D backflow of blood into the atria

[Turn over

13 The diagram shows the human circulatory system.

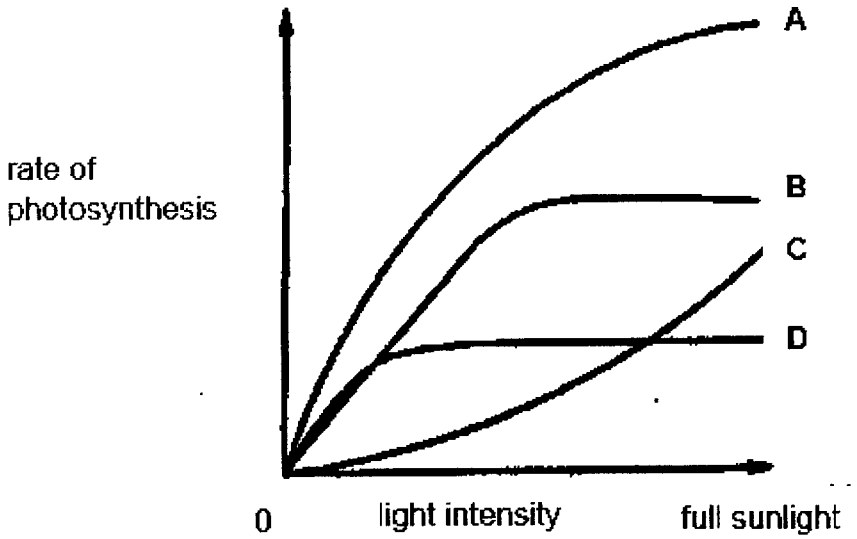
In which vessel, **A**, **B**, **C** or **D** will there be the highest amount of amino acids after a meal high in protein?



[Turn over

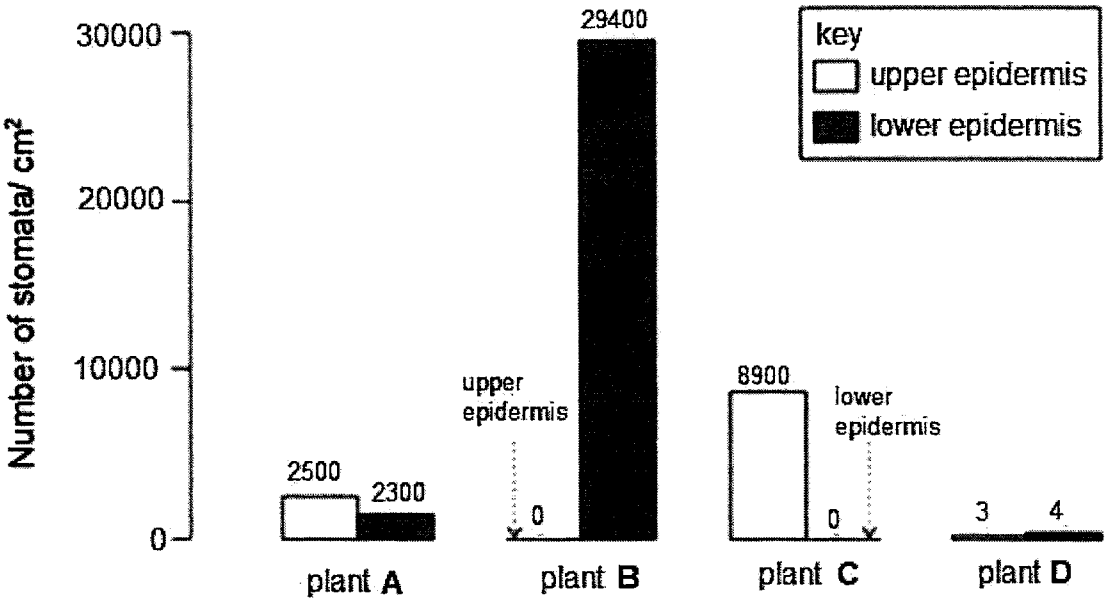
14 Plants of the rainforest floor are adapted to grow in conditions of permanently low light intensity.

Which graph shows the effect of light intensity on the rate of photosynthesis for these plants?



15 The graph shows the distribution of stomata on the upper and lower epidermis of the leaves of four plants.

Which of these plants can be found floating on the surface of an aquatic environment?



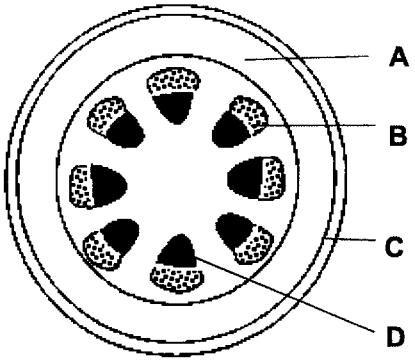
[Turn over

16 Which way could increase the rate of water uptake by a shoot?

A covering the shoot with a black plastic bag
B covering the shoot with a clear plastic bag
C removing the leaves from the shoot
D shining bright light onto the shoot

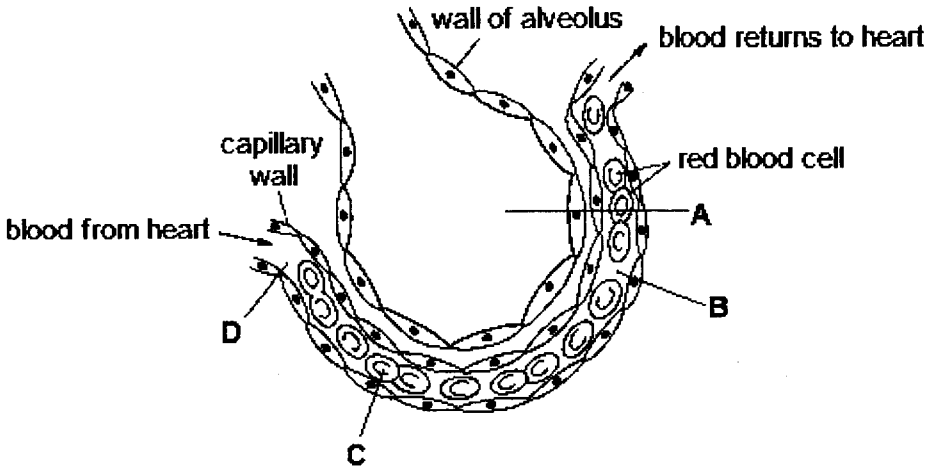
17 The diagram shows a section of a young stem.

Which cells do not respire?



18 The diagram shows a section through an alveolus and an associated blood capillary.

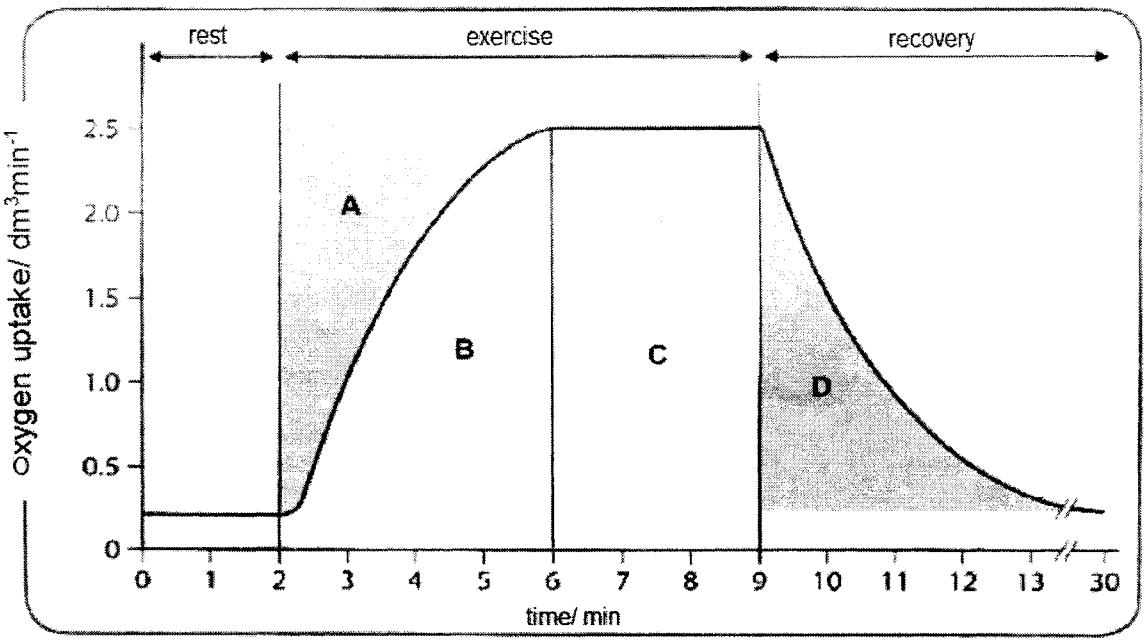
In which part is the concentration of carbon dioxide the highest?



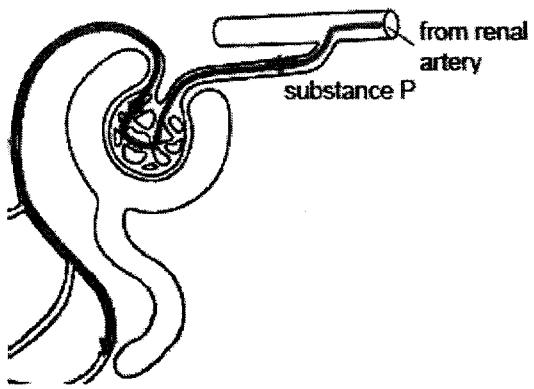
[Turn over

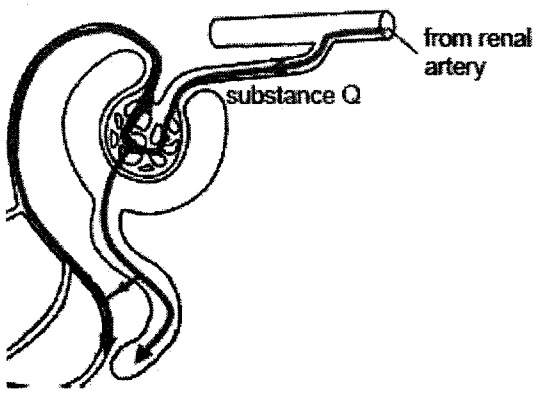
19 The diagram shows the oxygen uptake of a man before, during and after strenuous exercise.

