SINGAPORE SPORTS SCHOOL
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SINGAPORE SPORTS SCHOOL
PRELIMINARY EXAMINATION 2021
SECONDARY 4
EXPRESS

CANDIDATE NAME

CLASS

INDEX NUMBER

BIOLOGY

6093/01

Paper 1 Multiple Choice

30 August 2021

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in soft pencil.
Do not use staples, paper clips, highlighters, 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 **soft pencil** on the separate Answer Sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculated is expected, where appropriate.

This document consists of **24** printed pages

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1 The electron micrograph shows part of a plant cell.



Which combination correctly identifies the functions of the labelled cell structures?

	P	Q	R	S
A	Controls movement of substances into and out of the cells	Contains organelles	Site of aerobic respiration	Controls activities of the cell
B	Controls movement of substances into and out of the cells	Contains cell sap	Site of photosynthesis	Controls activities of the cell
C	Provides structural support to the cell	Contains organelles	Site of aerobic respiration	Site of ribosome synthesis
D	Provides structural support to the cell	Contains cell sap	Site of photosynthesis	Site of ribosome synthesis

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2 An amino acid enters a cell and is then used to synthesise an enzyme secreted by the cell.

What is the sequence of cell structures involved in the synthesis of the enzyme?

	first → last			
A	endoplasmic reticulum	Golgi apparatus	ribosome	vesicle
B	endoplasmic reticulum	ribosome	Golgi apparatus	cell membrane
C	ribosome	endoplasmic reticulum	Golgi apparatus	vesicle
D	ribosome	Golgi apparatus	endoplasmic reticulum	cell membrane

3 A student took a potato and cut three pieces from it.

Each piece is 5 cm X 0.5 cm X 0.5 cm.

He placed the three potato pieces into three different concentrations of sucrose solution. After two hours, he removed the potato pieces from the sucrose solutions and measured their lengths.

The results are shown in the table.

solution	**length of potato piece after two hours/ cm**
X	5.2
Y	4.7
Z	5.3

What can be concluded from these results?

A Solution **Y** had a lower water potential than the potato cells.

B Solution **Z** had the lowest water potential.

C The potato piece in solution **X** increased in length because sucrose diffused into the potato.

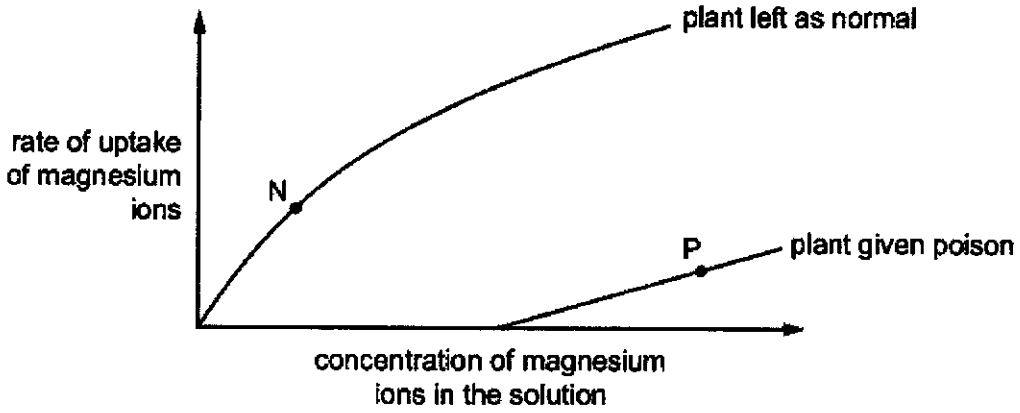
D The potato piece in solution **Y** decreased in length because sucrose diffused out of the potato.

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4 An experiment measured the rate at which plants take up magnesium ions from solution.

One plant was given a poison that stops respiration. Another plant was left as normal. The graph shows the results.



How are the magnesium ions being absorbed by the plants at points **N** and **P**?

	point **N**	point **P**
A	active transport	active transport
B	active transport	diffusion
C	diffusion	active transport
D	diffusion	diffusion

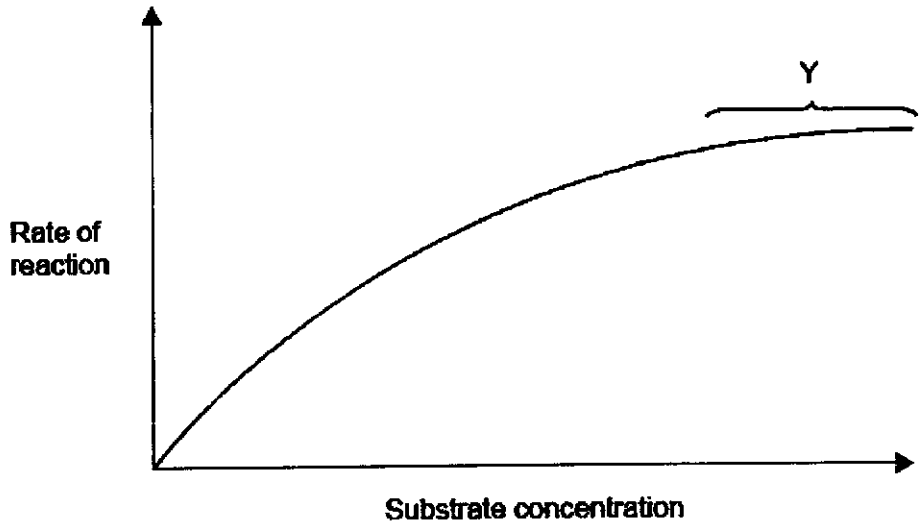
5 A solution of amylase was added to a suspension of starch. After 30 seconds, three samples of the mixture were tested with iodine solution, Benedict's solution or with biuret reagent.

Which are the expected results?

	Colour of test reagent		
	Iodine solution	**Benedict's solution**	**Biuret reagent**
A	blue-black solution	green precipitate formed	purple solution
B	blue-black solution	red precipitate formed	blue solution
C	brown solution	blue solution	purple solution
D	brown solution	yellow precipitate formed	blue solution

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6 The graph shows the effect of increasing the substrate concentration on the rate of an enzyme-catalysed reaction. What is occurring during the phase indicated by section Y of the graph?



A The concentration of enzymes becomes limiting.

B The enzyme becomes denatured.

C The substrate concentration is limiting.

D The rate of reaction is decreasing.

7 Four test tubes are set up in the following manner.

Test tube	Volume of hydrochloric acid/ cm^3	Volume of egg-white suspension/ cm^3	Volume of distilled water/ cm^3	Volume of boiled pepsin/ cm^3	Volume of pepsin/ cm^3
1	2.0	5.0	1.0	0.0	0.0
2	2.0	5.0	0.0	1.0	0.0
3	2.0	5.0	0.0	0.0	1.0
4	0.0	5.0	0.0	0.0	1.0

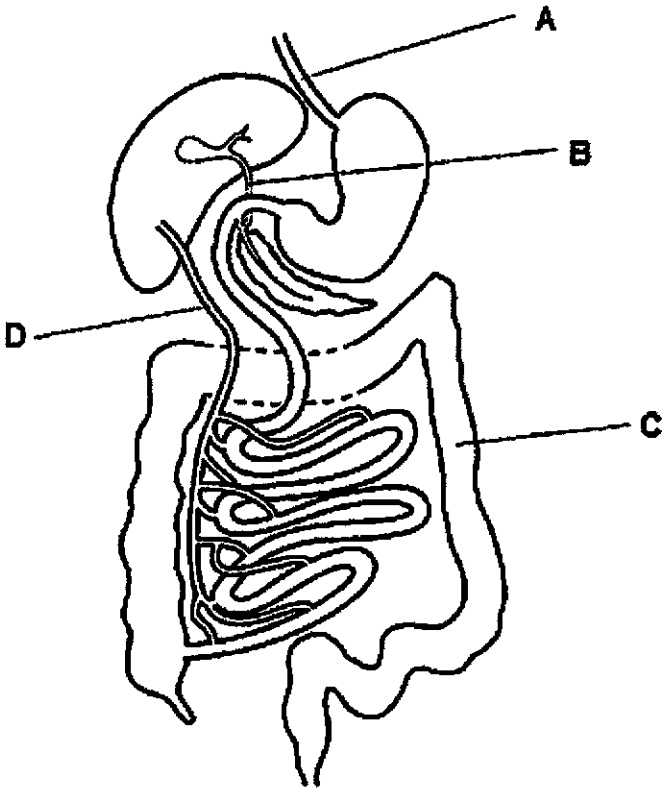
All four test tubes are then placed in a water bath at 37 °C for 20 minutes. What is the result?

	test tube			
	1	**2**	**3**	**4**
A	clear	clear	clear	clear
B	clear	cloudy	cloudy	clear
C	cloudy	cloudy	clear	cloudy
D	cloudy	clear	cloudy	clear

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8 The diagram shows part of the alimentary canal and associated organs.



Which of the structures, when blocked, will slow down fat digestion?

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9 The fungus *Rhytisma* grows on the leaves of certain trees, causing a yellow leaf area in which chlorophyll is no longer present. A black, tar-like stain later spreads out.



[Source: © International Baccalaureate Organization 2017]

What happens in the leaf when *Rhytisma* is present?

I. An increase in the production of carbon dioxide

II. A reduction in the production of oxygen

III. An increase in the loss of water

A I only

B II only

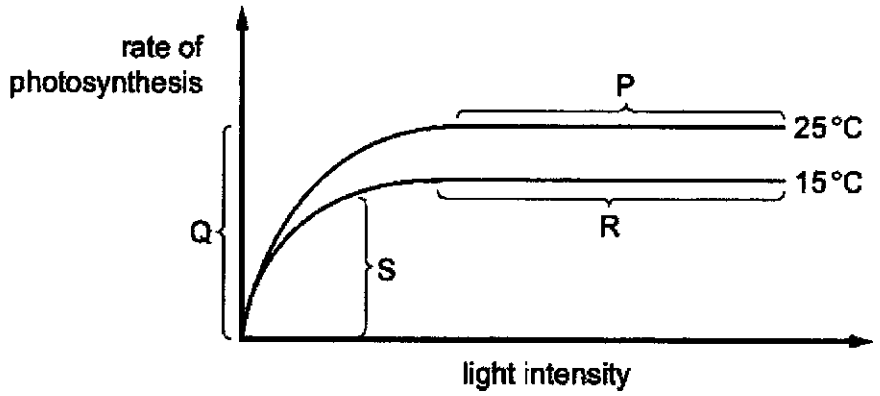
C II and III only

D I, II and III

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10 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?

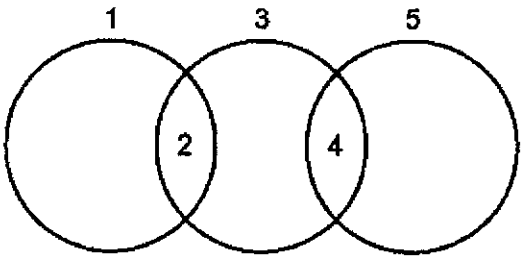
A P and R

B Q and S

C R and Q

D S and P

11 The diagram shows the relationship between phloem sieve tube elements, xylem vessel elements and companion cells.

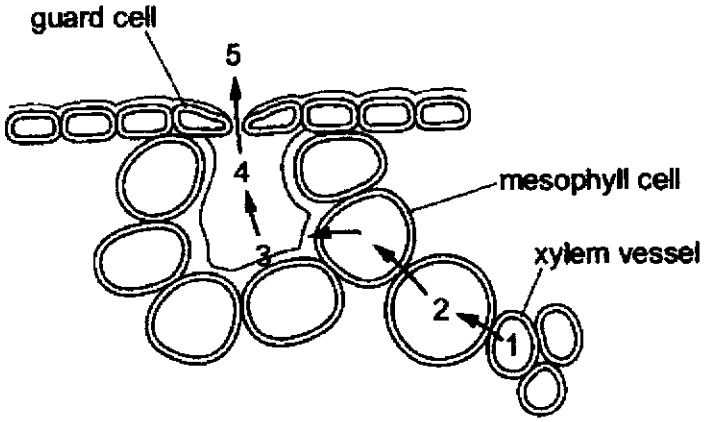


Which row is correct?

	1	2	3	4	5
A	companion cells	cytoplasm	phloem sieve tube elements	no nucleus	xylem vessels
B	companion cells	nucleus	phloem sieve tube elements	cytoplasm	xylem vessels
C	phloem sieve tube elements	mitochondria	companion cells	nucleus	xylem vessels
D	xylem vessel elements	no cytoplasm	phloem sieve tube elements	vacuole	companion cells

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12 The diagram shows the movement of water through part of a leaf.



Which processes are involved in the movement of water at these stages?

	1-2	3-4	4-5
A	diffusion	evaporation	osmosis
B	evaporation	diffusion	osmosis
C	osmosis	diffusion	evaporation
D	osmosis	evaporation	diffusion

13 Blood samples from three veins in the body were tested for the concentration of oxygen, carbon dioxide and urea. The results, in arbitrary units, are shown in the table below.

vein	oxygen concentration/ arbitrary units	carbon dioxide concentration/ arbitrary units	urea concentration / arbitrary units
1	40	48	1.5
2	40	48	7.5
3	90	40	4.0

Which of the following shows the correct veins that were tested?

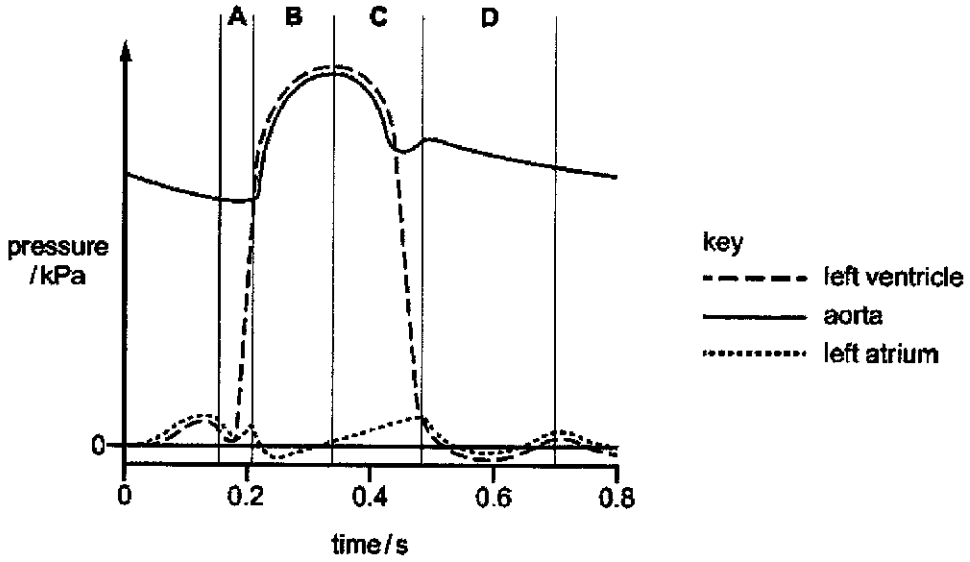
	hepatic vein	pulmonary vein	renal vein
A	1	3	2
B	2	3	1
C	3	1	2
D	3	2	1

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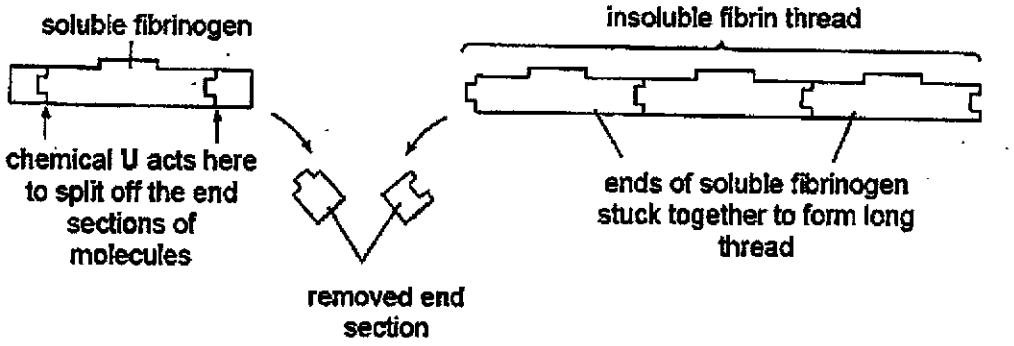
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14 The diagram shows the pressure changes in various structures of the left side of the heart during the cardiac cycle.

At the end of which period is the ventricle full of blood?



15 The diagram illustrates the formation of long insoluble fibrin threads during the clotting of blood at a cut in the skin.



Person **V** is unable to produce chemical **U**. What is a possible effect of person **V**'s condition?

A **V** will lose more blood than a normal person when injured.

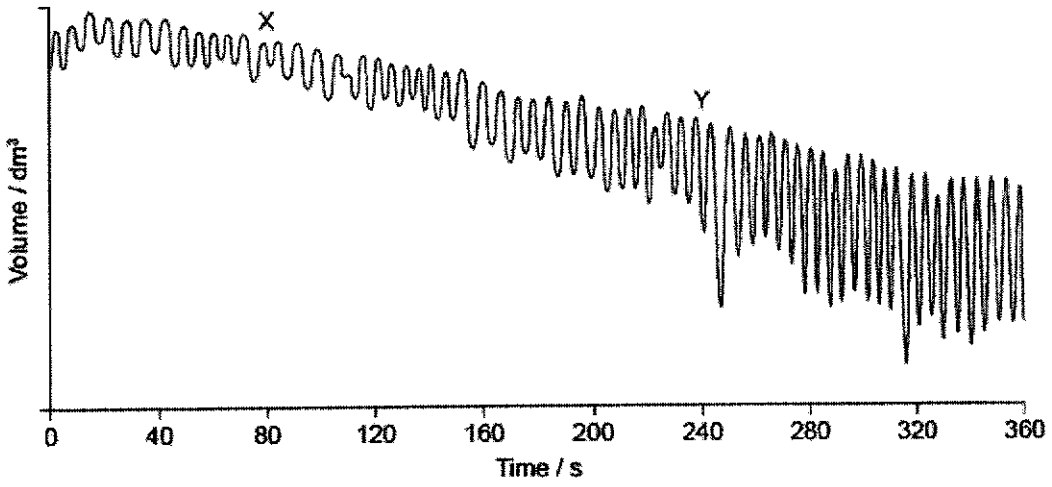
B **V** has a greater likelihood of suffering from blood clots in blood vessels.

C **V**'s platelets will not function properly.

D **V** will suffer from fainting spells because of high blood pressure.