Which region represents the repayment of oxygen debt?



20 The diagram shows the movement of substances P and Q through a normal, healthy human nephron.



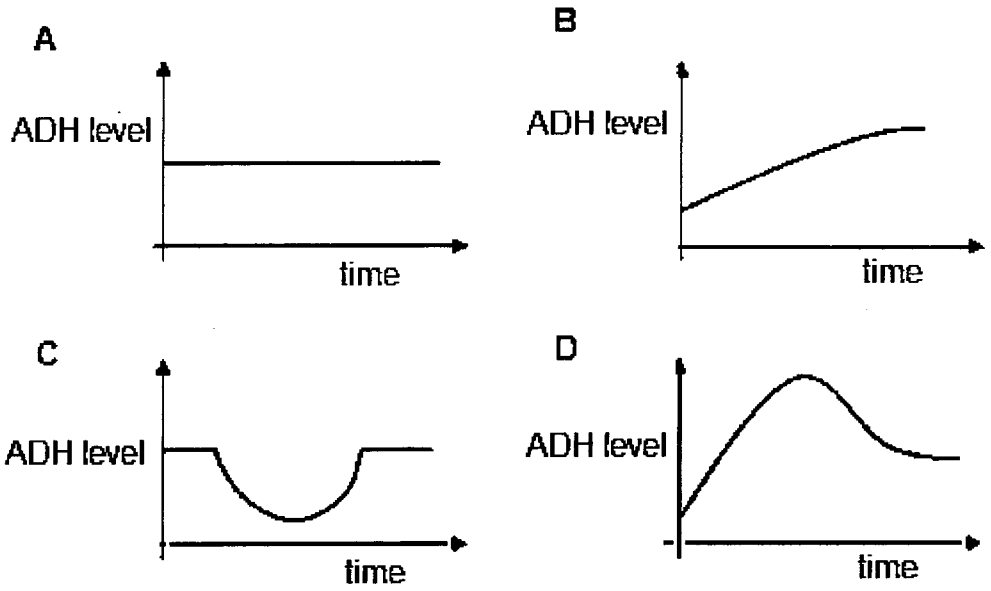


What could substances P and Q be?

	substance P	substance Q
A	glucose	mineral salts
B	mineral salts	plasma protein
C	plasma protein	water
D	water	glucose

[Turn over

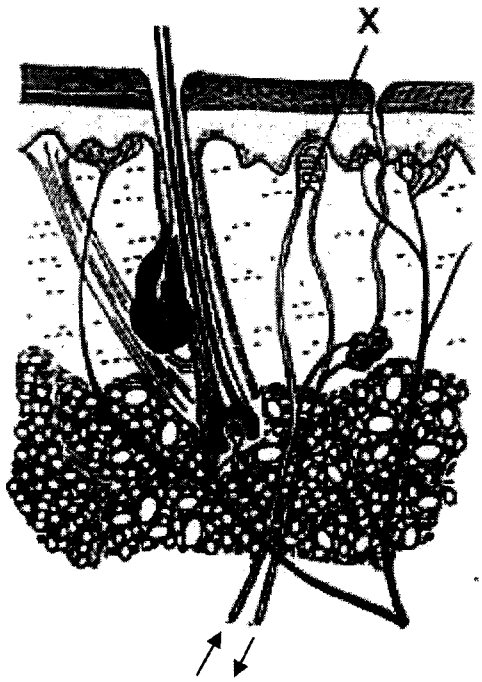
21 Which graph best represents the levels of anti-diuretic hormone in the blood of a person who has just drunk a large cup of water?



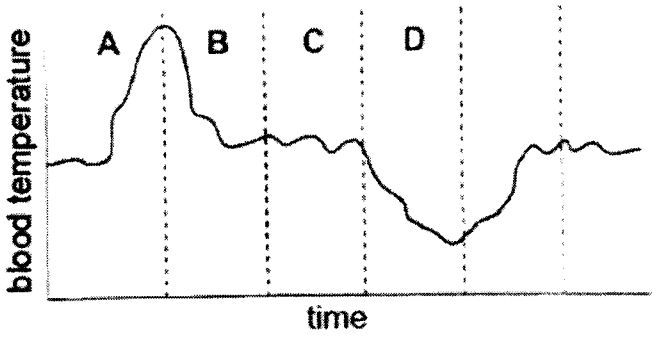
22 Which of the following is not an example of a homeostatic mechanism?

A osmoregulation
B production of sweat
C secretion of glucagon
D selective reabsorption in nephron

23 The diagram shows a section through the skin.

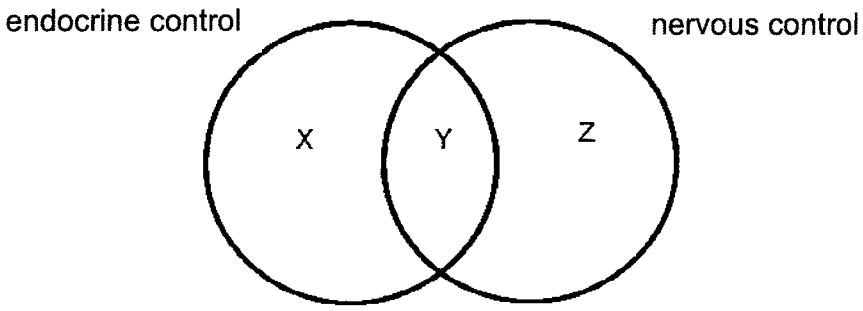


During which period of time will the muscles in structure X contract?



[Turn over

24 The comparison between an endocrine control and a nervous control can be illustrated using the following Venn diagram.

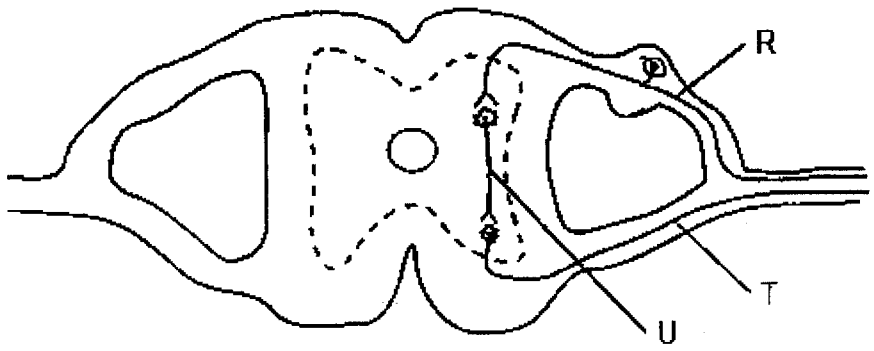


Which one of the following can fit into regions X, Y and Z?

	X	Y	Z
A	always involuntary	can be chemically transmitted	may be involuntary or voluntary
B	can be chemically transmitted	always involuntary	may be involuntary or voluntary
C	may be involuntary or voluntary	can be chemically transmitted	always involuntary
D	may be involuntary or voluntary	always involuntary	can be chemically transmitted

[Turn over

25 The diagram below shows a transverse section of the spinal cord with spinal nerves.



Nerve impulses in neurones can travel in the following directions.

1 away from the central nervous system
2 towards the central nervous system
3 within the central nervous system

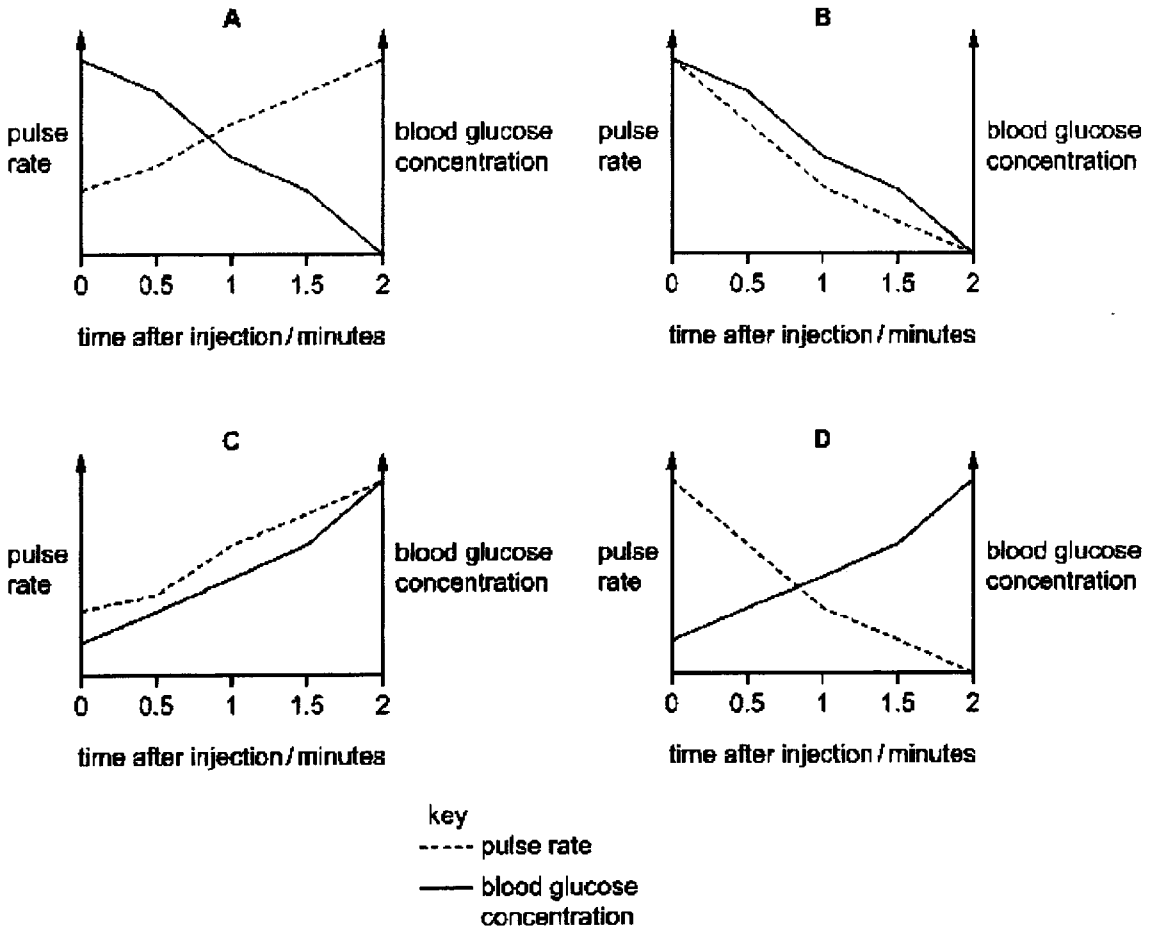
In which direction do impulses in neurones R, T and U travel?