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16 The graph shows a spirometer trace of oxygen consumption when breathing at rest and during exercise.



What explains the difference between the traces at regions **X** and **Y** on the graph?

A At **X**, the internal intercostal muscles contract more than the external intercostal muscles.

B At **Y**, the ribcage moves up and out more than at **X**.

C At **X**, the diaphragm flattens more per breath than at **Y**.

D At **Y**, the intercostal muscles contract more slowly than at **X**.

17 Which row show the change in concentrations of some substances in red blood cells when carbon dioxide diffuses from active cells?

	carbonic anhydrase	**hydrogencarbonate ions**
A	decreases	no change
B	increases	increases
C	no change	decreases
D	no change	increases

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18 Which of these statements describes control by **negative** feedback?

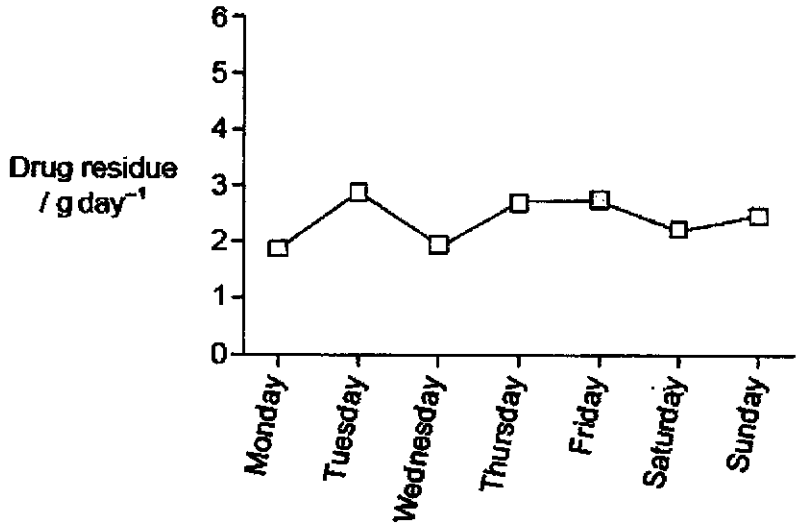
A An injury to body tissue activates platelets in the blood and these activated platelets release chemicals which activate more platelets.

B During the menstrual cycle, luteinising hormone (LH) stimulates the release of oestrogen which in turn stimulates the release of more LH.

C A higher concentration of carbon dioxide in the atmosphere increases temperature, which increases photosynthesis producing more carbon dioxide.

D When blood pressure is high, nerve impulses from the brain cause the blood vessels to dilate and blood pressure is reduced.

19 The graph shows the daily amount of the residue of a drug in the wastewater of a hospital.



What can be deduced from these data?

A The drug is not fully reabsorbed by the proximal convoluted tubules.

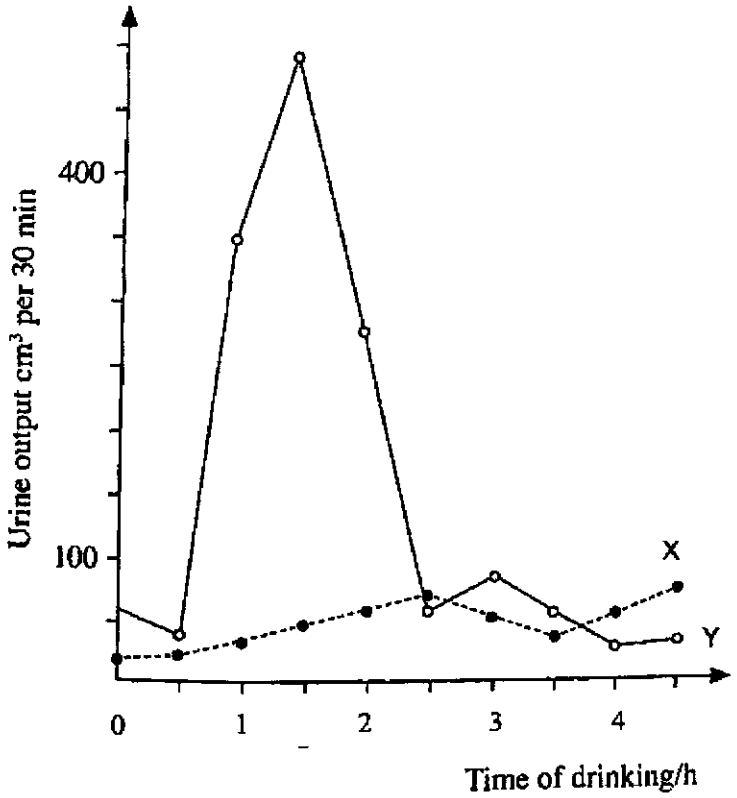
B The glomeruli are not permeable to the drug.

C The collecting ducts reabsorb all of the drug.

D The drug is catabolized by the liver.

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20 The graph below shows the effects of drinking 1 litre of water and 1 litre of concentrated salt water on the urine output of a healthy person.



Which option correctly identifies each line and the explanation for it?

	water	concentrated salt water	explanation
A	Y	X	intake of water causes more ADH to be produced
B	Y	X	intake of water causes less ADH to be produced
C	X	Y	intake of salt water causes more ADH to be produced
D	X	Y	intake of salt water causes less ADH to be produced

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21 Sciatica occurs when the narrowing of the spine compresses part of the sciatic nerve. This can result in

- loss of feeling in the affected leg
- weakness in the affected leg
- loss of bowel or bladder function

What conclusion can be made?

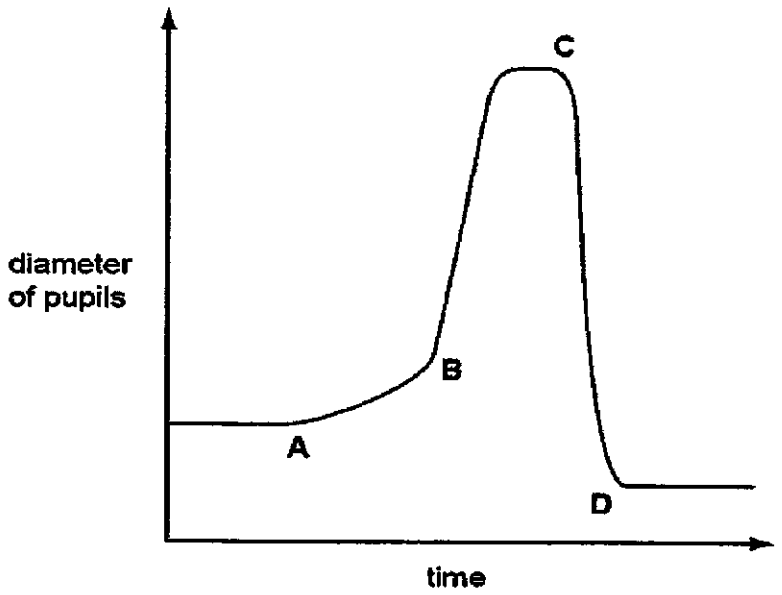
A The sciatic nerve contains only sensory neurones.

B The sciatic nerve contains only motor neurones.

C The sciatic nerve contains both sensory neurones and motor neurones.

D The sciatic nerve contains sensory, relay and motor neurones.

22 The graph shows changes in the diameter of a person's pupils while outdoors on a sunny day. At which time did the person take off a pair of sunglasses?



23 The liver and the pancreas work together to control the concentration of glucose in the blood.

Which statement is correct?

A The liver converts the small molecule glucose to the large molecule glucagon.

B The liver releases the hormone insulin when blood glucose levels are too high.

C The pancreas does not respond to an increase in blood glucose levels.

D The pancreas responds to a fall in blood glucose by increasing the release of the hormone glucagon.

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24 A number of new plants are growing from pieces of a plant that have become detached and have rooted in soil.

Which statement is correct about these new plants when they mature?

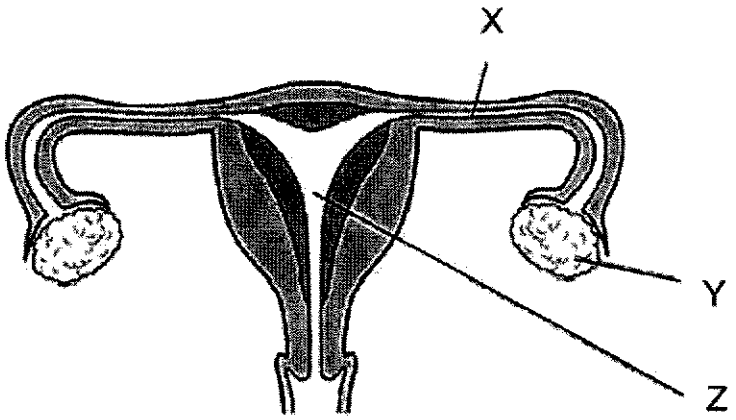
A The fruit they produce will all ripen at the same time.

B They will all grow to the same size.

C They will all have the same colour flowers.

D They will all produce the same number of fruit.

25 The diagram shows a cross-section of a female reproductive system.



In which organ(s) does/do mitosis occur if the lady is pregnant?

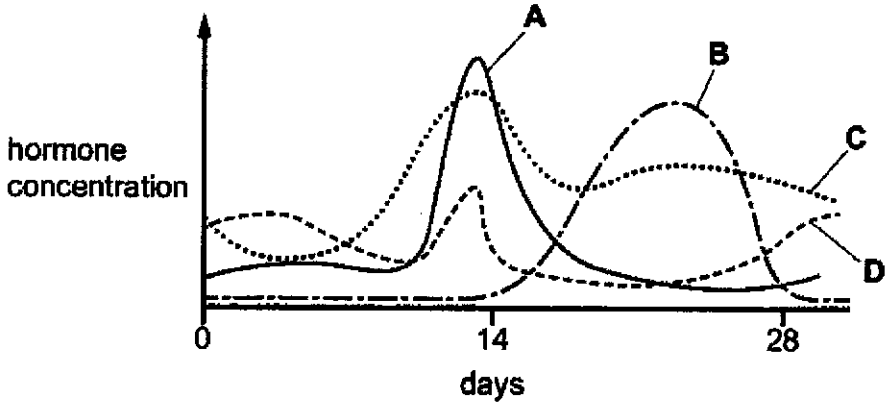
	X	Y	Z
A	no	no	yes
B	no	yes	yes
C	yes	yes	no
D	yes	no	yes

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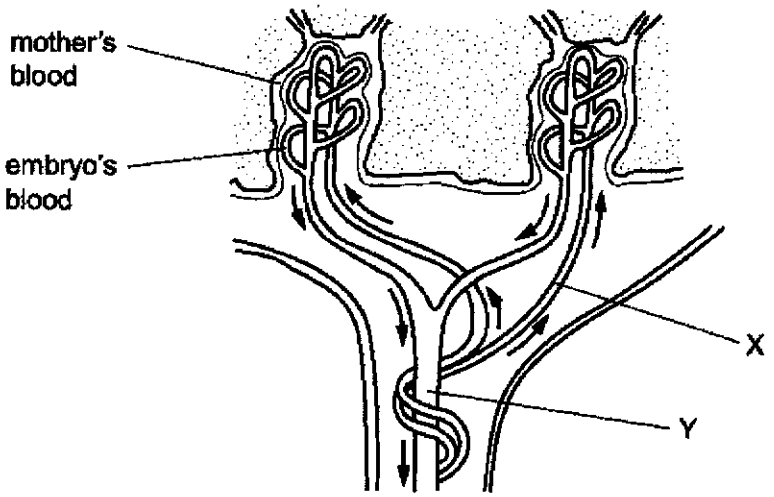
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26 The graph shows changes in the concentrations of hormones during a menstrual cycle.

Which curve represents oestrogen?



27 The diagram shows how the blood of a human embryo flows close to the mother's blood in the placenta.



Which substances are present at X in higher concentrations than at Y?

A carbon dioxide and glucose

B carbon dioxide and urea

C glucose and oxygen

D glucose and urea

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28 The photomicrograph shows a cell during mitosis.



What is happening in this cell?

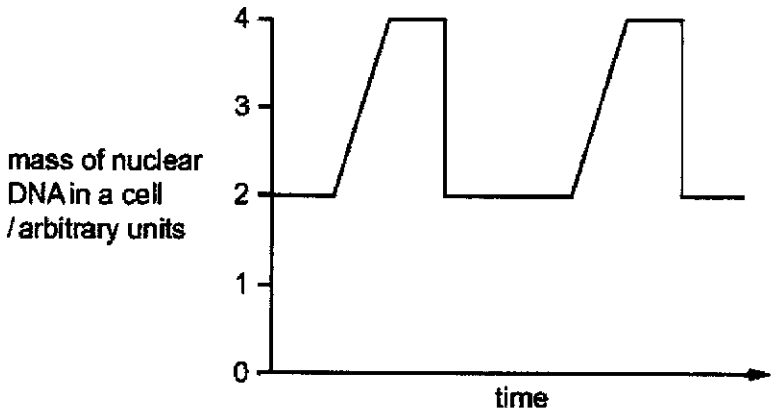
1 Centrioles are replicating.
2 Spindle microtubules are shortening.
3 Chromatin is condensing.

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

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29 Which processes that occur in cell division are represented in the diagram?



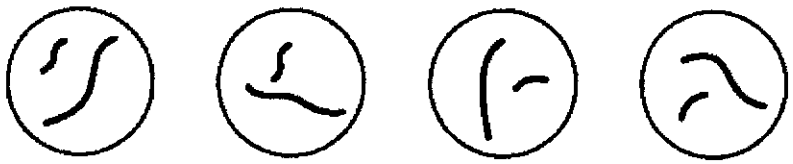
A DNA replication and mitosis only

B DNA replication and meiosis only

C DNA replication, mitosis and cytokinesis

D meiosis only

30 The diagram shows the chromosomes of four daughter cells produced by meiosis.



Which parent cell produced these cells?

A



B



C



D

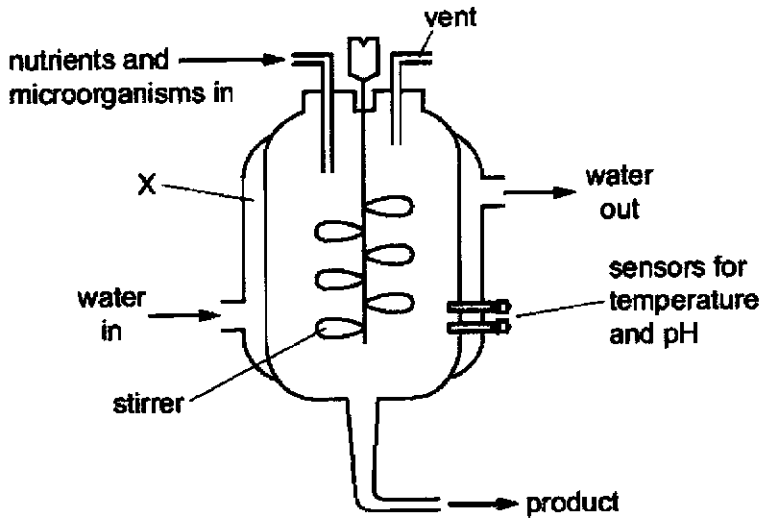


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31 Which row describes what happens in the production of proteins?

	What forms the genetic code	What the DNA codes for	What carries a copy of the gene to the cytoplasm
A	Sequence of amino acids	Sequence of bases	mRNA
B	Sequence of amino acids	Sequence of proteins	Ribosomes
C	Sequence of bases	Sequence of amino acids	mRNA
D	Sequence of bases	Sequence of proteins	Ribosomes

32 The diagram shows the equipment used in the industrial production of insulin.



What is the purpose of the structure labelled **X**?

A to insulate the fermentation vessel

B to maintain the pressure of the fermentation vessel

C to monitor the temperature of the fermentation vessel

D to remove the heat produced by the fermentation process

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33 A farmer uses sperm from a black male sheep to artificially inseminate (fertilise) 20 light brown female sheep.

All of the offspring produced were black.

Which statement explains these results?

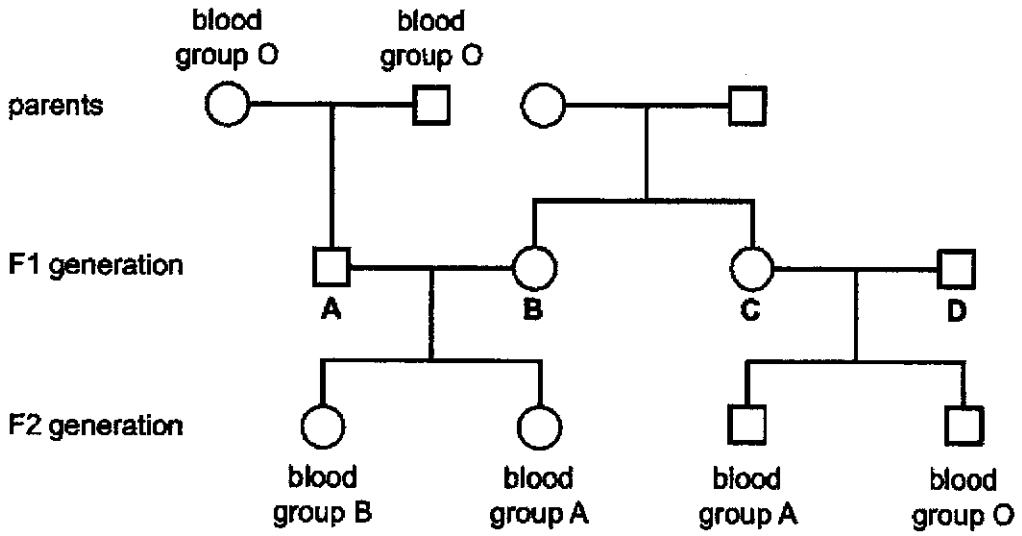
A The alleles for light brown colour are dominant.

B The male sheep is heterozygous and the allele for black colour is dominant.

C The male sheep is homozygous and the allele for black colour is codominant.