	R	T	U
A	1	2	3
B	1	3	2
C	2	3	1
D	2	1	3

[Turn over

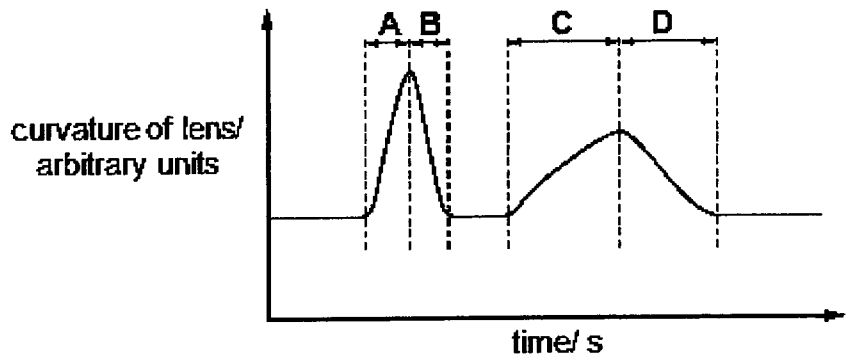
26 Jessica is injected with adrenaline.

Which graph shows the expected changes to pulse rate and blood glucose concentration?



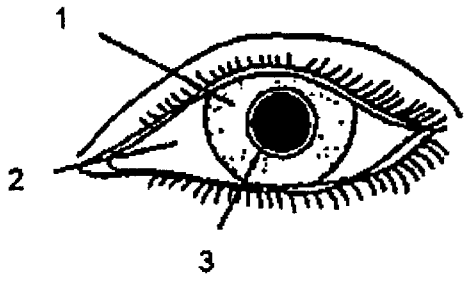
27 The diagram shows the curvature of the lens in a person's eye. The shape of the lens changes as the person watches two motorbikes move past at different speeds.

During which period was a motorbike moving towards the person at a higher speed?

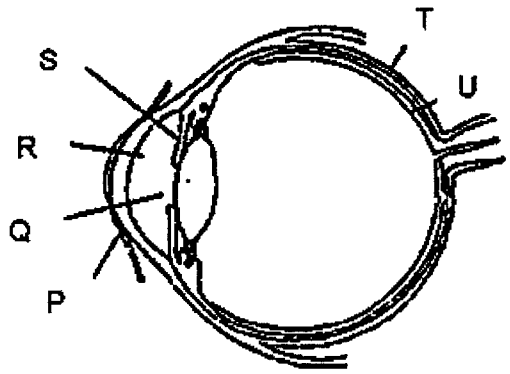


[Turn over

28 The diagrams show the front view and longitudinal section of the human eye.



front view



longitudinal section

What structures shown in the front view are same as the longitudinal section?

	1	2	3
A	S	T	Q
B	P	Q	S
C	S	R	U
D	Q	R	T

29 An experiment was set up using four groups of insect pollinated flowers in a field. In each group, different parts of the flower were removed as shown in the table and insects were allowed to visit the flowers freely.

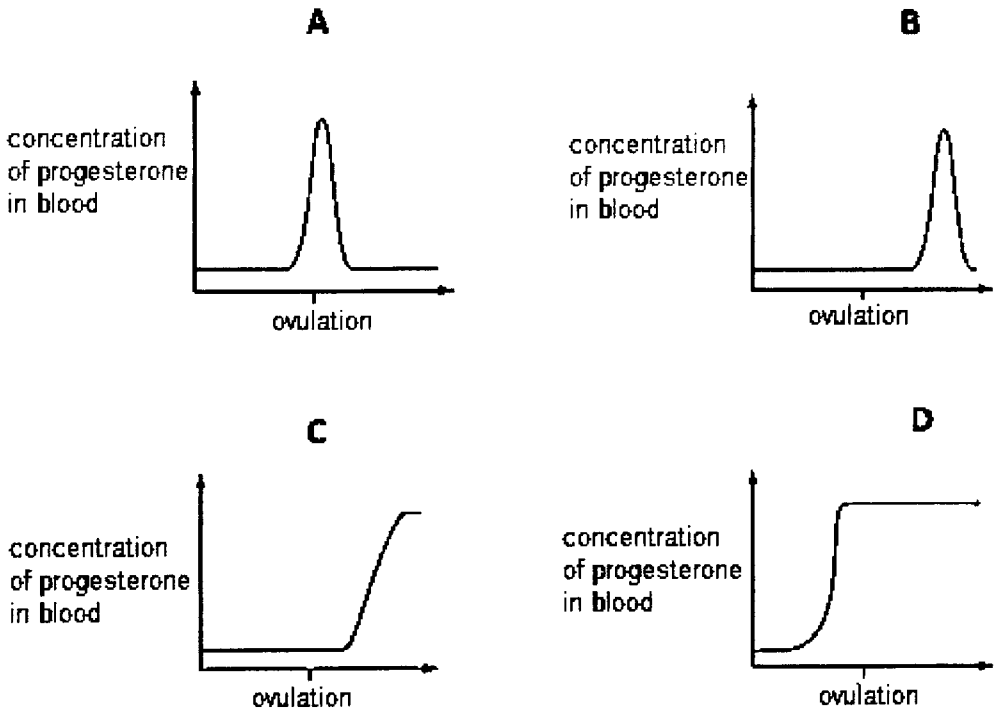
Which of the following groups of flowers will not produce seeds?

	petals	stigma	anthers
A	removed	intact	removed
B	intact	removed	intact
C	intact	intact	removed
D	removed	intact	intact

[Turn over

30 The graphs below show the concentration of progesterone in the blood of a female during a 28-day menstrual cycle.

Which graph shows the changes in concentration of progesterone if implantation occurs?



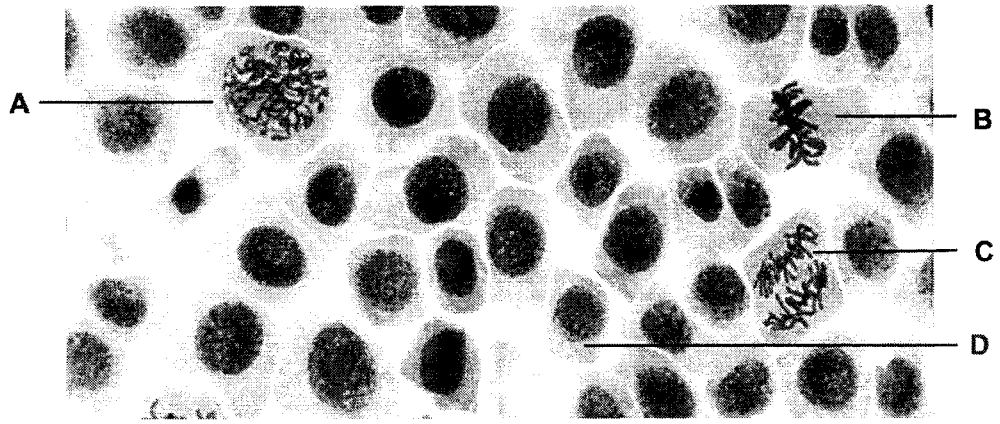
31 A couple who had been unsuccessful in having a baby wished to take advantage of in-vitro fertilisation, using the woman's own egg and her husband's sperm.

Which infertility problem could be most easily overcome in this way?

A blocked oviducts from severe infection
B failure of the follicle to mature
C pelvis is too small to allow normal development of the fetus
D unstable uterine wall which greatly reduces the probability of implantation

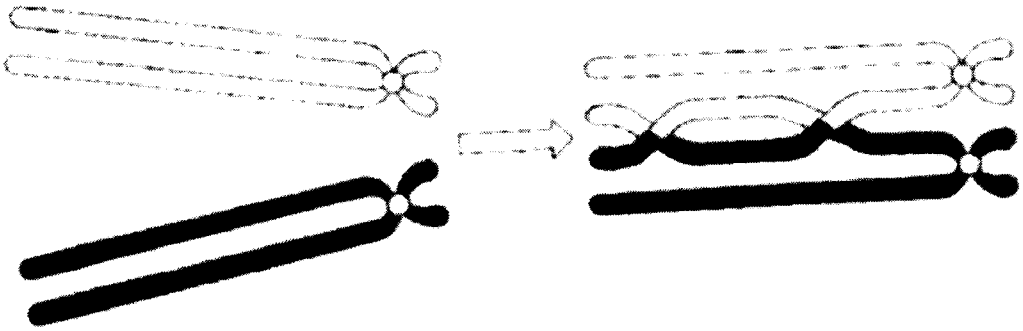
[Turn over

32 The photomicrograph shows cells obtained from the root tip of an onion.

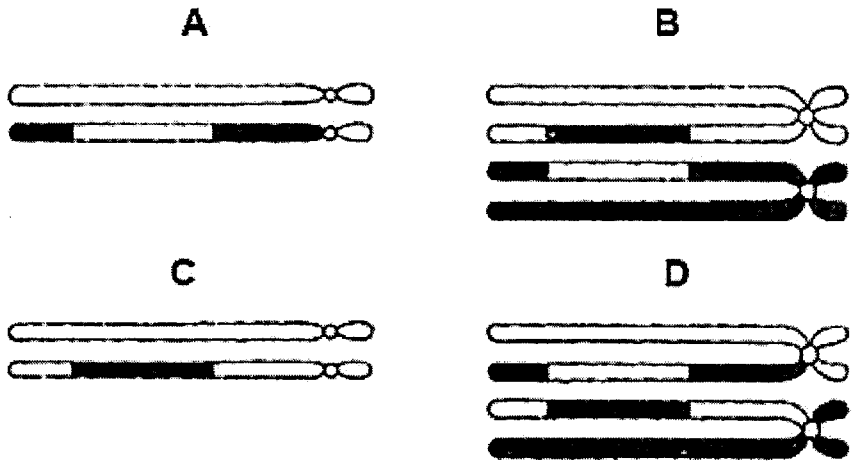


Which cell represents a cell during metaphase of mitosis?

33 The diagram below shows two chromosomes during the early stages of meiosis.

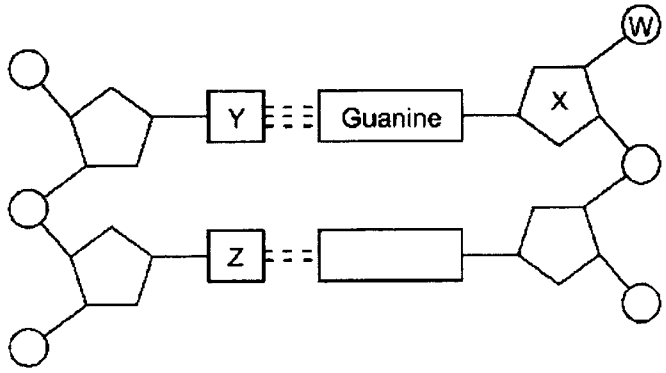


Which of the following diagrams represents the final products of the second meiotic division?



[Turn over

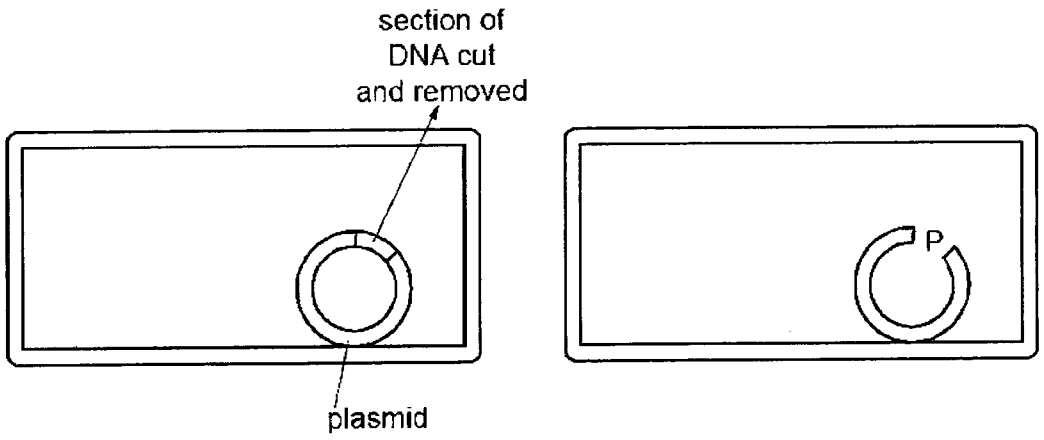
34 The diagram shows part of a DNA molecule.



Which letters indicate cytosine, deoxyribose sugar, phosphate and thymine?

	cytosine	deoxyribose	phosphate	thymine
A	W	X	Y	Z
B	Y	X	W	Z
C	Y	Z	X	W
D	Z	W	X	Y

35 The diagram shows a bacterium whose plasmid is being used during genetic engineering to produce human insulin.



What is inserted at P so that the bacterium can produce human insulin, and which enzyme is used to catalyse the insertion?

A a section of human DNA, using DNA ligase
B a section of human DNA, using restriction enzymes
C a section of human mRNA, using DNA ligase
D a section of human mRNA, using restriction enzymes

[Turn over

36 When a breed of cattle with red coats is crossed with the same breed with white coats, the offspring all have coats with a mixture of red and white hairs, a condition called roan.

What would the theoretical ratio of the offspring be, if a roan cow was crossed with a red coated bull?

A all red coated
B all roan
C 1 red coated : 1 roan
D 3 red coated : 1 roan

37 Two pure bred lines of different plant varieties, which differed greatly in bean seed mass, were crossed. The mass of bean seeds produced by the two parental varieties and their offspring were measured to the nearest gram. The number of bean seeds in each mass category was counted.

mass of bean/ mg		51-150	151-250	251-350	351-450	451-550	551-650	651-750
number of beans	parental	5	375	177			352	10
	offspring			13	544	974	48	

Which statement best explains these experimental data?

A The characteristic of bean mass shows continuous variation, which is brought about by the additive effects of multiple alleles.
B The mass of bean in plants is affected by various environmental factors, which caused the variation in bean mass observed in the offspring generation.
C The greater variation in bean mass observed in the offspring generation as compared to the parental generation may be due to random fusion of gametes.
D The mass of beans for the parental generation shows discontinuous variation while the offspring generation shows continuous variation.

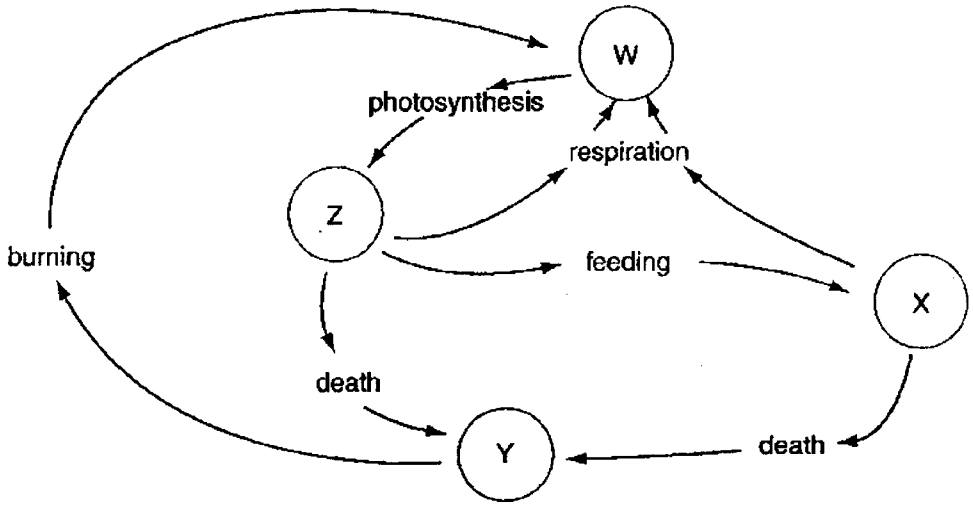
38 Which environmental factors act as forces of natural selection?

1 competition
2 disease
3 food supply
4 predation

A 1 only
B 1 and 4 only
C 1, 2, 3 and 4
D 2 and 3 only

[Turn over

39 The diagram shows some stages in the carbon cycle. W, X, Y and Z are carbon compounds.



What could X be?

A coal and oil
B carbon dioxide in the air
C carbon compounds in plants
D carbon compounds in animals

40 A scientist tested the level of pesticides in the following food chain.

plankton → clams → flounder → white-bellied sea eagle

Which option shows the likely results? (ppm = parts per million)

	plankton/ ppm	clam/ ppm	flounder/ ppm	white-bellied sea eagle/ ppm
A	0.03	0.23	2.05	18.45
B	0.03	0.06	0.09	1.00
C	0.03	0.03	0.56	6.30
D	0.03	0.005	0.00024	0.00001

End of Paper

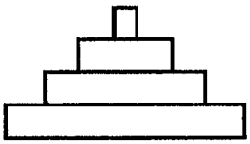
[Turn over

41 The diagram shows a food chain.

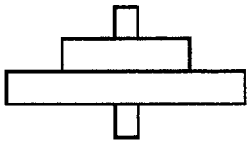
tree → herbivorous insects → carnivorous insects → bird

Which pyramid of numbers represents the food chain?

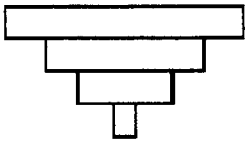
A



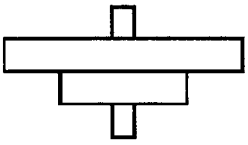
B



C



D



Register Number	Class

Name ______________________________

BENDEMEER SECONDARY SCHOOL
2022 PRELIMINARY EXAMINATION
SECONDARY 4 EXPRESS
BIOLOGY
6093/02

Date : 30 August 2022

Duration: 1 h 45 min

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

Section B (30 marks)
Answer **all** questions. Write your answers in the spaces provided on the question paper.
Question 9 is in the form of an **Either/Or** question. Only one part should be answered.

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

/ 80

This document consists of **20** printed pages.

[Turn over

Section A (50 marks)
Answer **all** questions.
Write your answers in the spaces provided.

1 A student cuts a section of a stem and made an outline drawing of the distribution of tissues as shown in Fig. 1.1.

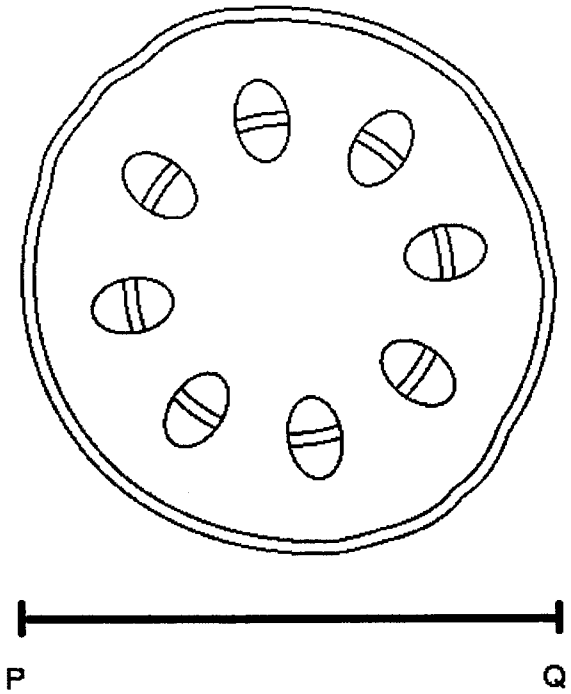


Fig. 1.1

(a) (i) Identify and label the position of xylem tissue on Fig. 1.1. [1]

(ii) The actual distance of P-Q is 0.08 mm.
Calculate the magnification of Fig. 1.1. Show your working clearly.

magnification = x ..... [1]

(iii) Explain why xylem is a tissue.