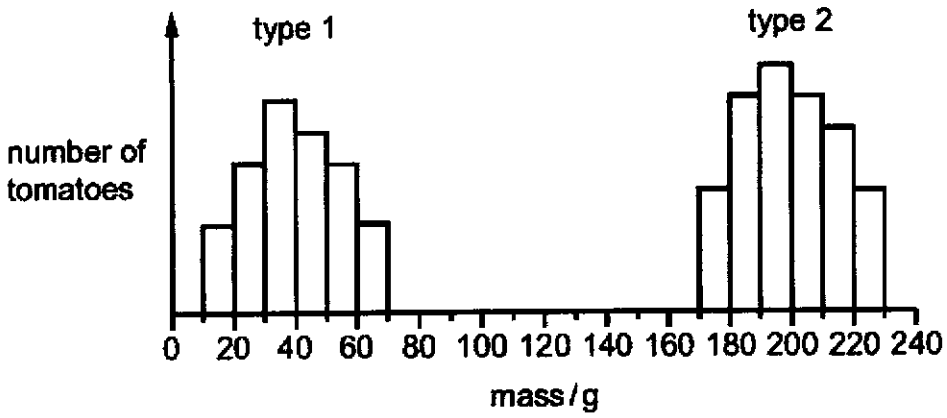
D The male sheep is homozygous and the allele for black colour is dominant.

34 The diagram shows the blood group phenotypes of some members of a family.
Which member of the F1 generation must have the AB blood group?



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35 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.

36 A farmer wants to produce extra-large, sweet oranges, by selective breeding.

Using information from the table, which plant types should the farmer select for breeding?

plant type	size of orange / cm			percentage sugar content	
	6–9	9–12	12–15	10	20
1		✗		✗	
2			✗	✗	
3	✗				✗
4		✗			✗
5	✗			✗	

A 1 and 2

B 1 and 3

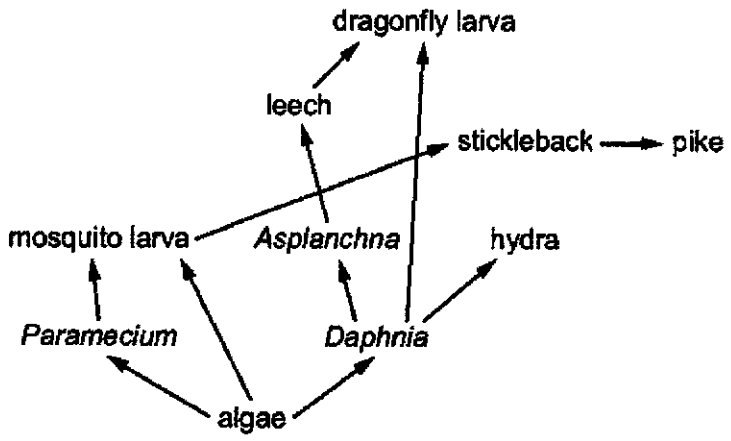
C 2 and 4

D 4 and 5

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37 The diagram shows a food web of organisms found in a pond.



Which organism is both a primary consumer and a secondary consumer?

A algae

B dragonfly larva

C mosquito larva

D *Paramecium*

38 The concentrations of a persistent pesticide in the tissues of four organisms were measured. These organisms are part of a food web. The table below shows the results.

organism	concentrations of insecticides (parts per million)
P	120
Q	1800
R	1400
S	410

Which of the following shows the energy flow between these organisms?

A P → S → R → Q

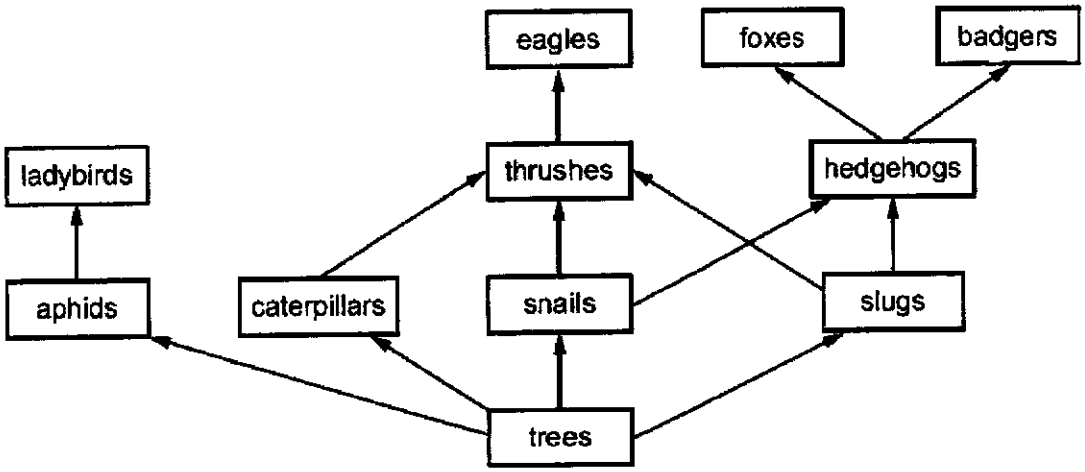
B P → R → S → Q

C Q → P → S → R

D Q → R → S → P

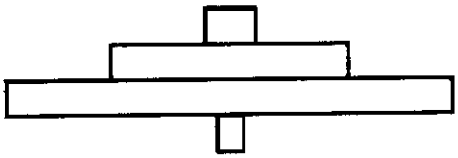
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39 The diagram shows part of a food web.



Which pyramid of numbers is based on this food web?

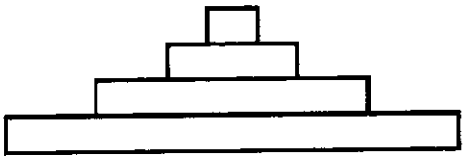
A



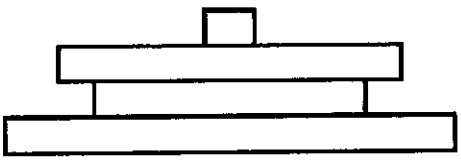
B



C



D

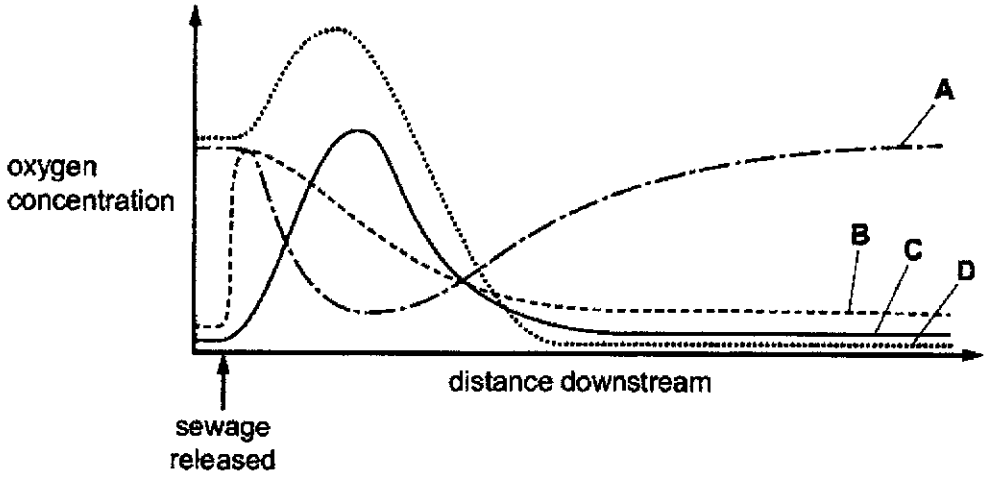


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40 Sewage is released into a river.

Which curve represents the oxygen concentration in the river?



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PRELIMINARY EXAMINATION 2021
SECONDARY 4
EXPRESS

CANDIDATE NAME

CLASS

INDEX NUMBER

BIOLOGY

6093/02

Paper 2

27 August 2021

1 hour 45 minutes

Candidates answer on the Question Booklet.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in a dark blue or black pen.
You may use a soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A

Answer **ALL** questions.
Write your answers in the spaces provided on the Question Paper.

Section B

Answer **all** the questions, the last question is in the form **Either/Or**.
Write your answers in the spaces provided on the Question Paper.

Electronic calculators may be used.

You are advised to spend no longer than one hour on Section A and no longer than 45 minutes on Section B.

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

For Examiner's Use	
Section A	
Section B	
Total	80

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Section A

Answer **all** questions

Write your answers in the spaces provided.

1 A seal is a mammal that spends most of its time in the sea. It breathes and respires in a very similar way to a human, but when it dives to hunt and catch fish, it is capable of staying under water for up to 20 minutes.

Fig. 1.1 shows the percentage concentrations of oxygen and carbon dioxide, and the concentration of lactic acid in a seal's blood over a 40-minute period during which it dives to hunt and catch fish.

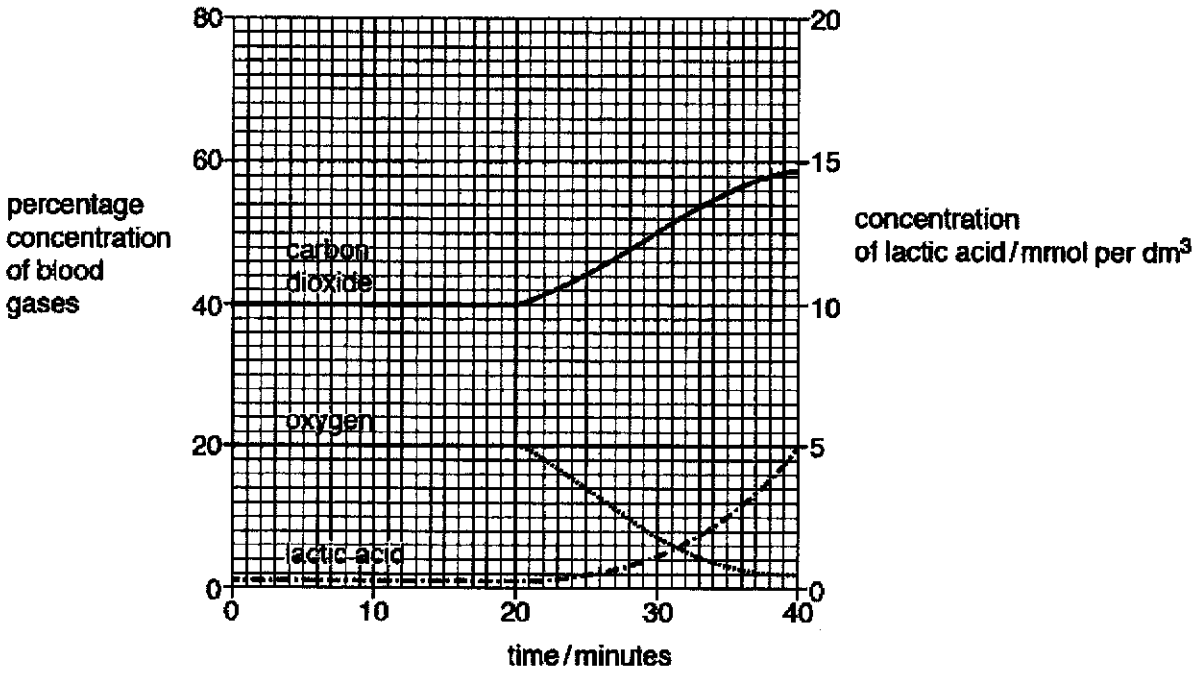


Fig. 1.1

(a) (i) State how long after the start of the time period the seal begins its dive. **[1]**

.....

.....

(ii) State the percentage of oxygen in the seal's blood 40 minutes after the start of the time period. **[1]**

.....

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(b) Name the chemical process which starts to take place in the seal's muscles during its dive and explain how the graph supports your answer. **[3]**

process .....

explanation .....

.....

.....

(c) Suggest and explain what would happen to the concentration of lactic acid in the seal's blood when it returns to the surface of the sea after its dive. **[3]**

.....

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[Total: 8]

2 The concentration of a person's urine can vary according to their diet.

(a) Explain how changes in a person's protein intake can affect the concentration of their urine. **[3]**

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(b) An investigation was carried out into the effect of different drinks on the rate of production of urine. Three students each took 1.5 dm^3 of a different drink **A**, **B** or **C**.
Fig. 2.1 shows the volume of urine released by each student over the next two and a half hours.

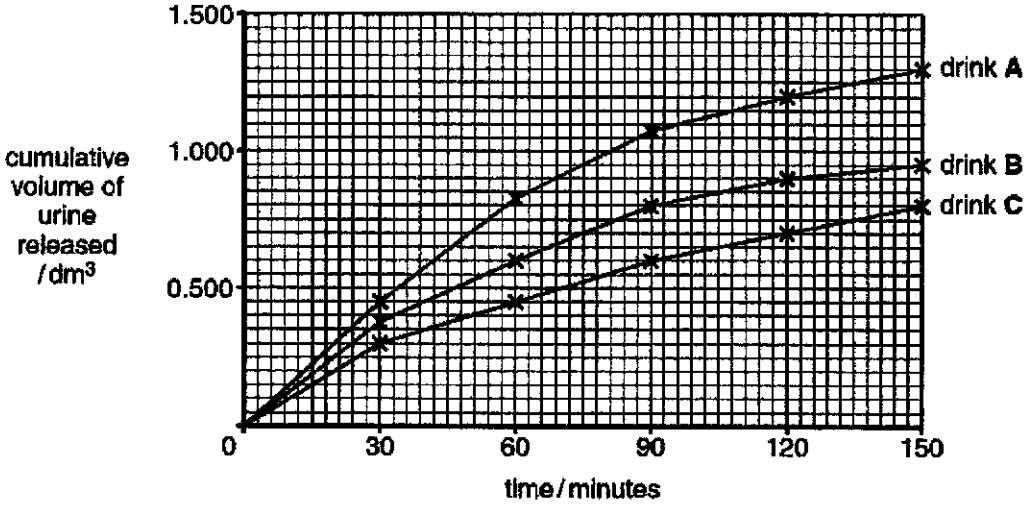


Fig. 2.1

Suggest which of the three drinks would be better to avoid on a very hot day. Give an explanation for your answer.

drink ..... **[1]**

explanation **[2]**

.....

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.....

.....

[Total: 6]

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3 **(a)** Table 3 shows how the thickness of the lens of the eye changes when focussing on an object at different distances from the front of the eye.

Table 3

distance from eye/ cm	thickness of lens/ mm
10	4.0
20	3.6
30	3.2
50	2.9
100	2.7
150	2.6
200	2.6

Describe the pattern shown by the data in Table 3. **[2]**

.....

.....

.....

(b) Explain how **named** components of the eye change the thickness of the lens when focusing on an object as it moves further from the front of the eye. **[3]**

.....

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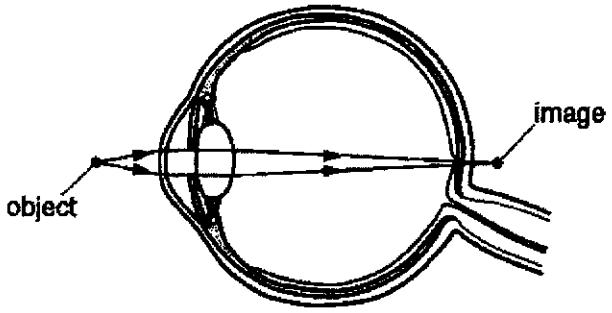
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(c) As a person becomes older, the lens of the eye becomes harder and less elastic. This results in the person seeing an image of a close object that is out of focus.



With reference to the curvature of the lens, suggest why this older person sees an image of a close object as out of focus. **[1]**

.....

.....

[Total: 6]

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4 Fig. 4.1 shows the rates of water loss for three plants, **D**, **E** and **F**, during the first 14 minutes of an experiment. The plants are of different species and are growing in identical conditions.

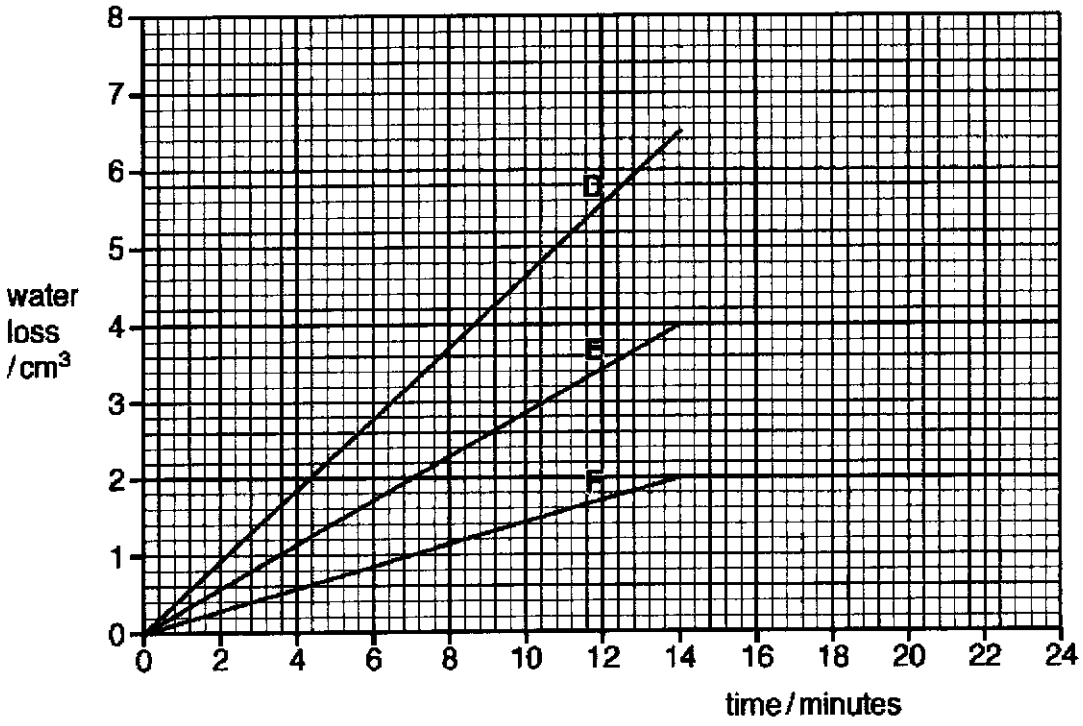


Fig. 4.1

(a) Name the process by which plants lose water to the atmosphere. **[1]**

.....

(b) Suggest **two** reasons for the differences in rates of water loss shown by the three plant species. **[2]**

.....

.....

(c) In the experiment, after 14 minutes, air is blown across plant **E** for 2 minutes and a black bag is placed over plant **F** for the remaining 10 minutes.

(i) Continue the lines on the graph in Fig. 4.1 to show what would happen to the rates of water loss for plants **E** and **F**. **[2]**

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(ii) Explain the shape of each line you have drawn. **[4]**

plant **E**

.....

.....

.....

plant **F**

.....

.....

.....

[Total: 9]

5 **(a)** DNA is the hereditary material of most organisms.

(i) Define each of the following terms related to hereditary materials: **[2]**

gene

.....

.....

dominant allele

.....

.....