.....

..... [1]

[Turn over

(b) Describe how water from the soil is transported to the xylem in the root.

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..... [3]

[Total: 6]

2 Fig. 2.1 shows the total cross-sectional area of the blood vessels in the systemic circulation. It also shows the changes that occur in blood pressure and the speed (velocity) of blood in the different blood vessels.

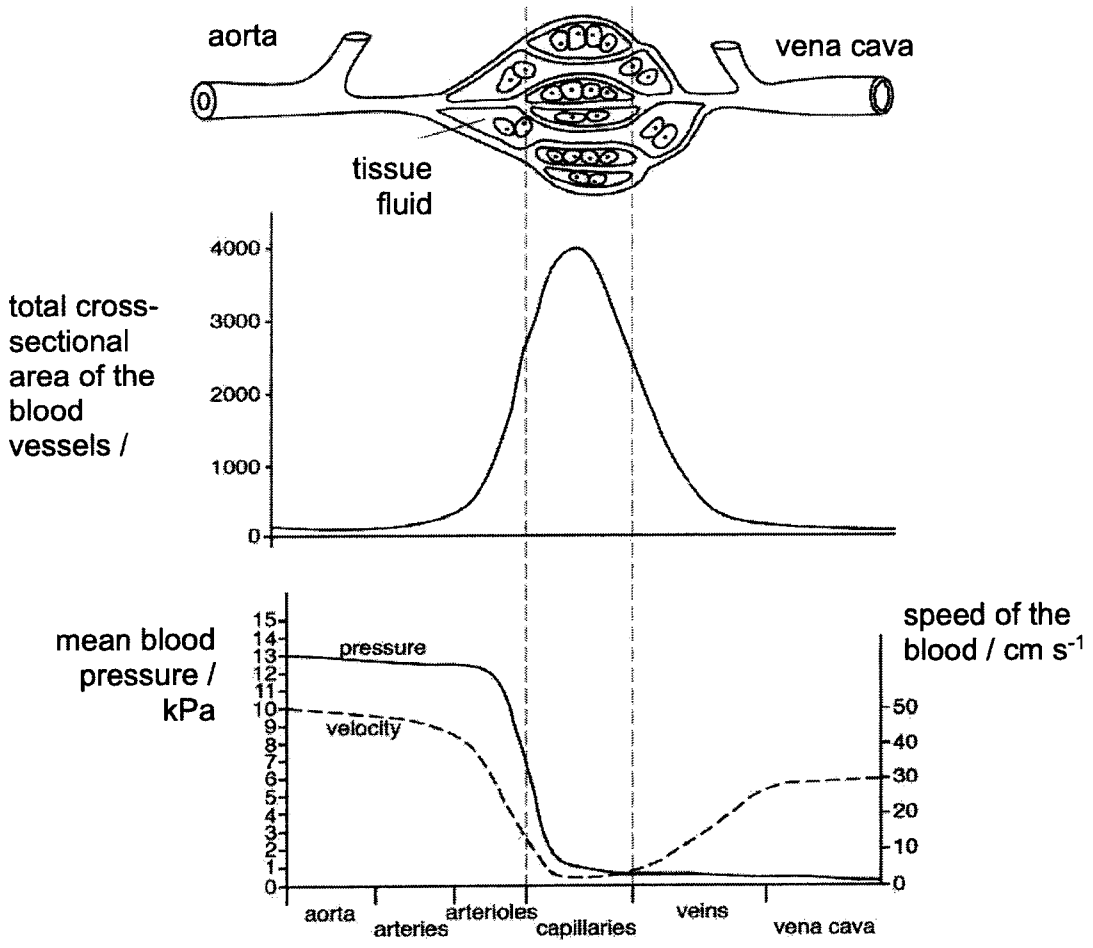

Fig. 2.1

[Turn over

(a) (i) State the maximum speed of the blood in the aorta.

..... [1]

(ii) Describe how mean blood pressure and speed of blood change with cross-sectional area of blood vessels, as shown in Fig. 2.1.

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..... [2]

(iii) Besides blood pressure and speed of blood, state two other ways in which the blood in aorta is different from the blood in vena cava.

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..... [2]

(b) Humans have a double circulation.

Explain two advantages of humans having a double circulation.

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..... [2]
[Total: 7]

[Turn over

3 **(a)** The concentration of lactic acid in the blood of two athletes was investigated. One athlete, P, had been training and the other, Q, was returning to training after an injury.

Blood samples were taken from both athletes during a training session. The results are shown in Fig. 3.1.

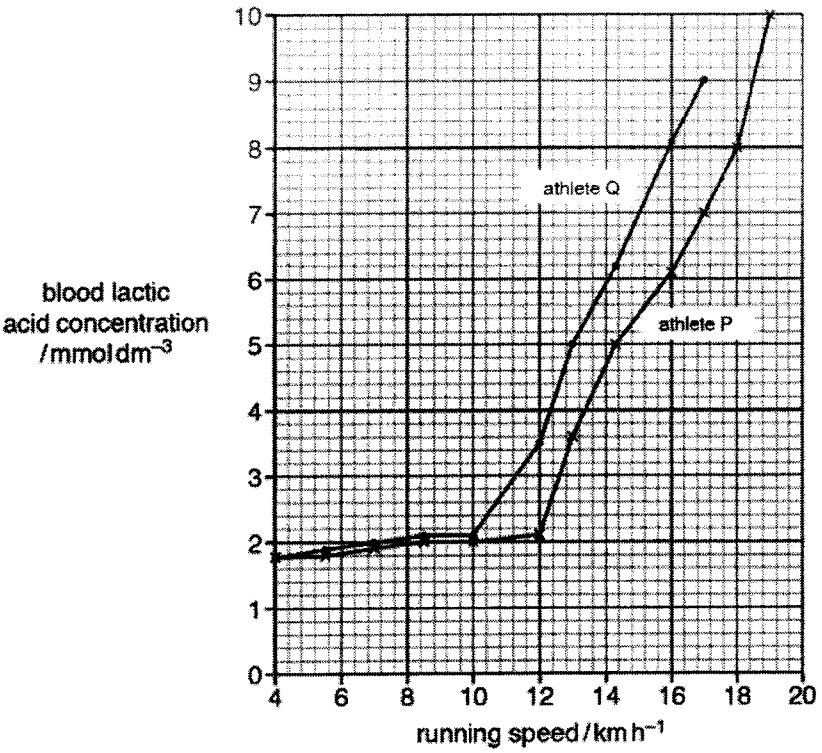

Fig. 3.1

(i) The lactic acid threshold is the running speed where the lactic acid concentration begins to increase sharply.

State the lactic acid threshold for athletes P and Q.

P: ..... km/h

Q: ..... km/h [1]

(ii) Suggest one reason for the difference in lactic acid threshold of athletes P and Q.

.....

..... [1]

[Turn over

(iii) Describe and explain the changes in blood lactic acid concentration of athlete P shown in Fig. 3.1.

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..... [4]

(b) Fig. 3.2 shows a photomicrograph of the epithelial lining in the human respiratory system.

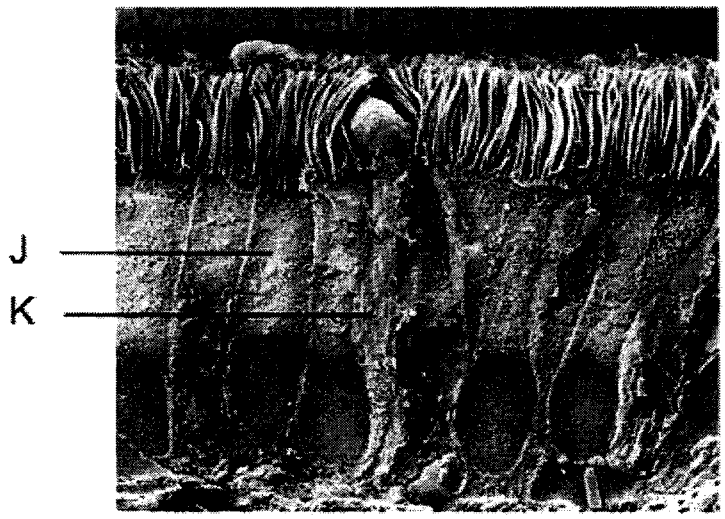

Fig. 3.2

Explain how cells J and K play a role in protecting the respiratory system.

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..... [2]

[Turn over

(c) When comparing to non-smokers, the ability of smoker to deliver oxygen to their body tissues are reduced. Two causes of this reduction include:

- a decrease in the volume of air per breath moving towards the alveoli
- a decrease in the ability of red blood cells to carry oxygen.

(i) Suggest one reason why smoking tobacco, even after only a short time, may cause a decrease in the volume of air per breath moving towards the alveoli.

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..... [1]

(ii) Explain why smoking tobacco causes a decrease in the ability of red blood cells to carry oxygen.

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..... [2]

[Total: 11]

[Turn over

4 The graph in Fig. 4.1 shows the sharpness of the image formed on various parts of the retina of a normal person, located at various degrees from a certain point X. The higher the value, the sharper the image formed on the retina.

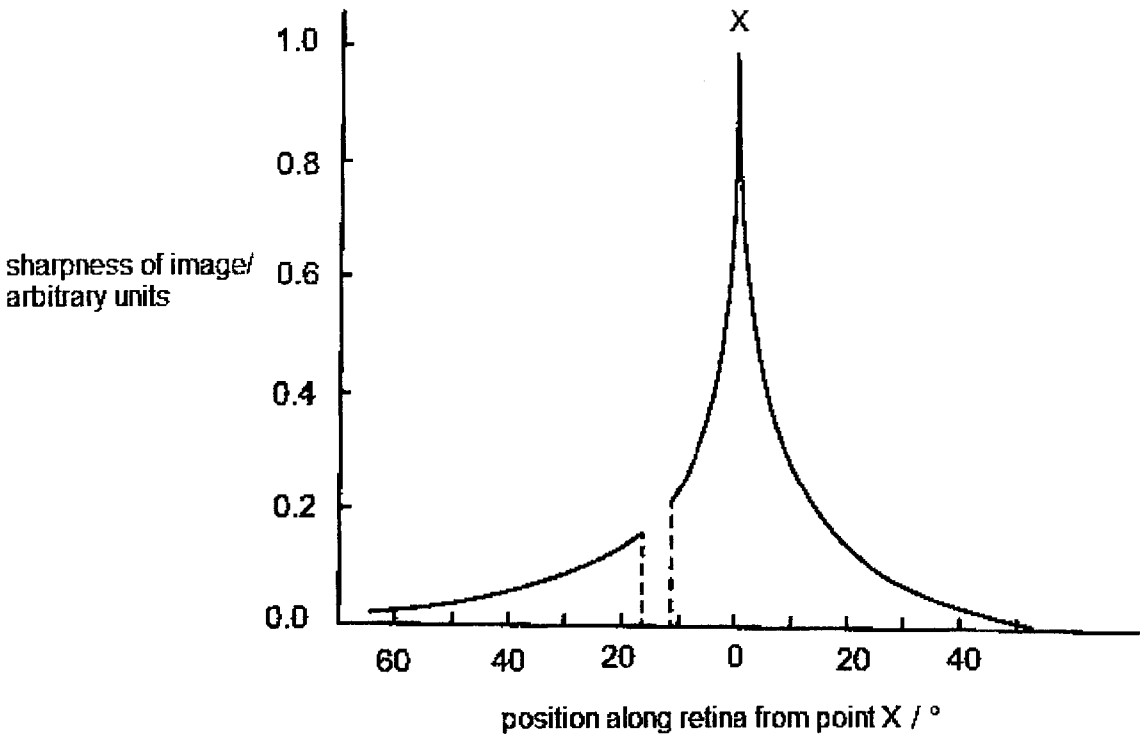

Fig. 4.1

(a) (i) With reference to the structure of the eye, suggest why there is a break in the graph when the position along retina is between 10° and 20° from point X.

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..... [2]

(ii) Suggest why the sharpness of image is only high at point X, rather than it being uniform throughout the retina.

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..... [1]

[Turn over

(b) Describe how the parts of the eye produce a focused image of a distant object.

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..... [3]

[Total: 6]

5 Fig. 5.1 shows two seeds, one from each of the two pea plants of the same species. Seeds from this species of plant have either a smooth surface or a wrinkled surface.

Fig. 5.1

(a) The type of surface of a seed is controlled by a single gene. The allele of the gene that gives the seed a smooth surface (R) is dominant to the allele that gives the seed a wrinkled surface (r).

(i) Distinguish clearly between the terms *gene* and *allele*.

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..... [2]

(ii) Explain the terms *dominant* and *recessive*.

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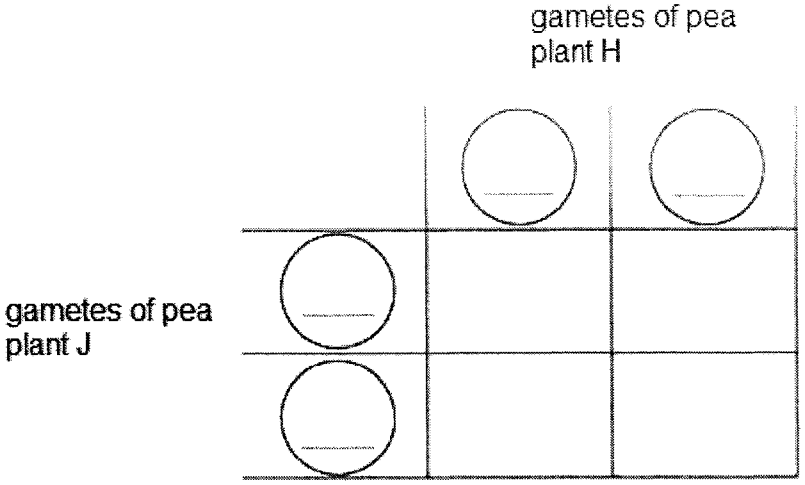
..... [2]

[Turn over

(b) One pea plant, H, has a homozygous genotype that develops seeds with a wrinkled surface. Another pea plant, J, has an unknown genotype. When these two plants were cross-pollinated, approximately half of the new plants produced had peas with a wrinkled surface.

Complete the genetic diagram below for this cross and state the genotype of pea plant J.



genotype of pea plant J: ..... [2]

[Total: 6]

6 A group of students collected 30 butterflies from a garden. They recorded the colour of the wings and measured the length of wings of each butterfly. The measurements and observations are organised in Table 6.1 and 6.2.

Table 6.1

length of wings/ mm	21-25	26-30	31-35	36-40	41-45
number of butterflies	4	10	12	8	6

Table 6.2

colour of wings	blue	yellow
number of butterflies	13	17

(a) (i) State what type of variation is exhibited by the colour of wings. Explain your answer.

.....

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..... [2]

[Turn over

(ii) State a genetic explanation for the difference in the type of variation between length of wings and colour of wings.

..... [1]

(b) The forest is the natural habitat for species D. A small group of individuals of species D live in a forest. Fig. 6.1 shows what can happen, over the same period of time, if some members of species D migrate from the forest to a desert region.

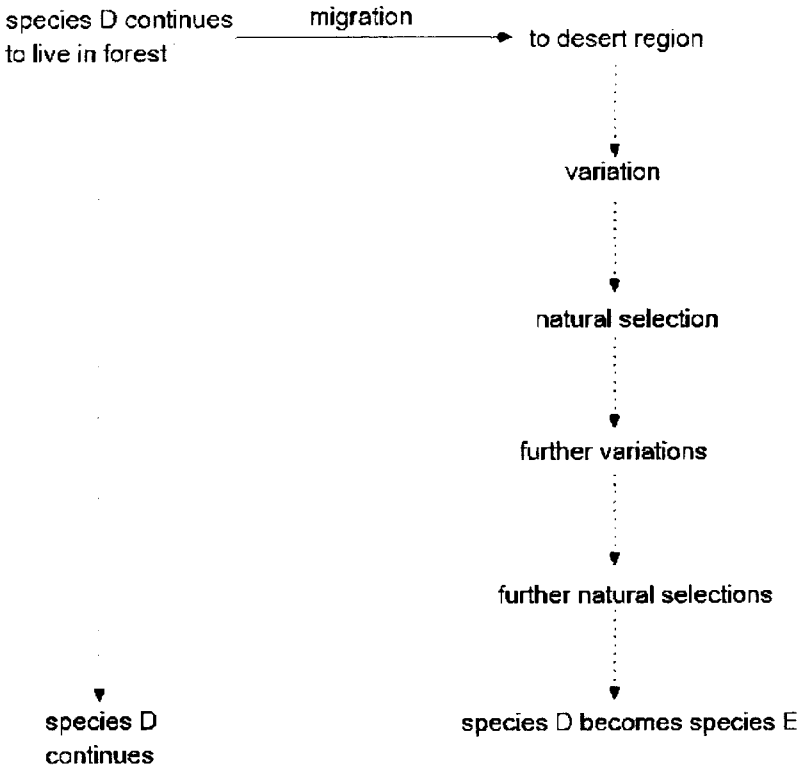

Fig. 6.1

Describe and explain how the processes of variation and natural selection lead to formation of the new species E.

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..... [3]

[Total: 6]

[Turn over

7 A scientist studies communities in different parts of a desert and estimated the biomass of the organisms in each area. He divided the organisms into three groups according to their roles in the food web as shown in Table 7.1.

Table 7.1

groups of organisms in the food web	biomass/ g per m^2
producers	480
herbivores	340
carnivores	40

Some of these results are shown as a pyramid of biomass in Fig. 7.1.

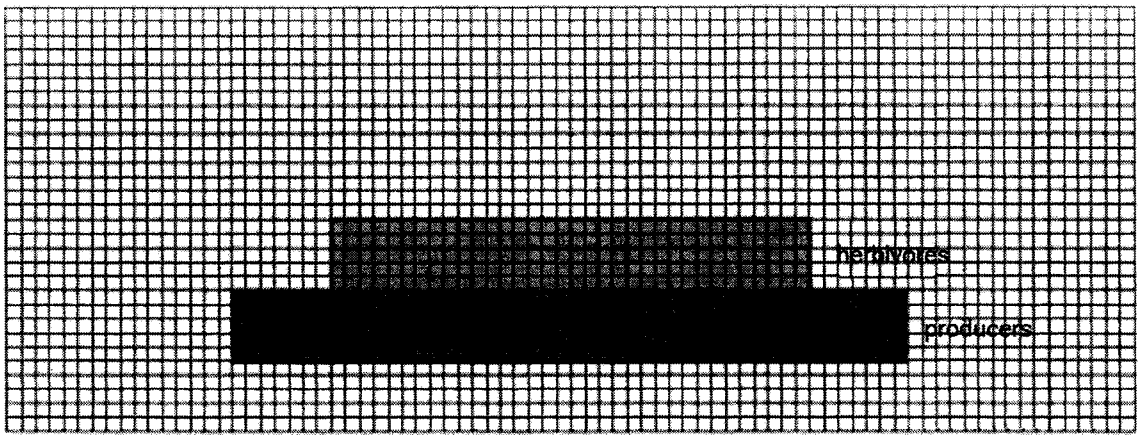

Fig. 7.1

(a) Use the information in Table 7.1 to complete the pyramid of biomass in Fig. 7.1. [1]

(b) Explain why there are rarely more than four or five trophic levels in ecosystems.