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(ii) Some people find that certain vegetables, such as Brussels sprouts, taste bitter and are unpleasant to eat. Scientists believe that one dominant allele (**T**) of a particular gene gives people the ability to detect the bitter taste.

Two parents find that Brussels sprouts taste bitter. In the space below, draw a genetic diagram to show how these parents can have a child who does **not** find that Brussels sprouts taste bitter. **[3]**

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(b) Some organisms such as viruses use RNA as their genetic material.

Fig. 5.1 is a diagram of a nucleotide of RNA.

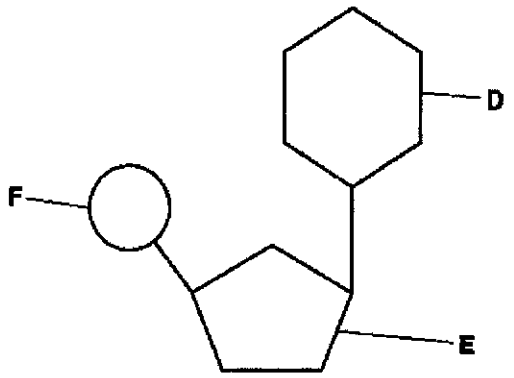


Fig. 5.1

(i) Identify **D**, **E** and **F** in Fig. 5.1. **[2]**

D .....

E .....

F .....

(ii) State **one** way in which the structure of DNA differs from the structure of RNA. **[1]**

.....

.....

[Total: 8]

6 **(a)** Meiosis is one process that contributes to genetic variation.
Describe how events in prophase I of meiosis leads to genetic variation. **[2]**

.....

.....

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(b) Fig. 6.1 shows a species of tree frog.



Fig. 6.1

Each tree frog of this species is either **grey** or **green** in colour.
The following are true for **both** grey and green tree frogs. They:

- eat insects
- live above the ground in vegetation
- live near water and lay their eggs in small pools
- are sometimes eaten by snakes and birds.

Grey tree frogs are more commonly found in areas where there are many trees with grey bark.
Green tree frogs are more commonly found in areas where there are many swamp and marsh plants with green leaves.

(i) State the type of variation shown by the colour of these tree frogs. **[1]**

.....

(ii) Use your knowledge of the process of natural selection to explain the distribution of grey and green tree frogs in different areas. **[4]**

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[Total: 7]

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7 Fig. 7.1 shows a pyramid of biomass and part of the carbon cycle.

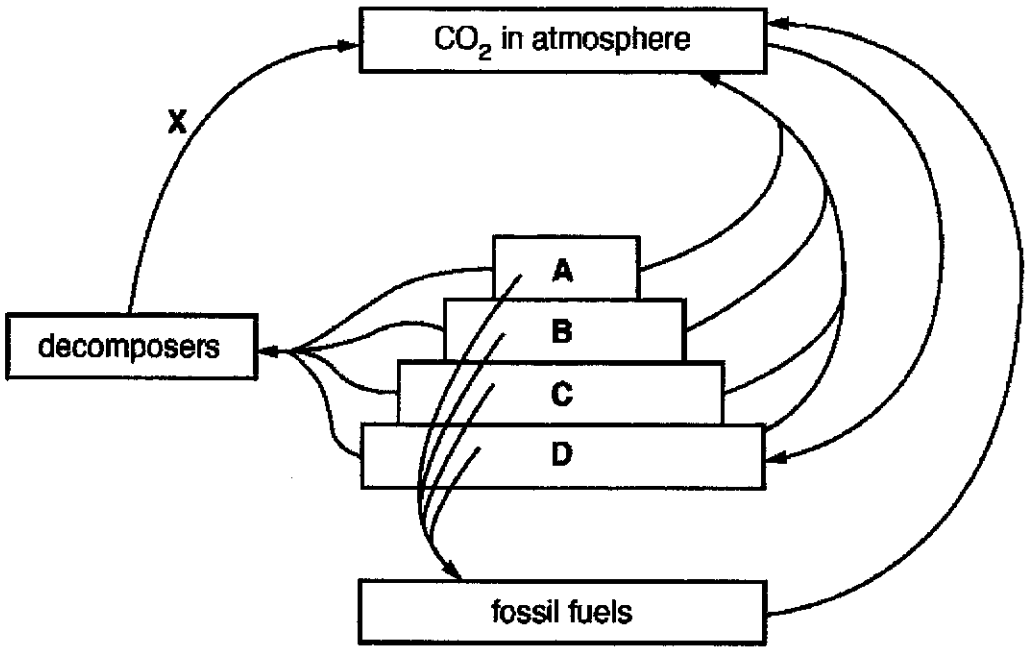


Fig. 7.1

(a) State the letter that represents the primary consumers in Fig. 7.1 and its trophic level. **[1]**

.....

(b) State how carbon is transferred from producers to primary consumers. **[1]**

.....

(c) Explain why trophic level **A** is smaller than trophic level **B** in the pyramid of biomass in Fig. 7.1. **[3]**

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(d) Arrow **X** on Fig. 7.1 indicates the transfer of carbon from decomposers to the atmosphere. State the name of process **X**. **[1]**

.....

[Total: 6]

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Section B

Answer **three** questions.

Question 10 is in the form of an **Either/Or** question.

Only one part should be answered.

8 **(a)** Laboratory experiments were carried out to investigate the effect of day length on the rate of photosynthesis in a photosynthetic marine organism, *Zostera marina.*

- The temperature was controlled at 4 °C.
- A low concentration of carbon dioxide dissolved in the water was used.
- The light exposure period (day length) was different for five groups of *Z. marina.*
- This was maintained for 10 days to allow *Z. marina* to adapt to these conditions.
- After 10 days, the rate of photosynthesis was measured for each group under the **same** controlled conditions.
- The experiment was repeated using five groups of *Z. marina* with a high concentration of carbon dioxide dissolved in water.

Table 8 shows the rate of photosynthesis for each group.

Table 8

Day length/ hours	**rate of photosynthesis/ arbitrary units**	
	low carbon dioxide	**high carbon dioxide**
12	2.0	2.5
14	3.0	5.0
16	4.0	7.0
18	5.5	11.0
20	7.5	18.0

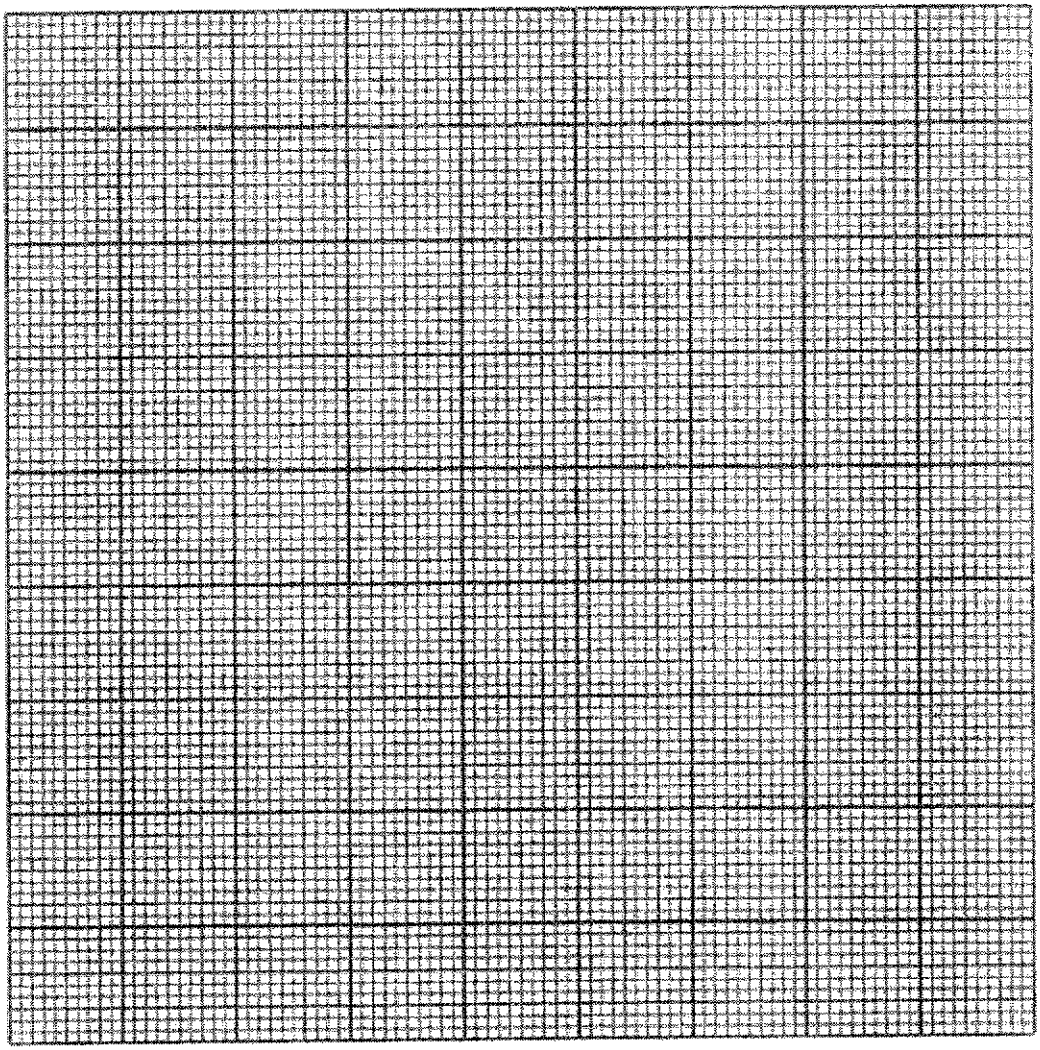
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(i) Using the data from Table 8, plot the line graphs on the grid given below. Draw lines of best fit. **[4]**



(ii) With reference to Table 8, explain the difference in the rate of photosynthesis at high carbon dioxide concentration compared to low carbon dioxide concentration. **[2]**

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(iii) With reference to Table 8, describe **and** explain the effect of increasing day length on the rate of photosynthesis for the *Z. marina* in high carbon dioxide concentration. **[2]**

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(b) In the laboratory, a seaweed was grown in water with different pH values. All other variables, including temperature and light, were standardised.

The mean rate of photosynthesis was calculated over a 24-hour period for each pH value.

The results are shown in Fig 8.1.

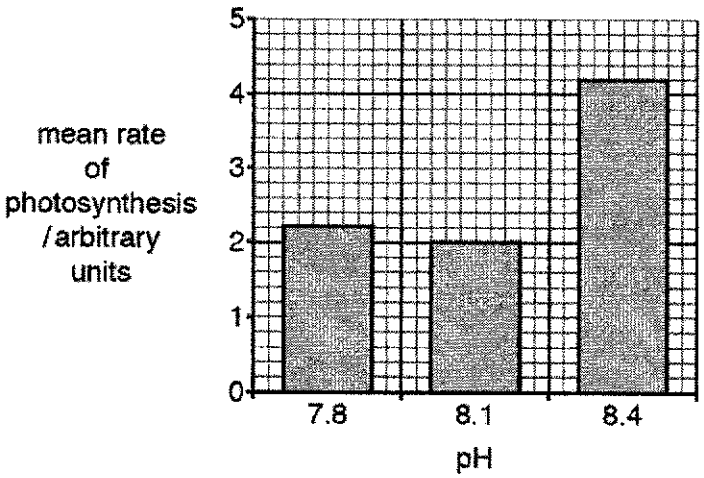


Fig. 8.1

With reference to Fig. 8.1, explain the effect on the rate of photosynthesis when the pH increases from 8.1 to 8.4. **[2]**

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[Total: 10]

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9 Fig. 9.1 shows a pollen grain with a pollen tube growing from it.

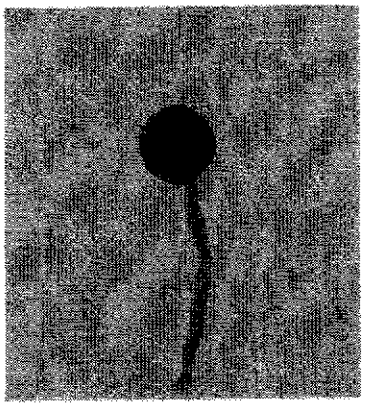


Fig. 9.1

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

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

Table 9 shows the results of the investigation.

Table 9

% sucrose concentration	% of pollen grains germinated	mean pollen tube length/ mm
1	6	0.005
2	13	0.008
4	25	0.015
8	56	0.040
10	31	0.030
20	25	0.018
40	13	0.006

(a) (i) A total of 12 pollen grains were placed in the 20% sucrose solution.
Use the information in the table to calculate the number of pollen grains that germinated to produce a pollen tube in the 20% sucrose solution. **[1]**

.....

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(ii) Use the information in the table to suggest the optimum (best) concentration of sucrose solution for pollen tube germination and growth. Explain how the information in the table enabled you to reach this conclusion. **[2]**

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(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 **(a)(ii)** may result in a lower percentage of germination. **[2]**

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(b) Describe the role of a growing pollen tube in plant reproduction. **[5]**

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[Total: 10]

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10 EITHER

(a) Describe the double circulation of blood in the human circulatory system. **[6]**

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(b) Describe the structure of a capillary and the transfer of a named material between capillaries and tissue fluid. **[4]**

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[Total: 10]

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10 OR

(a) Describe the roles of enzymes in human digestion. Give examples in your answers. **[4]**

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(b) Describe the sequence of events that occur after a human egg cell is fertilised which enable it to develop and survive in the uterus. **[6]**

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[Total: 10]

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CLASS

INDEX NUMBER

BIOLOGY 6093/01

Paper 1 Multiple Choice **30 August 2021**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in soft pencil.
Do not use staples, paper clips, highlighters, 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 **soft pencil** on the separate Answer Sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculated is expected, where appropriate.

This document consists of **24** printed pages

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1 The electron micrograph shows part of a plant cell.



Which combination correctly identifies the functions of the labelled cell structures?

	P	Q	R	S
A	Controls movement of substances into and out of the cells	Contains organelles	Site of aerobic respiration	Controls activities of the cell
B	Controls movement of substances into and out of the cells	Contains cell sap	Site of photosynthesis	Controls activities of the cell
C	Provides structural support to the cell	Contains organelles	Site of aerobic respiration	Site of ribosome synthesis
D	Provides structural support to the cell	Contains cell sap	Site of photosynthesis	Site of ribosome synthesis

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2U An amino acid enters a cell and is then used to synthesise an enzyme secreted by the cell.

What is the sequence of cell structures involved in the synthesis of the enzyme?

	first → last			
A	endoplasmic reticulum	Golgi apparatus	ribosome	vesicle
B	endoplasmic reticulum	ribosome	Golgi apparatus	cell membrane
C	ribosome	endoplasmic reticulum	Golgi apparatus	vesicle
D	ribosome	Golgi apparatus	endoplasmic reticulum	cell membrane

3U A student took a potato and cut three pieces from it.

Each piece is 5 cm X 0.5 cm X 0.5 cm.

He placed the three potato pieces into three different concentrations of sucrose solution. After two hours, he removed the potato pieces from the sucrose solutions and measured their lengths.

The results are shown in the table.

solution	length of potato piece after two hours/ cm
X	5.2
Y	4.7
Z	5.3

What can be concluded from these results?

A Solution **Y** had a lower water potential than the potato cells.

B Solution **Z** had the lowest water potential.

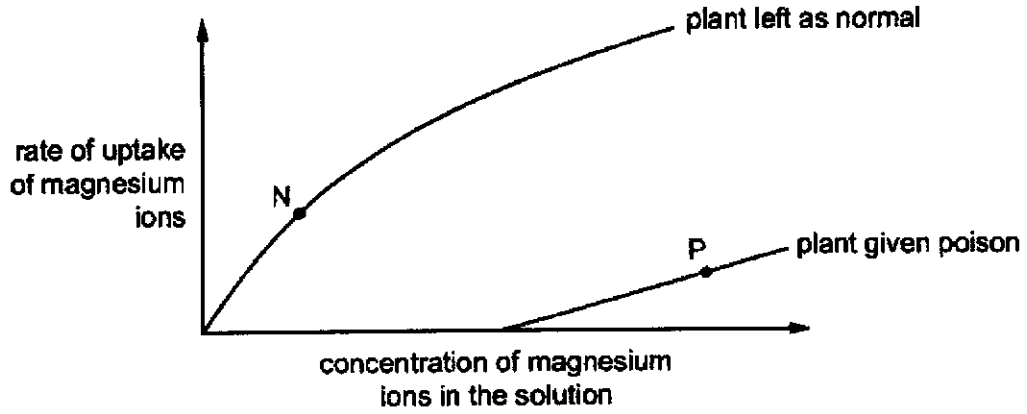
C The potato piece in solution **X** increased in length because sucrose diffused into the potato.

D The potato piece in solution **Y** decreased in length because sucrose diffused out of the potato.

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4^ An experiment measured the rate at which plants take up magnesium ions from solution.

One plant was given a poison that stops respiration. Another plant was left as normal. The graph shows the results.



How are the magnesium ions being absorbed by the plants at points **N** and **P**?

	point **N**	point **P**
A	active transport	active transport
B	active transport	diffusion
C	diffusion	active transport
D	diffusion	diffusion

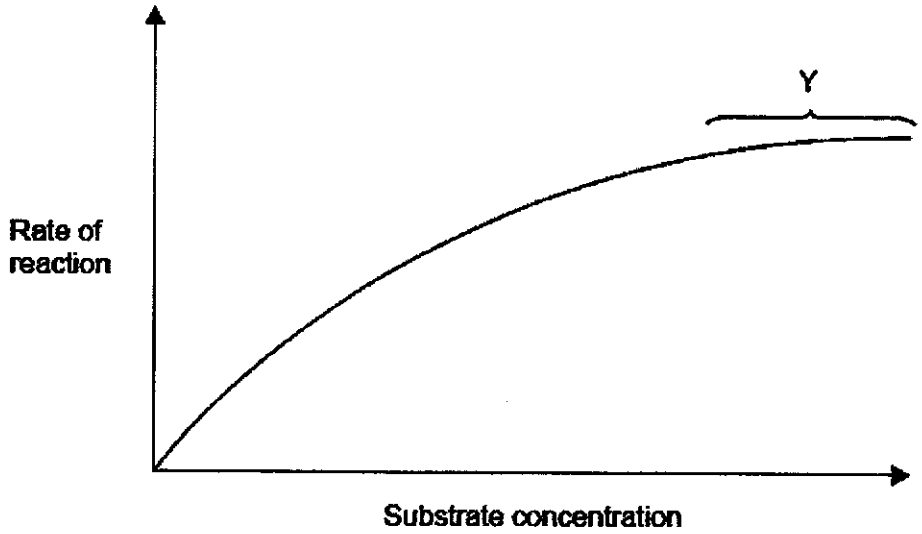
5^ A solution of amylase was added to a suspension of starch. After 30 seconds, three samples of the mixture were tested with iodine solution, Benedict's solution or with biuret reagent.