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..... [2]

(c) State a disadvantage of using pyramid of numbers to study the community.

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..... [1]

[Total: 4]

[Turn over

8 A healthy kidney controls the excretion of urea and other waste products of metabolism from the blood. When kidneys failed, there are two possible treatments: dialysis or a kidney transplant.

Fig. 8.1 shows how blood and dialysis fluid move through a dialysis machine.

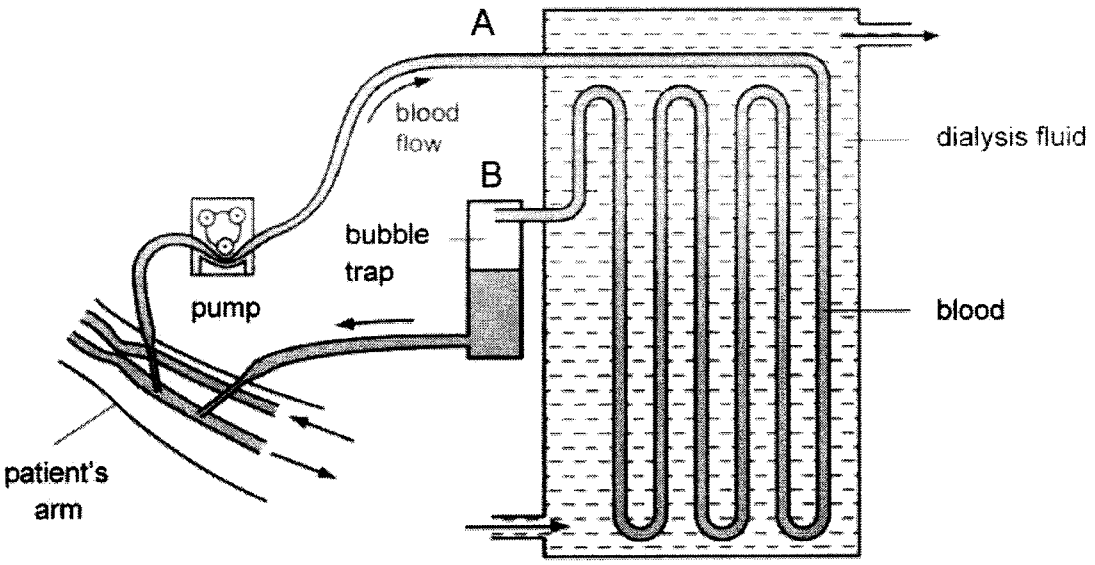

Fig. 8.1

(a) Describe and explain the changes that occur to the blood as it flows through the dialysis machine from A to B.

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..... [2]

(b) (i) Discuss an advantage of kidney transplants over dialysis.

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..... [1]

(ii) Explain why there is a need to ensure the donor organ for transplant is compatible with the recipient.

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..... [1]

[Total: 4]

[Turn over

Section B (30 marks)

Answer **three** questions.

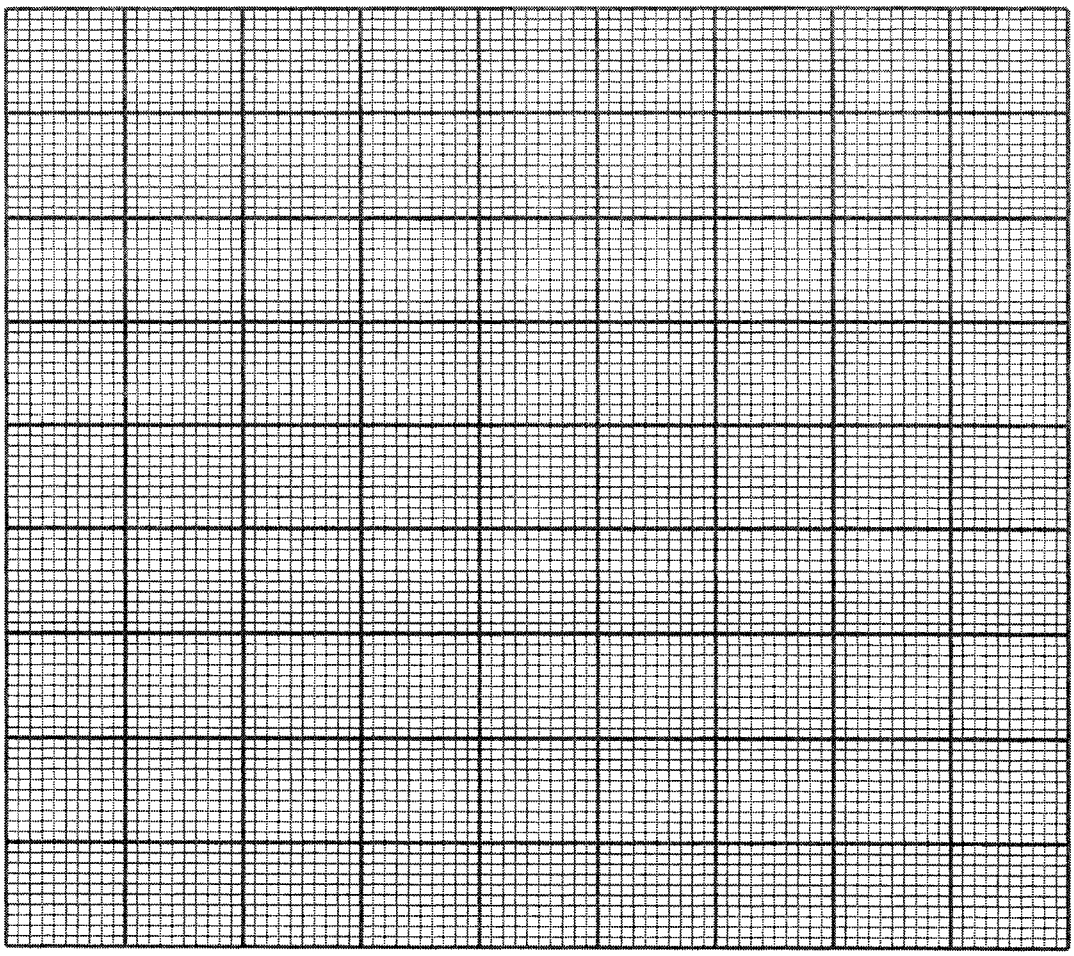
Question **11** is in the form of an **Either/Or** question. Only **one** part should be answered.

9 Table 9.1 shows the results obtained in an investigation to compare the rate of transpiration with the rate of water absorption of a plant taken at four-hour intervals on a summer day.

Table 9.1

time / h	rate of water absorption / g/h	rate of transpiration / g/h	light intensity / %
0400	1.50	0.25	0
0800	1.50	2.00	70
1200	3.50	5.00	100
1600	5.50	7.25	100
2000	3.25	2.50	10
2400	2.00	0.75	0

(a) Using the data in Table 9.1, plot a graph to show how the rate of water absorption and the rate of transpiration changes with time. Join the points using suitable line(s).



[4]

[Turn over

(b) Based on the results, what is the time of the maximum water absorption and maximum transpiration? Explain your answer.

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..... [4]

(c) With reference to Table 9.1, suggest whether the plant can live indefinitely under the conditions of the experiment.

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(d) Describe and explain how the rate of transpiration and water absorption will be affected if a polyethene bag is used to cover the leafy parts of the plant.

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..... [3]

[Total: 12]

[Turn over

10 Chemical X is a waste material from the manufacturing of fabric dyes.

In the past 30 years, factories dumped large quantities of chemical X into the river of a town. Studies measured the concentrations of chemical X in the tissues of organisms in a food chain with four trophic levels in the river, as shown in Table 10.1.

Table 10.1

concentrations of chemical X in arbitrary units	food chain in river
11000 – 16400	large-sized fishes
	↑
5 – 37	small-sized fishes
	↑
1.56	zooplankton
	↑
0.85	phytoplankton

(a) Define the term "trophic level".

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..... [1]

(b) Explain why large-sized fishes contain much higher concentrations of chemical X compared to the rest of the organisms in the food chain.

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..... [3]

[Turn over

(c) A surge in the amount of chemical X released into the river can cause large amounts of fishes to die.
Explain why these mass deaths result in depletion of dissolved oxygen in the river.

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..... [3]

(d) Chemical X is toxic to many organisms because they bind to a common protein molecule in living cells. A population of medium-sized fish lives in the river of the town. 80% of this population is resistant to the effects of chemical X.

Suggest why.

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..... [1]
[Total: 8]

[Turn over

EITHER

11 (a) In conditions of prolonged exposure to extreme cold temperatures (e.g. below 0^0C), frostbite occurs and the person may feel complete loss of sensation in the fingers and toes. Explain how this happens.

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..... [4]

(b) The after effect of frostbite can cause pain to the patient. Aspirin is a strong drug often used to relieve aches and pains. For the drug to act on its target organs, it must be absorbed by the small intestine into the bloodstream.
Describe and explain how the structure of villi contributes to the absorption of Aspirin.

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[Turn over

OR

11 (a) Describe the changes during a menstrual cycle and explain the role of the hormones in the process.

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..... [6]

[Turn over

(b) Fig. 11.1 shows the human life cycle. The components of the diagram are not drawn to the same scale.
Fig. 11.1 shows cells L, M and N, and two types of cell divisions, K and O.