Which are the expected results?

	Colour of test reagent		
	Iodine solution	**Benedict's solution**	**Biuret reagent**
A	blue-black solution	green precipitate formed	purple solution
B	blue-black solution	red precipitate formed	blue solution
C	brown solution	blue solution	purple solution
D	brown solution	yellow precipitate formed	blue solution

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6[U] The graph shows the effect of increasing the substrate concentration on the rate of an enzyme-catalysed reaction. What is occurring during the phase indicated by section Y of the graph?



A The concentration of enzymes becomes limiting.

B The enzyme becomes denatured.

C The substrate concentration is limiting.

D The rate of reaction is decreasing.

7[A] Four test tubes are set up in the following manner.

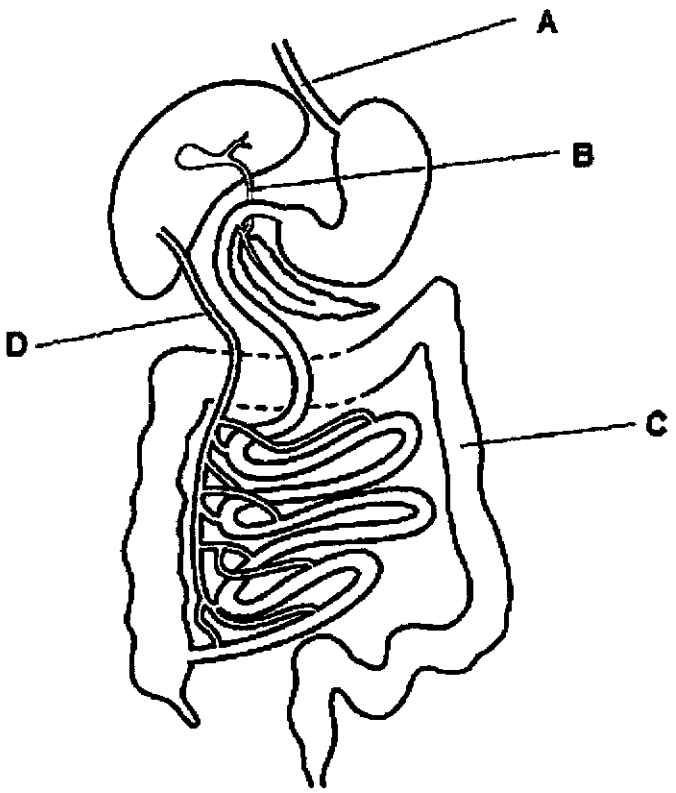
Test tube	Volume of hydrochloric acid/ cm^3	Volume of egg-white suspension/ cm^3	Volume of distilled water/ cm^3	Volume of boiled pepsin/ cm^3	Volume of pepsin/ cm^3
1	2.0	5.0	1.0	0.0	0.0
2	2.0	5.0	0.0	1.0	0.0
3	2.0	5.0	0.0	0.0	1.0
4	0.0	5.0	0.0	0.0	1.0

All four test tubes are then placed in a water bath at 37 °C for 20 minutes. What is the result?

	test tube			
	1	**2**	**3**	**4**
A	clear	clear	clear	clear
B	clear	cloudy	cloudy	clear
C	cloudy	cloudy	clear	cloudy
D	cloudy	clear	cloudy	clear

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8 The diagram shows part of the alimentary canal and associated organs.

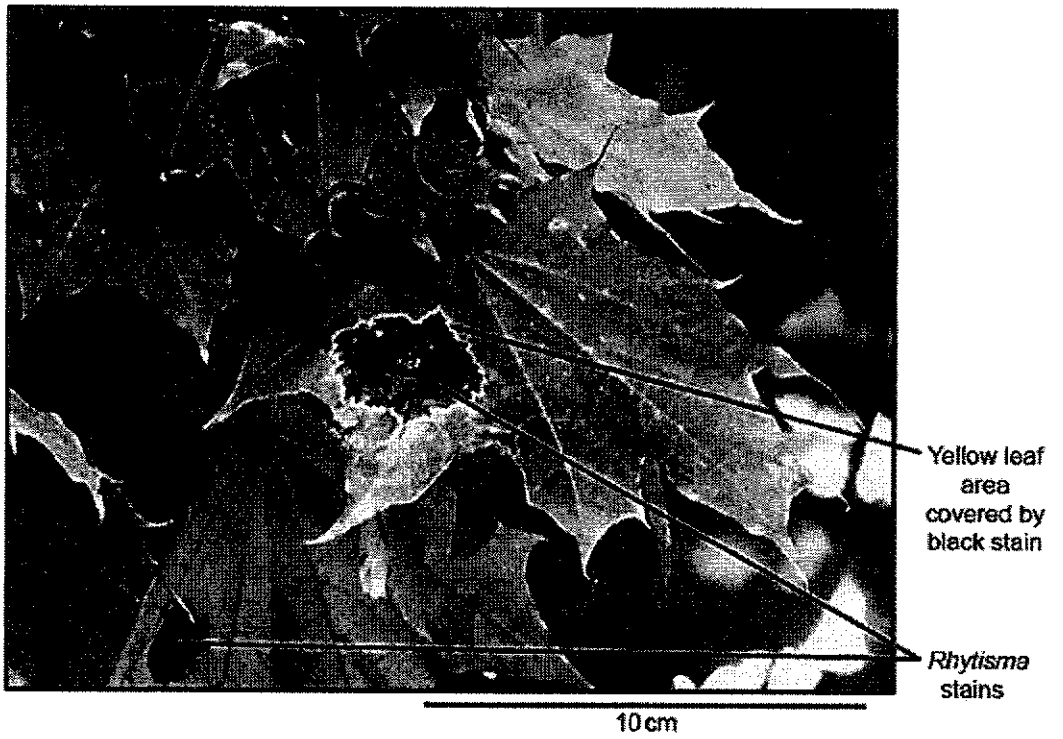


Which of the structures, when blocked, will slow down fat digestion? B

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9^A The fungus *Rhytisma* grows on the leaves of certain trees, causing a yellow leaf area in which chlorophyll is no longer present. A black, tar-like stain later spreads out.



[Source: © International Baccalaureate Organization 2017]

What happens in the leaf when *Rhytisma* is present?

I. An increase in the production of carbon dioxide

II. A reduction in the production of oxygen

III. An increase in the loss of water

A I only

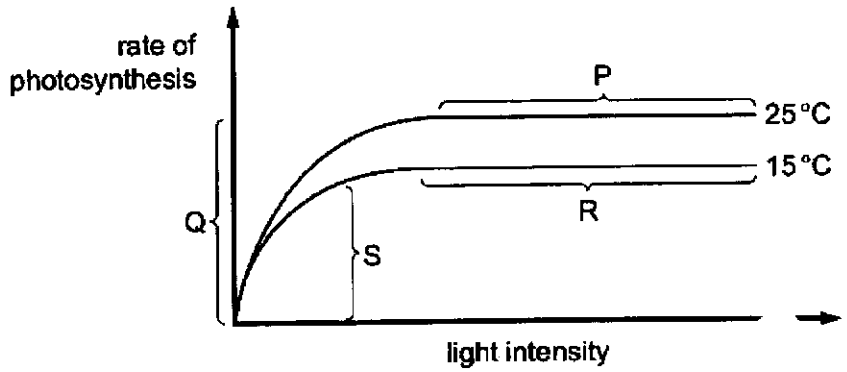
B II only

C II and III only

D I, II and III

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10^ 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?

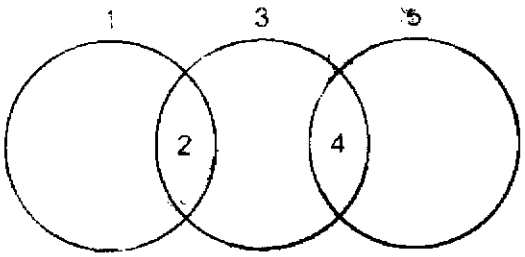
A P and R

B Q and S

C R and Q

D S and P

11^ The diagram shows the relationship between phloem sieve tube elements, xylem vessel elements and companion cells.



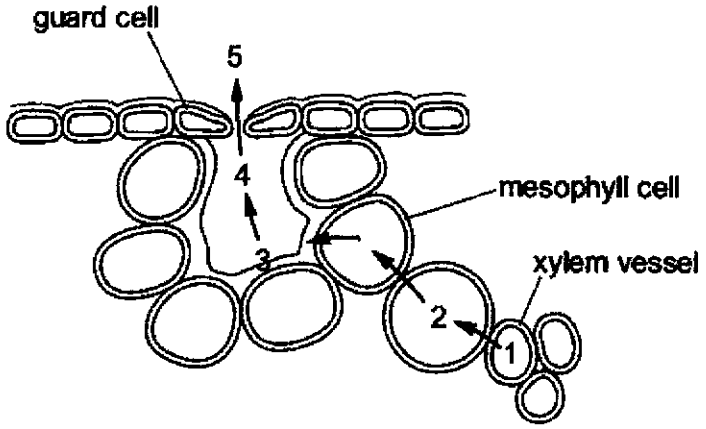
Which row is correct?

	1	2	3	4	5
A	companion cells	cytoplasm	phloem sieve tube elements	no nucleus	xylem vessels
B	companion cells	nucleus	phloem sieve tube elements	cytoplasm	xylem vessels
C	phloem sieve tube elements	mitochondria	companion cells	nucleus	xylem vessels
D	xylem vessel elements	no cytoplasm	phloem sieve tube elements	vacuole	companion cells

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12[K] The diagram shows the movement of water through part of a leaf.



Which processes are involved in the movement of water at these stages?

	1-2	3-4	4-5
A	diffusion	evaporation	osmosis
B	evaporation	diffusion	osmosis
C	osmosis	diffusion	evaporation
D	osmosis	evaporation	diffusion

13[A] Blood samples from three veins in the body were tested for the concentration of oxygen, carbon dioxide and urea. The results, in arbitrary units, are shown in the table below.

vein	oxygen concentration/ arbitrary units	carbon dioxide concentration/ arbitrary units	urea concentration / arbitrary units
1	40	48	1.5
2	40	48	7.5
3	90	40	4.0

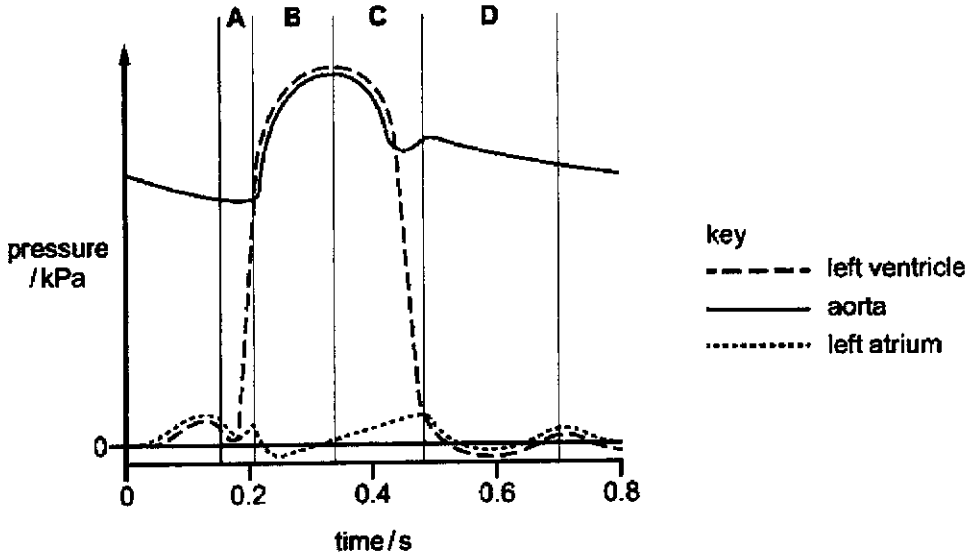
Which of the following shows the correct veins that were tested?

	hepatic vein	pulmonary vein	renal vein
A	1	3	2
B	2	3	1
C	3	1	2
D	3	2	1

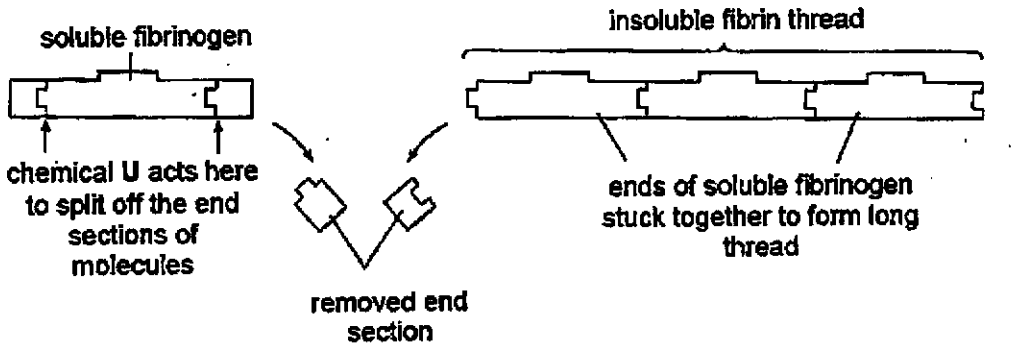
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14 The diagram shows the pressure changes in various structures of the left side of the heart during the cardiac cycle.

At the end of which period is the ventricle full of blood? **A**



15 The diagram illustrates the formation of long insoluble fibrin threads during the clotting of blood at a cut in the skin.



Person **V** is unable to produce chemical **U**. What is a possible effect of person **V**'s condition?

A **V** will lose more blood than a normal person when injured.

B **V** has a greater likelihood of suffering from blood clots in blood vessels.

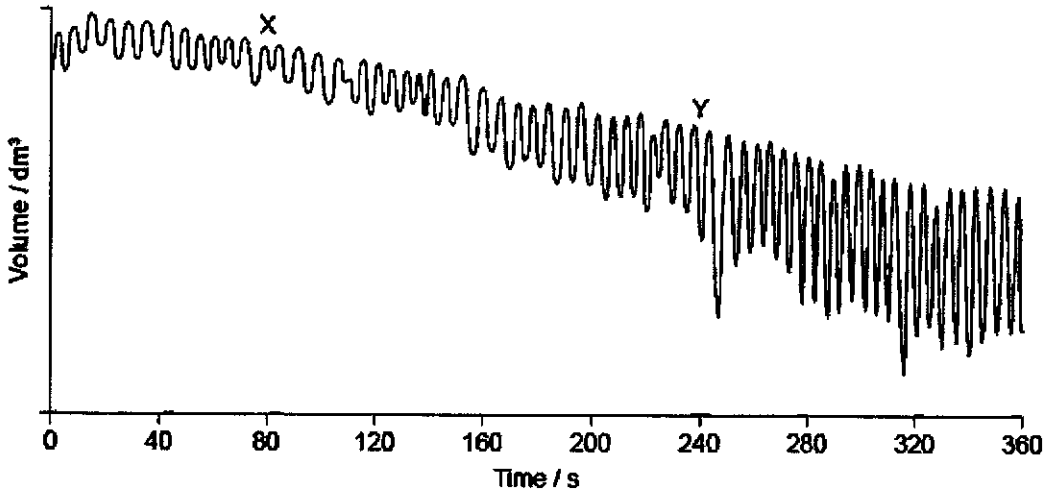
C **V**'s platelets will not function properly.

D **V** will suffer from fainting spells because of high blood pressure.

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16[A] The graph shows a spirometer trace of oxygen consumption when breathing at rest and during exercise.



What explains the difference between the traces at regions **X** and **Y** on the graph?

A At **X**, the internal intercostal muscles contract more than the external intercostal muscles.

B At **Y**, the ribcage moves up and out more than at **X**.

C At **X**, the diaphragm flattens more per breath than at **Y**.

D At **Y**, the intercostal muscles contract more slowly than at **X**.

17[A] Which row show the change in concentrations of some substances in red blood cells when carbon dioxide diffuses from active cells?

	carbonic anhydrase	hydrogencarbonate ions
A	decreases	no change
B	increases	increases
C	no change	decreases
D	no change	increases

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18 Which of these statements describes control by **negative** feedback?

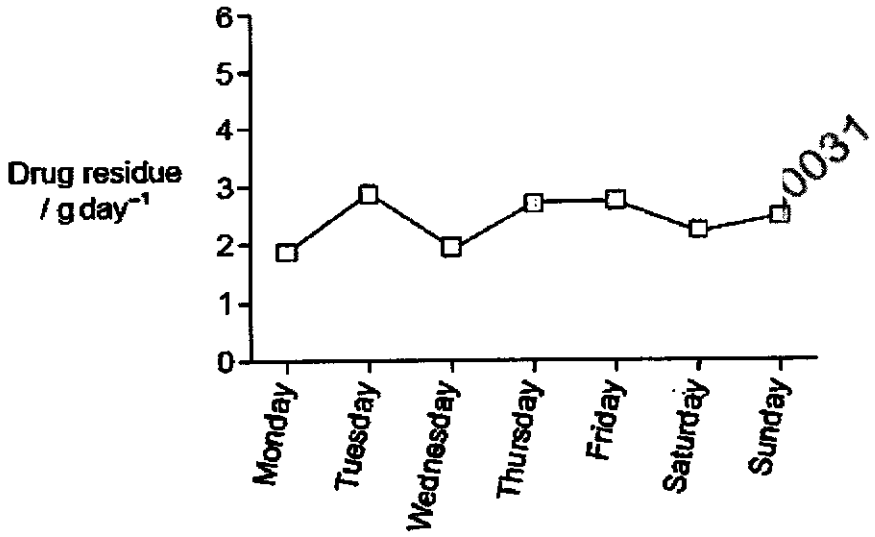
A An injury to body tissue activates platelets in the blood and these activated platelets release chemicals which activate more platelets.

B During the menstrual cycle, luteinising hormone (LH) stimulates the release of oestrogen which in turn stimulates the release of more LH.

C A higher concentration of carbon dioxide in the atmosphere increases temperature, which increases photosynthesis producing more carbon dioxide.

D When blood pressure is high, nerve impulses from the brain cause the blood vessels to dilate and blood pressure is reduced.

19 The graph shows the daily amount of the residue of a drug in the wastewater of a hospital.



What can be deduced from these data?

A The drug is not fully reabsorbed by the proximal convoluted tubules.

B The glomeruli are not permeable to the drug.

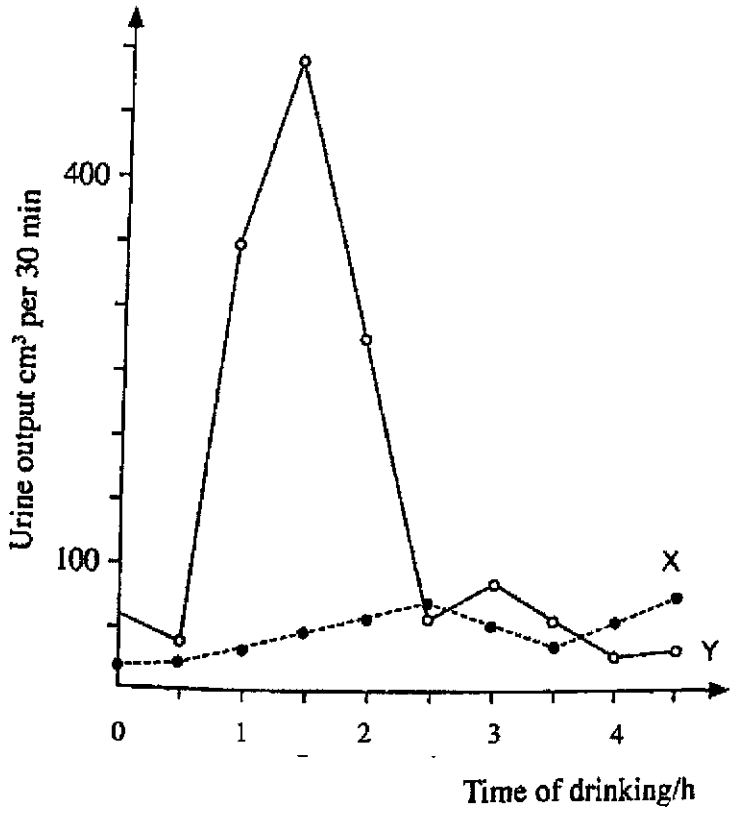
C The collecting ducts reabsorb all of the drug.

D The drug is catabolized by the liver.

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20 The graph below shows the effects of drinking **1** litre of water and **1** litre of concentrated salt water on the urine output of a healthy person.



Which option correctly identifies each line and the explanation for it?

	water	concentrated salt water	explanation
A	Y	X	intake of water causes more ADH to be produced
B	Y	X	intake of water causes less ADH to be produced
C	X	Y	intake of salt water causes more ADH to be produced
D	X	Y	intake of salt water causes less ADH to be produced

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21^A Sciatica occurs when the narrowing of the spine compresses part of the sciatic nerve. This can result in

- loss of feeling in the affected leg
- weakness in the affected leg
- loss of bowel or bladder function

What conclusion can be made?

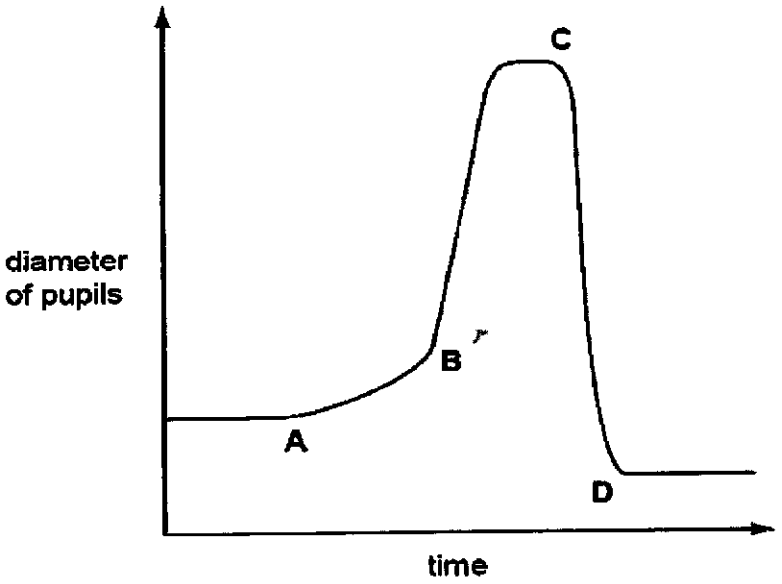
A The sciatic nerve contains only sensory neurones.

B The sciatic nerve contains only motor neurones.

C The sciatic nerve contains both sensory neurones and motor neurones.

D The sciatic nerve contains sensory, relay and motor neurones.

22^A The graph shows changes in the diameter of a person's pupils while outdoors on a sunny day. At which time did the person take off a pair of sunglasses? **C**



23^K The liver and the pancreas work together to control the concentration of glucose in the blood.

Which statement is correct?

A The liver converts the small molecule glucose to the large molecule glucagon.

B The liver releases the hormone insulin when blood glucose levels are too high.

C The pancreas does not respond to an increase in blood glucose levels.

D The pancreas responds to a fall in blood glucose by increasing the release of the hormone glucagon.

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24[U] A number of new plants are growing from pieces of a plant that have become detached and have rooted in soil.

Which statement is correct about these new plants when they mature?

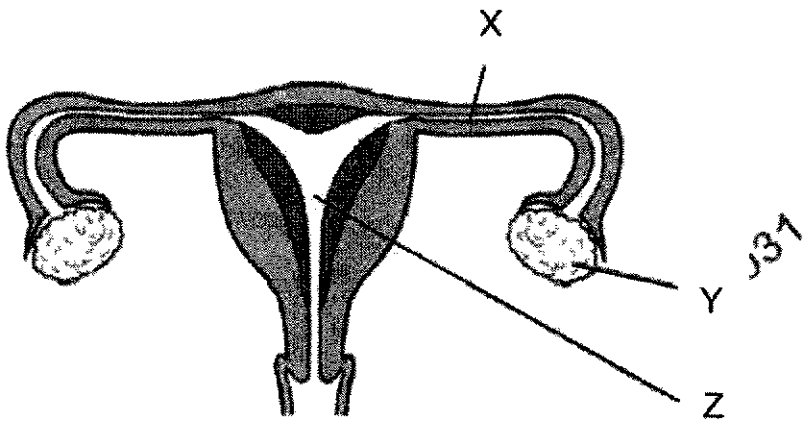
A The fruit they produce will all ripen at the same time.

B They will all grow to the same size.

C They will all have the same colour flowers.

D They will all produce the same number of fruit.

25[K] The diagram shows a cross-section of a female reproductive system.



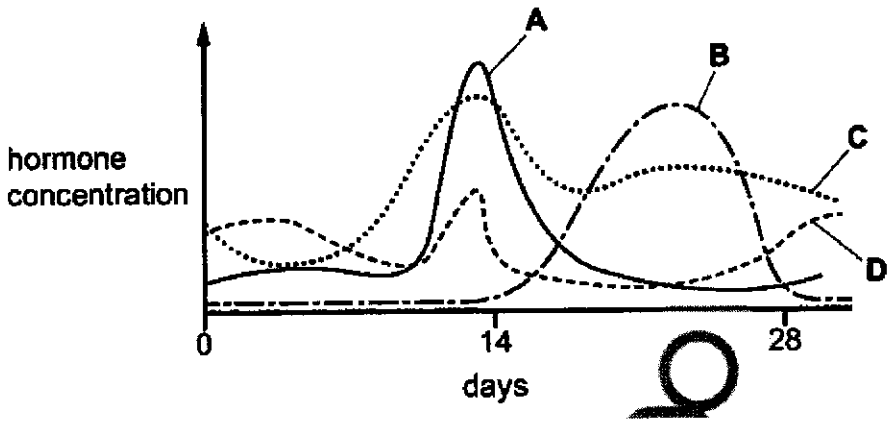
In which organ(s) does/do mitosis occur if the lady is pregnant?

	X	Y	Z
A	2	no	yes
B	no	yes	yes
C	yes	yes	no
D	yes	no	yes

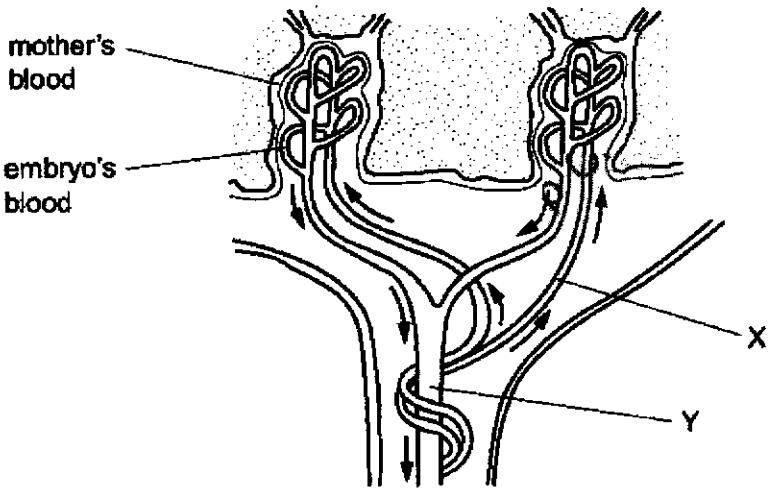
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26 The graph shows changes in the concentrations of hormones during a menstrual cycle.

Which curve represents oestrogen? **C**



27 The diagram shows how the blood of a human embryo flows close to the mother's blood in the placenta.



Which substances are present at X in higher concentrations than at Y?

A carbon dioxide and glucose

B carbon dioxide and urea

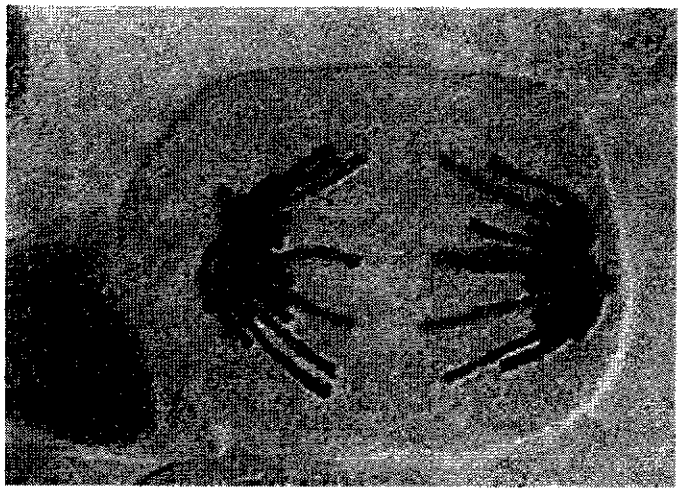
C glucose and oxygen

D glucose and urea

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28[U] The photomicrograph shows a cell during mitosis.



What is happening in this cell?

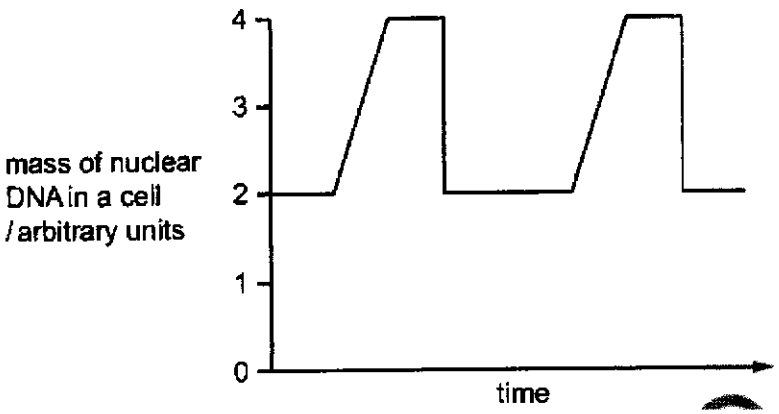
1 Centrioles are replicating.
2 Spindle microtubules are shortening.
3 Chromatin is condensing.

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

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29[A] Which processes that occur in cell division are represented in the diagram?



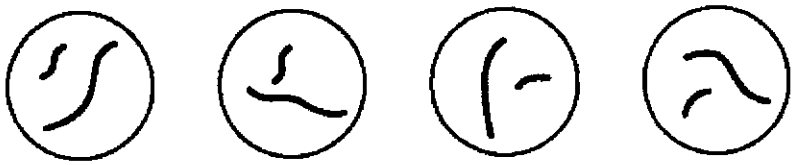
A DNA replication and mitosis only

B DNA replication and meiosis only

C DNA replication, mitosis and cytokinesis

D meiosis only

30[A] The diagram shows the chromosomes of four daughter cells produced by meiosis.



Which parent cell produced these cells? [B]

A



B



C



D



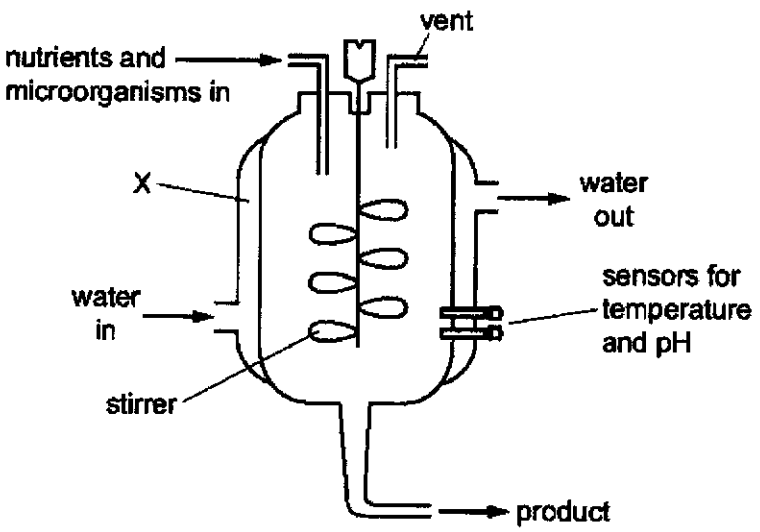
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31[K] Which row describes what happens in the production of proteins?

	What forms the genetic code	What the DNA codes for	What carries a copy of the gene to the cytoplasm
A	Sequence of amino acids	Sequence of bases	mRNA
B	Sequence of amino acids	Sequence of proteins	Ribosomes
C	Sequence of bases	Sequence of amino acids	mRNA
D	Sequence of bases	Sequence of proteins	Ribosomes

32[A] The diagram shows the equipment used in the industrial production of insulin.



What is the purpose of the structure labelled **X**?

A to insulate the fermentation vessel

B to maintain the pressure of the fermentation vessel

C to monitor the temperature of the fermentation vessel

D to remove the heat produced by the fermentation process

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33^A A farmer uses sperm from a black male sheep to artificially inseminate (fertilise) 20 light brown female sheep.

All of the offspring produced were black.

Which statement explains these results?

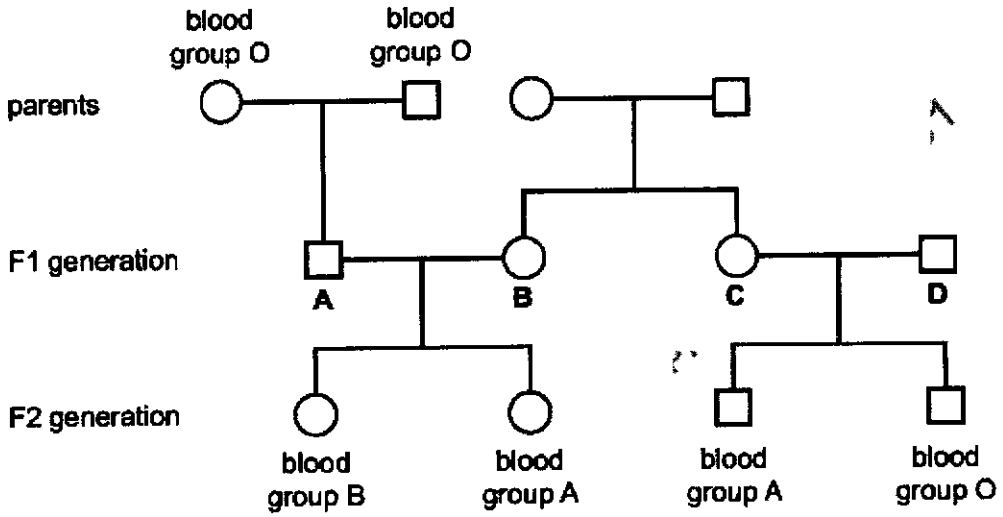
A The alleles for light brown colour are dominant.

B The male sheep is heterozygous and the allele for black colour is dominant.

C The male sheep is homozygous and the allele for black colour is codominant.

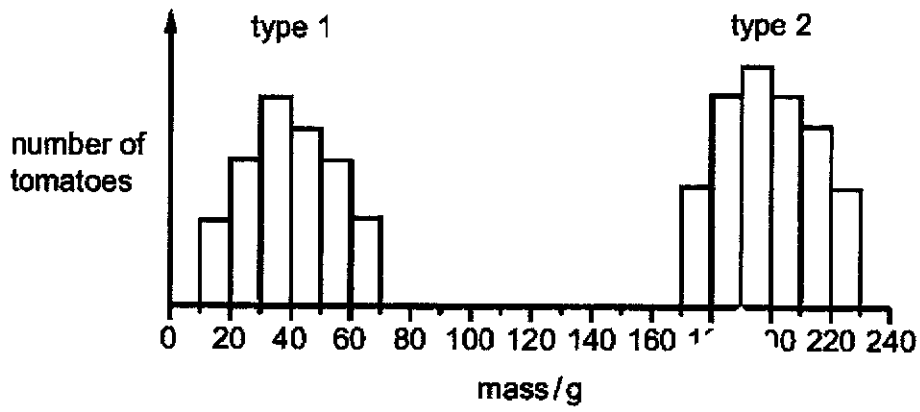
D The male sheep is homozygous and the allele for black colour is dominant.

34^ The diagram shows the blood group phenotypes of some members of a family.
Which member of the F1 generation must have the AB blood group? **B**



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35[U] 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.

36[U] A farmer wants to produce extra-large, sweet oranges, by selective breeding.