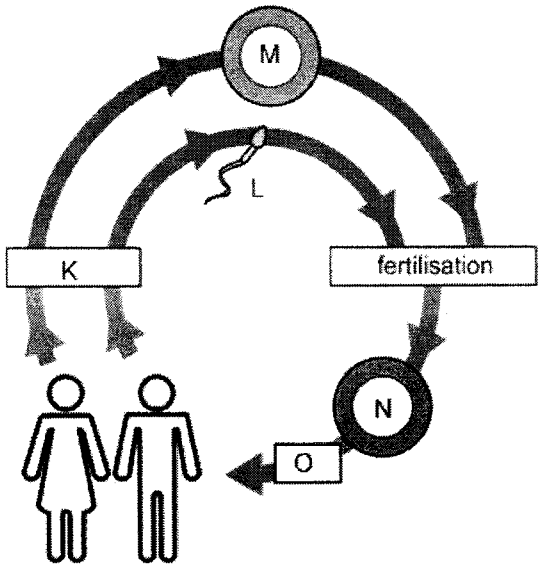

Fig. 11.1

Identify and compare the types of cell division K and O.

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..... [4]

End of paper

[Turn over

2022 Prelim Exam
4EPure Biology
6093

Answer Key
Paper 1

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

Paper 2

No	Answers	Marks
1ai	xylem tissue correctly identified and labelled	1
aii	Magnification = 67/0.08 = x837.5	1
aiii	composed of (a group of) xylem cells with similar structures + working together to perform a specific function;	1
b	• active transport of ions into root hair cell lowers water potential of cell sap/ or ref to concentrated cell sap of root hair cell; • water potential gradient between two solutions described, osmosis; • movement of water molecules from cell to cell (down water potential gradient) to xylem;	1 1 1
2ai	50 cm s^{-1}	1
aii	blood pressure decreases as cross-sectional area increases (in capillaries) ; blood pressure decreases slightly / remains roughly constant / as cross-sectional area decreases (in the veins) ; speed of blood decreases as cross-sectional area increases (in capillaries) ; speed of blood increases as cross-sectional area decreases (in veins / vena cava) ; Quota data	1 1 1 1 (max 2 – must be one on speed and one on pressure)
aiii	aorta higher concentration of oxygen than vena cava ; aorta lower concentration of carbon dioxide than vena cava. aorta lower temperature than vena cava; aorta lower concentration of lactic acid than vena cava.	Any 2 1m each
b	allows only deoxygenated blood to be transported to the lungs allows only oxygenated blood + transported to the rest of the body lower pressure blood + transported to the lungs higher pressure blood + transported to the rest of the body reference to increased efficiency of oxygen transport to body cells reference to increased efficiency of exchange of gases / carbon dioxide / oxygen in the lungs ;	1 1 1 1 (max 2)
3ai	P: 12km/h Q: 10km/h	½ each
aii	trained athlete / P has a higher level of (aerobic) fitness than Q; OR difference in, gender / age / height / mass / lung capacity / lung mass	1
aiii	describe: • when running speed increases from 4 – 12 km h^{-1}, lactic acid concentration increases gradually from 1.8 – 2.1 mmol dm^{-3}; explain: • ref. to low rate of anaerobic of respiration / energy is released by aerobic respiration as oxygen is still available; describe: • when running speed increases from 12 – 19 km h^{-1}, lactic acid concentration increases sharply from 2.1 – 10 mmol dm^{-3}; explain: (max 1) • oxygen demand increases, cells switch to anaerobic respiration to release energy;	1 1 1 1

	• anaerobic respiration produces lactic acid;	
b	cell J has cilia to help sweep the trapped particles up the bronchi and trachea; cell K secretes mucus to trap dust and bacteria;	1 1
ci	• ref. to airways / trachea / bronchi carry less air because the diameter of lumen decreases; smooth muscle contraction in bronchi cause narrowing of airway • inflammation; • thicker layer of mucus; • smoke present in inhaled air (so lower proportion of air);	1 1 1 1 (max 1)
ii	• carbon monoxide (present in smoke) binds to haemoglobin / ref. to carboxyhaemoglobin formed; • ref. to irreversible/ permanent binding; • presence of carbon monoxide lowers affinity of haemoglobin for oxygen; • comparatively less haemoglobin per red blood cell to bind oxygen;	1 1 1 1 (max 2)
4ai	The break in the graph corresponds to the location of the blind spot / region where optic nerve leaves the eye. The blind spot lacks photoreceptors, thus it cannot detect light and provide vision.	1 1
aii	When light enters the eye, it is only focused on one spot of the retina (the fovea) instead of the entire retina.	1
b	When the eye focuses on a distant object, the ciliary muscles relax and pull on the suspensory ligaments. The suspensory ligaments become taut and pull on the lens. The lens become thinner and less convex, increasing its focal length and focussing light rays from the distant object on the retina.	1 1 1
5ai	Allele is the alternate form of the same gene Gene is a unit of inheritance/ small segment of DNA/ sequence of nucleotides that codes for a single polypeptide of a trait (while allele express itself into a particular characteristic.)	1 1
aii	The dominant allele will be expressed in both homozygous or heterozygous condition while the recessive allele will only be expressed in homozygous condition	1 1
b	Pea plant J is Rr	1 – parent genotype 1-offspring genotype
6ai	Discontinuous variation The colour of the wings of butterflies can be grouped into 2 distinct groups without intermediate phenotype.	1 1
aii	Length of wings is controlled by multiple genes while the colour of the wings is controlled by one gene.	1
b	By chance, mutations result in variations in species D some varieties are better adapted to desert conditions than others; The better adapted varieties live longer, reproduce and pass their beneficial genes to their offspring; the less adapted varieties die off	1 1

	Many rounds of mutations and natural selections result in accumulation of many beneficial genes cumulative effect over many generations lead to a change in appearance in species D, thus forming new species E.	1
7a	Show 4 squares + Label carnivore	1
b	Only 10 % of energy is transferred across trophic levels 90% is lost as heat during respiration/uneaten parts/faeces and excretory products, therefore insufficient energy available to support more than 5 trophic levels	1 1
c	Pyramid of numbers does not account for the size of the organism	1
8a	urea concentration decreases as the blood entering the dialysis machine contains a higher concentration of urea than the dialysis fluid/ dialysis fluid does not contain any urea; urea molecule diffuses out of the blood into the dialysis fluid down a concentration gradient; salt concentration decreases/ water content +could be increases / decreases/ glucose concentration could be increases / decreases / stays the same	1 1
bi	no need to go to clinic / hospital regularly ; increased freedom / better quality of life; a disadvantage of dialysis: pain / tiring / discomfort / time-consuming / can have wider diet; reference to cost or economic benefit to health service / individual ;	Max 1
bii	Recipients white blood cells will not produce antibodies to attack/ or engulf and ingest the transplanted organ	1
9a	- labelled axes with correct units with suitable scale - accurate plotting of points for both graphs (1m for each graph) - lines drawn/ join the points for both graphs	4
b	1600 At 1600, light intensity is 100%, stomata are widely open, causing maximum water transpiration. Rate of water absorption also increases to the maximum to replace the amount of water loss. At the same time at high light intensity, the rate of water absorption increases as the photosynthetic rate of plant increases.	1 1 1 1
c	No. Rate of transpiration is higher than rate of absorption between 6.48am to 7.48pm / for a long period of time / for most hours in the day, causing plant to wilt.	1
d	Decrease rate of transpiration and water absorption Increase humidity as water vapour are trapped in the polyethene bag, reduce the water vapour concentration gradient between the air spaces and the surrounding	1 1 1
10a	It is the feeding position of an organism in a food chain.	1
b	• animals at higher trophic levels consume more animals below them in the food chain due to inefficient flow of energy in food chain/ to obtain enough energy to survive	1

	• chemical X cannot be excreted/ removed / broken down/non-biodegradable • bioaccumulation (relating to individual organism and including the keyword and include description: build up / increase in concentration in the tissues) /bioamplification (including the keyword and relating to effects of increasing concentration along the food chain)	1 1
c	• dead fishes result in large amount of organic matter available • decomposition by bacteria • Increase in bacteria population + increase rate of aerobic respiration + decreases concentration of dissolved oxygen	1 1 1
d	Mutation resulted in a different protein molecule produced	1
11a(E)	Temperature drops, arterioles constricting; less blood flow to blood capillaries in skin; reduce blood flow to the skin to prevent heat loss; oxygen supply to skin reduced, ice crystals in spaces around the cells; cause cell death and destruction of cells in fingers and toes;	1 1 1 1 1 (max 4)
b	The presence of villi, a finger-like projections on the (inner) surface of the small intestine increases the surface area to volume ratio for a faster rate of absorption This surface area to volume ratio is further increased with the presence of microvilli on the epithelium of the villus, resulting in a faster rate of absorption. The wall of the villus is one-cell thick, reducing the diffusion distance allowing for a faster rate of diffusion of Aspirin into the bloodstream. Many blood capillaries are present in a villus to help carry away absorbed aspirin to maintain a steep concentration gradient for a faster rate of diffusion.	1 1 1 1 1 1 1 1 (max 6)
11a (O)	[duration] each menstrual cycle lasts about 28 days, involving 4 major phases, menstruation, repair of uterine lining, ovulation, preparation of lining for implantation [menstruation phase] during menstruation, which is between day 1 to 5, the uterine lining breaks down and discharged from the body. This is due to the low level of progesterone and oestrogen. (As the uterine lining is discharged, follicles are maturing in the ovary, resulting in the formation of mature follicle) [repair phase] the follicles produce oestrogen and the levels of oestrogen in the blood increases to repair the uterine lining [ovulation phase] high levels of oestrogen stimulates ovulation at about day 14, (in which an ovum is released into the oviduct.) [preparation of lining - ovary] the remains of mature follicles form corpus luteum which produces progesterone and some oestrogen to thicken the uterine lining [preparation of lining] Without fertilisation, corpus luteum disintegrates, levels of progesterone and oestrogen decreases and the uterine lining gets broken down, the cycle repeats.	1 1 1 1 1 1 1
b	K – meiosis and O - mitosis **Meiosis** | **Mitosis**	1

	chromosome + number halved / 46 to 23 / diploid to haploid (reduction division)	chromosome + number maintained / 46 to 46/ diploid to diploid	1m each, max 3
	genetically different, 4 daughter cells	genetically identical, 2 daughter cells	
	Involves crossing over	No crossing over	
	takes place in testes / ovaries / gonads – for reproduction	takes place in all parts of the body except the gonads – for growth	
	2 nuclear divisions	1 nuclear dvision	