Using information from the table, which plant types should the farmer select for breeding?

plant type	size of orange / cm			percentage sugar content	
	6–9	9–12	12–15	10	20
1		✗		✗	
2			✗	✗	
3	✗				✗
4		✗			✗
5	✗			✗	

A 1 and 2

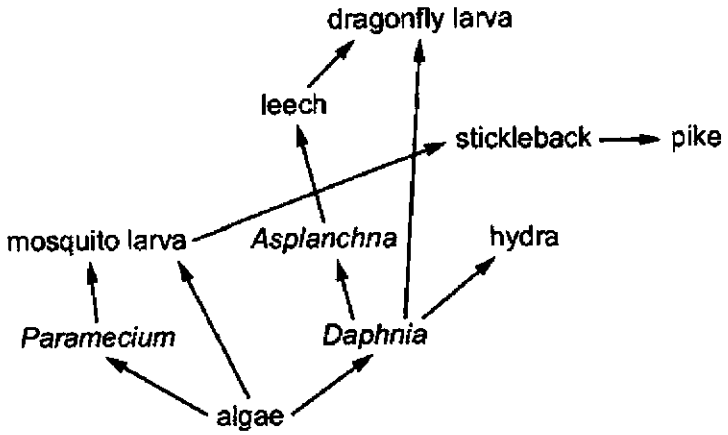
B 1 and 3

C 2 and 4

D 4 and 5

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37 The diagram shows a food web of organisms found in a pond.



Which organism is both a primary consumer and a secondary consumer?

A algae

B dragonfly larva

C mosquito larva

D *Paramecium*

38 The concentrations of a persistent pesticide in the tissues of four organisms were measured. These organisms are part of a food web. The table below shows the results.

organism	concentrations of insecticides (parts per million)
P	120
Q	1800
R	1400
S	410

Which of the following shows the energy flow between these organisms?

A P → S → R → Q

B P → R → S → Q

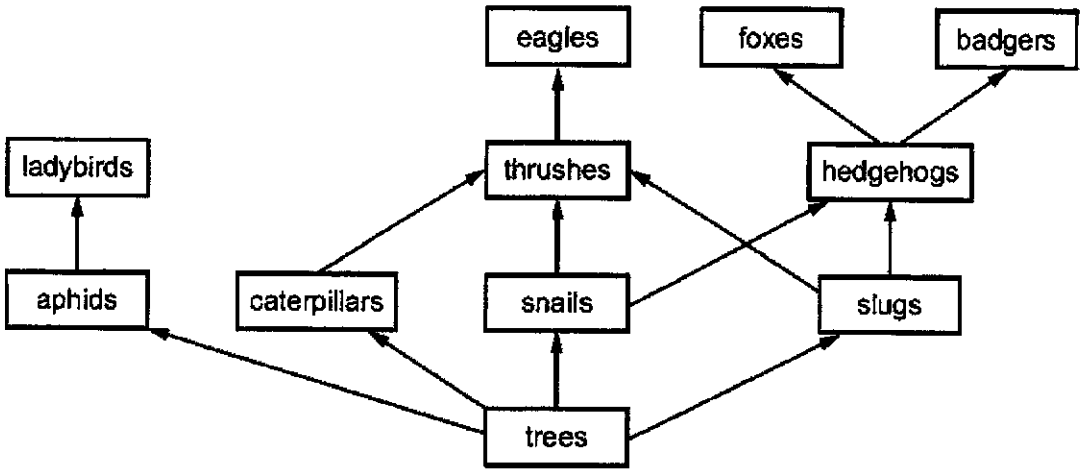
C Q → P → S → R

D Q → R → S → P

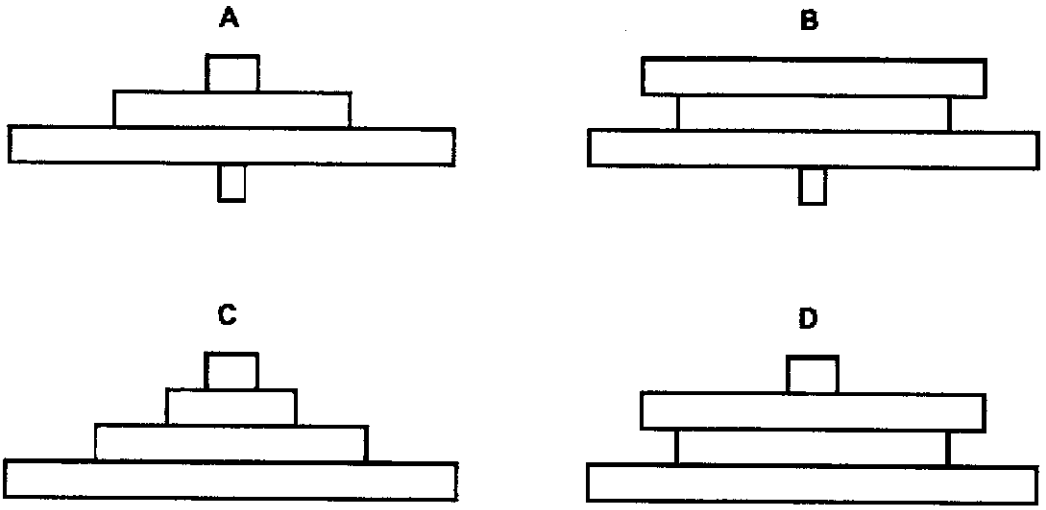
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39[U] The diagram shows part of a food web.



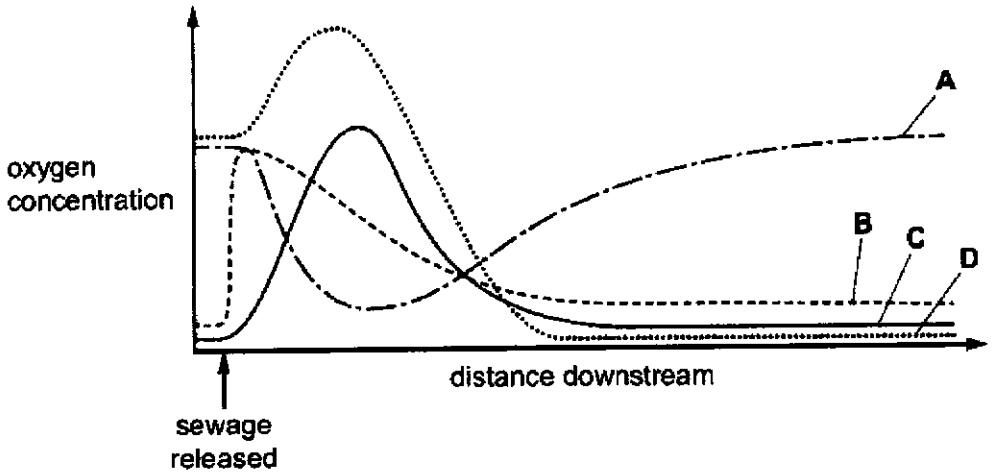
Which pyramid of numbers is based on this food web? **A**



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40 Sewage is released into a river.

Which curve represents the oxygen concentration in the river? A



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CANDIDATE NAME

CLASS

INDEX NUMBER

BIOLOGY

6093/02

Paper 2

27 August 2021

1 hour 45 minutes

Candidates answer on the Question Booklet.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in a dark blue or black pen.
You may use a soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A

Answer **ALL** questions.
Write your answers in the spaces provided on the Question Paper.

Section B

Answer **all** the questions, the last question is in the form **Either/Or**.
Write your answers in the spaces provided on the Question Paper.

Electronic calculators may be used.

You are advised to spend no longer than one hour on Section A and no longer than 45 minutes on Section B.

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

For Examiner's Use	
Section A	
Section B	
Total	/80

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Section A

Answer **all** questions

Write your answers in the spaces provided.

1 A seal is a mammal that spends most of its time in the sea. It breathes and respires in a very similar way to a human, but when it dives to hunt and catch fish, it is capable of staying under water for up to 20 minutes.

Fig. 1.1 shows the percentage concentrations of oxygen and carbon dioxide, and the concentration of lactic acid in a seal's blood over a 40-minute period during which it dives to hunt and catch fish.

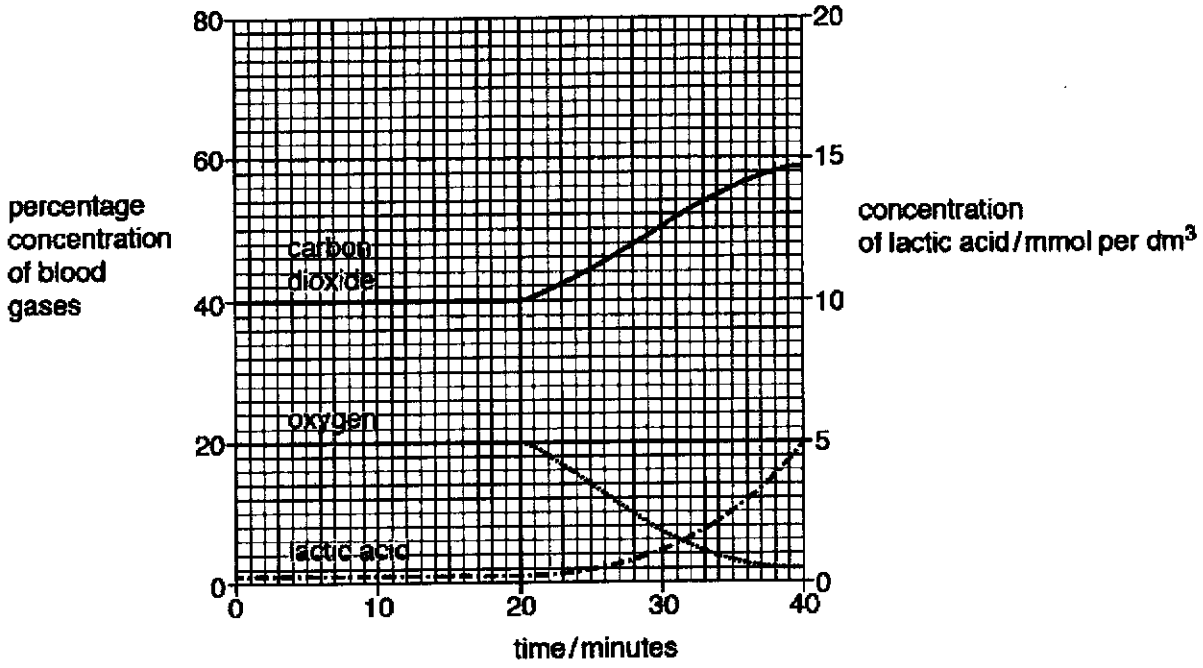


Fig. 1.1

(a) (i) State how long after the start of the time period the seal begins its dive. **[1]**[U]

20 minutes

(ii) State the percentage of oxygen in the seal's blood 40 minutes after the start of the time period. **[1]**[U]

2%

(b) Name the chemical process which starts to take place in the seal's muscles during its dive and explain how the graph supports your answer. **[3]**[A]

process **anaerobic respiration**

explanation

a. **During its dive from 20 to 40 minutes, percentage of oxygen decreased from 20 to 2%;**

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b. **Corresponding increase in concentration of lactic acid from 1 to 5 mmol/dm^3;**
c. **Lactic acid is a product of anaerobic respiration;**

(c) Suggest and explain what would happen to the concentration of lactic acid in the seal's blood when it returns to the surface of the sea after its dive. **[3]^A**

a. **Concentration of lactic acid will decrease;**
b. **as the seal would start to breathe in air containing oxygen;**
c. **Oxygen will oxidise lactic acid to form energy in the liver which will be used to convert lactic acid to glucose (which will be stored in the liver as glycogen)/transported to the muscle;**

[Total: 8]

2 The concentration of a person's urine can vary according to their diet.

(a) Explain how changes in a person's protein intake can affect the concentration of their urine. **[3]^A**

a. **Increased protein in diet will lead to increase concentration of amino acids;**
b. **liver will convert the amino acids into urea by the process of deamination;**
c. **this leads to more concentrated urine formed;**

(b) An investigation was carried out into the effect of different drinks on the rate of production of urine. Three students each took 1.5 dm^3 of a different drink **A**, **B** or **C**.
Fig. 2.1 shows the volume of urine released by each student over the next two and a half hours.

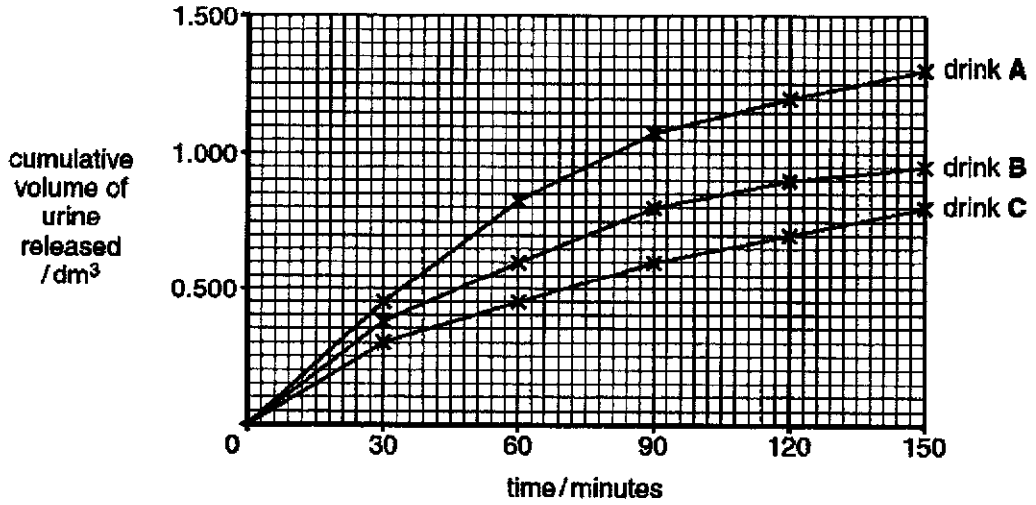


Fig. 2.1

Suggest which of the three drinks would be better to avoid on a very hot day. Give an explanation for your answer.

drink **A** **[1]^A**
explanation **[2]^A**
a. **Drink A causes the highest volume urine to be produced at 1.3 dm^3 ;**

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b. **As it is a very hot day, water is already being lost in sweat to regulate body temperature;**
c. **There is a danger of dehydration;**

[Total: 6]

3 **(a)** Table 3 shows how the thickness of the lens of the eye changes when focussing on an object at different distances from the front of the eye.

Table 3

distance from eye/ cm	thickness of lens/ mm
10	4.0
20	3.6
30	3.2
50	2.9
100	2.7
150	2.6
200	2.6

Describe the pattern shown by the data in Table 3. **[2]**[A]

a. **distance from eye increases, the thickness / width of lens decreases QV from 10 to 150 cm, the thickness of lens decreased from 4.0 to 2.6mm;** ***converse accepted***
b. **From 150 to 200 cm, the thickness of lens stays constant at 2.6mm;**

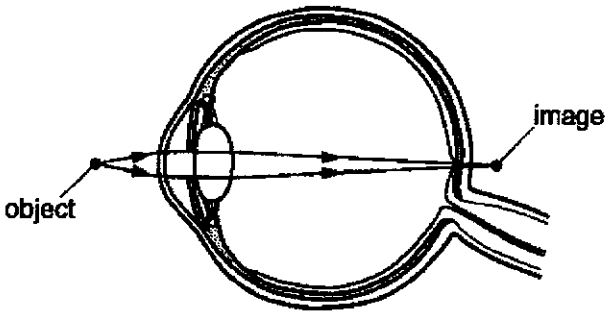
(b) Explain how **named** components of the eye change the thickness of the lens when focusing on an object as it moves further from the front of the eye. **[3]**[U]

a. **As the object moves further from the front of the eye, the light rays become more parallel;**
b. **The ciliary muscles relax and the suspensory ligaments become taut;**
c. **The lens becomes thinner to increase the focal length;**

(c) As a person becomes older, the lens of the eye becomes harder and less elastic. This results in the person seeing an image of a close object that is out of focus.

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With reference to the curvature of the lens, suggest why this older person sees an image of a close object as out of focus. [1]A

When looking at a close object, the lens remains thin as it is inelastic, hence the image is out of focus.

[Total: 6]

4 Fig. 4.1 shows the rates of water loss for three plants, **D**, **E** and **F**, during the first 14 minutes of an experiment. The plants are of different species and are growing in identical conditions.

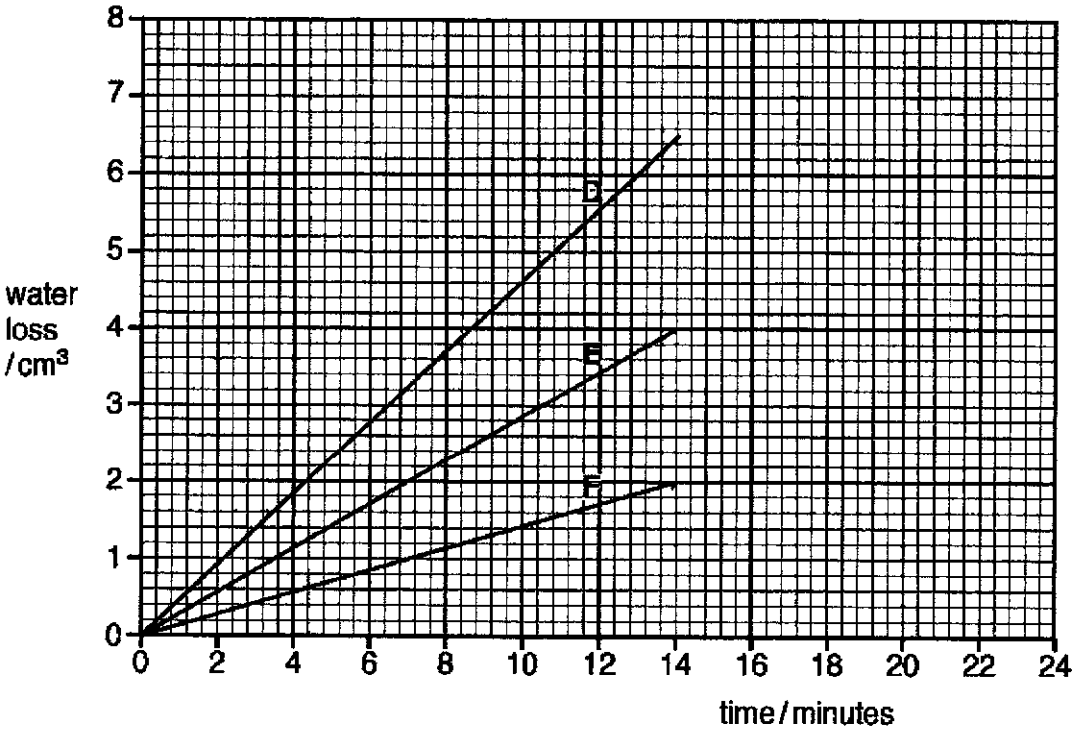


Fig. 4.1

(a) Name the process by which plants lose water to the atmosphere. [1]K

Transpiration

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(b) Suggest **two** reasons for the differences in rates of water loss shown by the three plant species. **[2]**[U]

a. **Number of leaves ;**
b. **Surface area of leaves;**
c. **Number of stomata ;**
d. **Number of root hairs ;**
e. **Thickness of cuticle ;**
f. **Presence of hairs / sunken stomata ;**

(c) In the experiment, after 14 minutes, air is blown across plant **E** for 2 minutes and a black bag is placed over plant **F** for the remaining 10 minutes.

(i) Continue the lines on the graph in Fig. 4.1 to show what would happen to the rates of water loss for plants **E** and **F**. **[2]**[A]

E gradient increases for minimum of 2 minutes ;
F line with a reduced gradient / horizontal line to 24 minutes ;

(ii) Explain the shape of each line you have drawn. **[4]**[A]

plant **E**

a. **increased transpiration as wind removed water vapour;**
b. **increased water vapour concentration gradient between the intercellular air spaces of the leaves and the environment;**

plant **F**

a. **decreased transpiration as there is decrease in photosynthesis/ increase in water vapour concentration**

b. **guard cells lose their turgidity and stomata closed;**

OR

c. **there is decreased water vapour concentration gradient between the intercellular air spaces of the leaves and the environment;**

[Total: 9]

5 **(a)** DNA is the hereditary material of most organisms.

(i) Define each of the following terms related to hereditary materials: **[2]**[K]

gene

a. **A gene is made of DNA and found on a section of a chromosome ;**
b. **which codes for a protein;**

dominant allele

An alternative copy of a gene that is always expressed;

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(ii) Some people find that certain vegetables, such as Brussels sprouts, taste bitter and are unpleasant to eat. Scientists believe that one dominant allele (**T**) of a particular gene gives people the ability to detect the bitter taste.

Two parents find that Brussels sprouts taste bitter. In the space below, draw a genetic diagram to show how these parents can have a child who does **not** find that Brussels sprouts taste bitter. **[3]**[A]

Parental phenotypes	**Can taste bitter x Can taste bitter**	
Parental genotypes	**Tt x Tt**	**1**
Gametes	**T, t T,t**	**0.5**
Offspring genotypes	**TT Tt Tt tt**	**0.5**
Offspring phenotypes	**Bitter bitter bitter cannot taste bitter**	**0.5**
Offspring phenotypic ratio	**3 can taste bitter: 1 cannot taste bitter**	**0.5**

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(b) Some organisms such as viruses use RNA as their genetic material.

Fig. 5.1 is a diagram of a nucleotide of RNA.

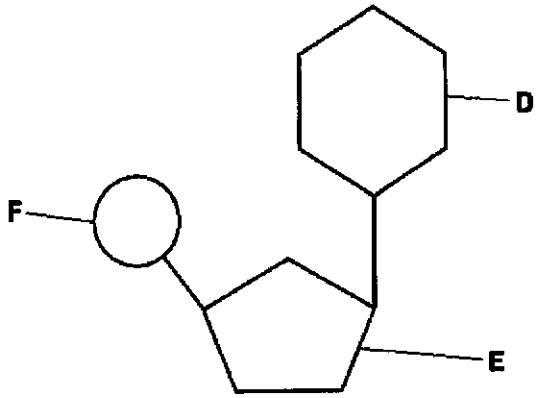


Fig. 5.1

(i) Identify **D**, **E** and **F** in Fig. 5.1. **[2]**^{K}

D nitrogenous base

E (ribose/pentose) sugar

F phosphate group

(ii) State **one** way in which the structure of DNA differs from the structure of RNA. **[1]**^{K}

DNA	RNA
Sugar is deoxyribose	Sugar is ribose
Nitrogenous bases are adenine (A), thymine (T), guanine (G) and cytosine (C)	Nitrogenous bases are adenine (A), uracil (U), guanine (G) and cytosine (C)
Ratio of A:T and G:C is 1:1.	No fixed ratio between A and U and between G and C.
It is a large insoluble molecule.	Small soluble molecule
It is a double helix	It is usually single stranded

[Total: 8]

6 (a) Meiosis is one process that contributes to genetic variation.
Describe how events in prophase I of meiosis leads to genetic variation. **[2]**^{K}

a. **Homologous chromosomes pair up via synapsis to form bivalents;**
b. **Non-sister chromatids of homologous chromosomes cross over to form recombinant chromosomes;**

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(b) Fig. 6.1 shows a species of tree frog.



Fig. 6.1

Each tree frog of this species is either **grey** or **green** in colour.
The following are true for **both** grey and green tree frogs. They:

- eat insects
- live above the ground in vegetation
- live near water and lay their eggs in small pools
- are sometimes eaten by snakes and birds.

Grey tree frogs are more commonly found in areas where there are many trees with grey bark.
Green tree frogs are more commonly found in areas where there are many swamp and marsh plants with green leaves.

(i) State the type of variation shown by the colour of these tree frogs. **[1]**^{U}

Discontinuous variation

(ii) Use your knowledge of the process of natural selection to explain the distribution of grey and green tree frogs in different areas. **[4]**^{A}

a. **State there is variation already in the population:**
There is variation within the population where some frogs are green and some are grey
b. **Identify the selection pressure and its effects on the population:**
The selection pressure is their predators such as snakes and birds
c. **Survive to reproduce and pass on specified allele:**
Those that can camouflage in their respective areas (e.g. green frogs survive better in the marshes and grey frogs survive better in areas where there are trees with grey bark) can escape from predators and survive to maturity and reproduce to pass on the skin colouration allele to the next generation.
d. **State that the specified allele increases over time:**
Over time, the frequency of the specific colour alleles increases in the population, causing more of the population to have that colour.

[Total: 7]

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7 Fig. 7.1 shows a pyramid of biomass and part of the carbon cycle.

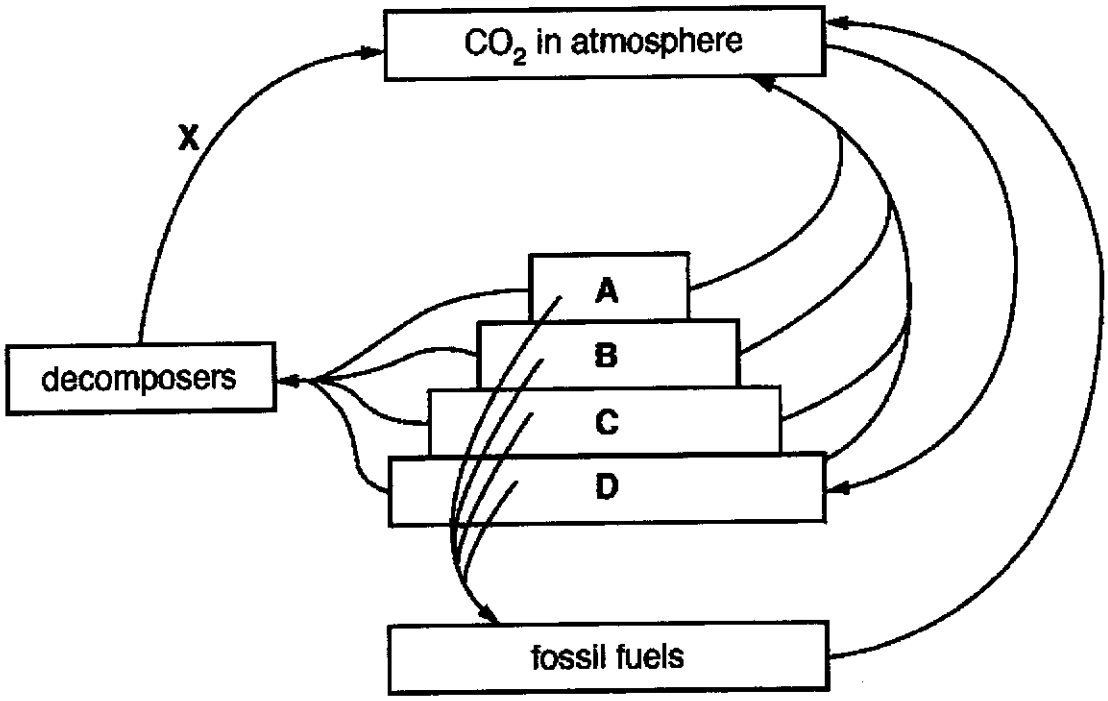


Fig. 7.1

(a) State the letter that represents the primary consumers in Fig. 7.1 and its trophic level. **[1]^K**

C; 2nd trophic level

(b) State how carbon is transferred from producers to primary consumers. **[1]^K**

Through feeding

(c) Explain why trophic level **A** is smaller than trophic level **B** in the pyramid of biomass in Fig. 7.1. **[3]^U**

a. **energy is lost as heat from respiration as it is transferred from one trophic level to the next ;**
b. **only 10% energy transferred**
c. **not all organisms (in one trophic level) are eaten / not all parts of the organisms are eaten ;**
d. **some energy is lost in excretion and through undigested matter;**

(d) Arrow **X** on Fig. 7.1 indicates the transfer of carbon from decomposers to the atmosphere. State the name of process **X**. **[1]^K**

Respiration

[Total: 6]

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Section B

Answer **three** questions.

Question 10 is in the form of an **Either/Or** question.

Only one part should be answered.

8 **(a)** Laboratory experiments were carried out to investigate the effect of day length on the rate of photosynthesis in a photosynthetic marine organism, *Zostera marina.*

- The temperature was controlled at 4 °C.
- A low concentration of carbon dioxide dissolved in the water was used.
- The light exposure period (day length) was different for five groups of *Z. marina.*
- This was maintained for 10 days to allow *Z. marina* to adapt to these conditions.
- After 10 days, the rate of photosynthesis was measured for each group under the **same** controlled conditions.
- The experiment was repeated using five groups of *Z. marina* with a high concentration of carbon dioxide dissolved in water.

Table 8 shows the rate of photosynthesis for each group.

Table 8

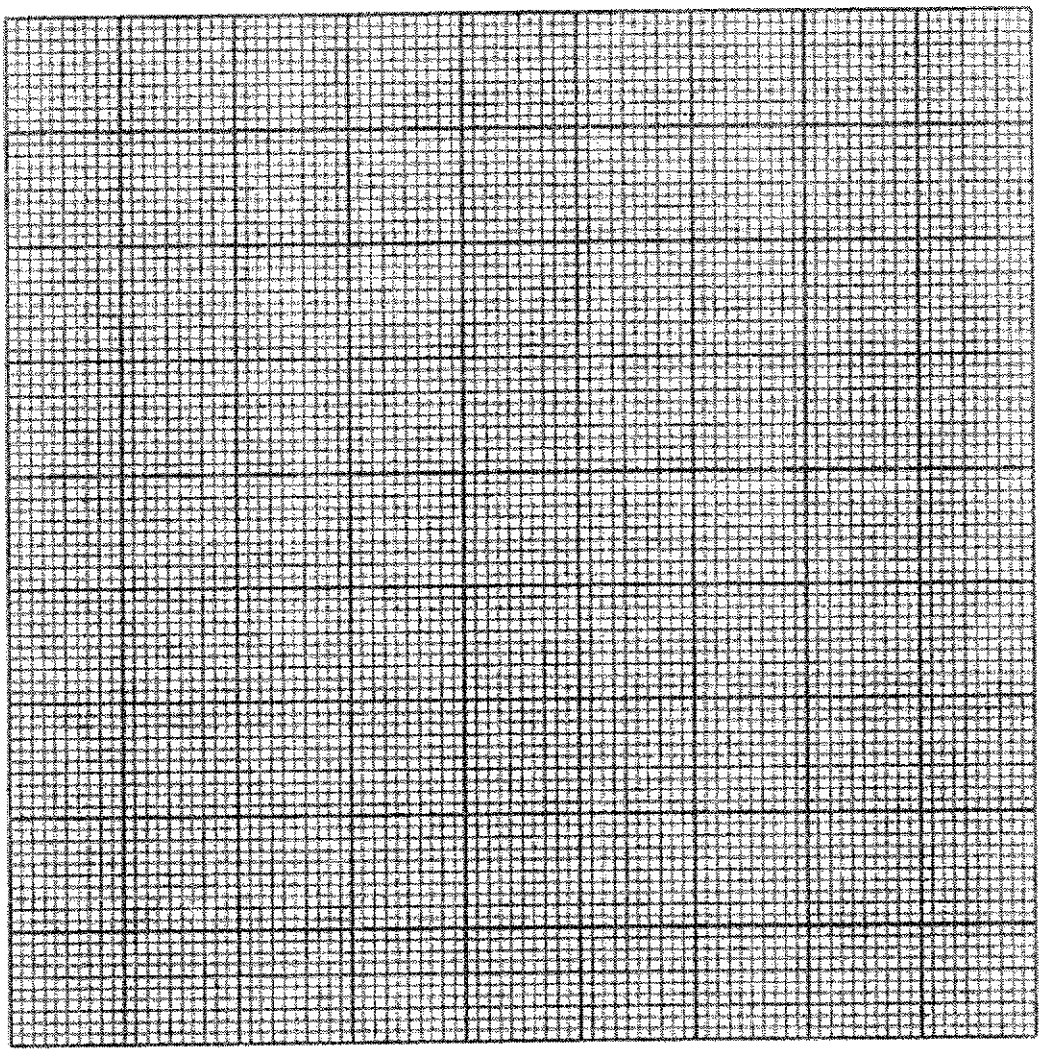
Day length/ hours	**rate of photosynthesis/ arbitrary units**	
	low carbon dioxide	**high carbon dioxide**
12	2.0	2.5
14	3.0	5.0
16	4.0	7.0
18	5.5	11.0
20	7.5	18.0

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(i) Using the data from Table 8, plot the line graphs on the grid given below. Draw lines of best fit. [4]A



Correct scale
Appropriate axes with units
All points plotted correctly
Lines of best fit

(ii) With reference to Table 8, explain the difference in the rate of photosynthesis at high carbon dioxide concentration compared to low carbon dioxide concentration. [2]A

a. **more carbon dioxide available for light independent reaction to take place;**
b. **producing more glucose/products hence leading to increase in rate of photosynthesis;**

(iii) With reference to Table 8, describe **and** explain the effect of increasing day length on the rate of photosynthesis for the *Z. marina* in high carbon dioxide concentration. [2]A

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a. **As day length increases rate of photosynthesis increases as daylength increased from 12 to 20 hours, rate of photosynthesis increased from 2.5 to 18.0 a.u.**
b. **More light is absorbed by chlorophyll in the light dependent reaction;**

(b) In the laboratory, a seaweed was grown in water with different pH values. All other variables, including temperature and light, were standardised.

The mean rate of photosynthesis was calculated over a 24-hour period for each pH value.

The results are shown in Fig 8.1.

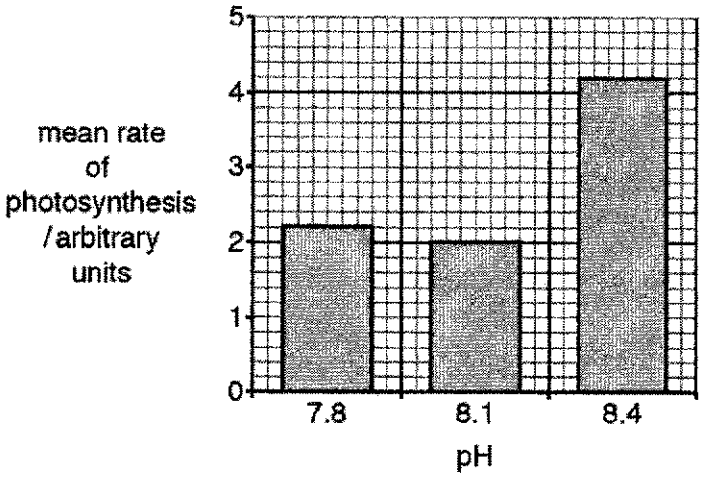


Fig. 8.1

With reference to Fig. 8.1, explain the effect on the rate of photosynthesis when the pH increases from 8.1 to 8.4. **[2]**[A]

a. **When pH increased from 8.1 to 8.4, the rate of photosynthesis increased from 2.0 to 4.2 a.u.;**
b. **As the optimum pH for photosynthetic enzymes is 8.4;**

[Total: 10]

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9 Fig. 9.1 shows a pollen grain with a pollen tube growing from it.

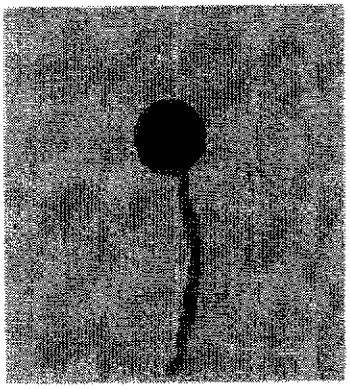


Fig. 9.1

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

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

Table 9 shows the results of the investigation.

Table 9

% sucrose concentration	% of pollen grains germinated	mean pollen tube length/ mm
1	6	0.005
2	13	0.008
[redacted]	25	0.015
[redacted]	56	0.040
10	31	0.030
20	25	0.018
40	13	0.006

(a) (i) A total of 12 pollen grains were placed in the 20% sucrose solution.
Use the information in the table to calculate the number of pollen grains that germinated to produce a pollen tube in the 20% sucrose solution. **[1]**[A]

25/100 x 12 = 3

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(ii) Use the information in the table to suggest the optimum (best) concentration of sucrose solution for pollen tube germination and growth. Explain how the information in the table enabled you to reach this conclusion. **[2]**[A]

a. **8%;**
b. **highest % number germinated at 56% and longest mean pollen tube length at 0.040mm;**

(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 **(a)(iii)** may result in a lower percentage of germination. **[2]**[A]

a. **water potential is higher in the pollen grain than sucrose solution;**
b. **water leaves the pollen grain down the water potential gradient by osmosis;**

(b) Describe the role of a growing pollen tube in plant reproduction. **[5]**[K]

a. **As the pollen tube grows, it secretes enzymes to digest the surrounding tissue of the stigma and style towards the ovary;**
b. **The pollen tube enters the ovule usually through an opening in the ovule wall called the micropyle;**
c. **The generative nucleus in the pollen tube divides to form two male gametes;**
d. **Within the ovule, the tip of the pollen tube absorbs sap and bursts, releasing the two male gametes;**
e. **The male gamete fuses with the ovum in the ovule and another will fuse with the endosperm nucleus;**

[Total: 10]

10 EITHER

(a) Describe the double circulation of blood in the human circulatory system. **[6]**[U]

a. **Blood flows through heart twice;**
b. **Deoxygenated blood is pumped to the lungs from the right ventricle through the pulmonary artery at lower pressure;**
c. **Where it becomes oxygenated and releases carbon dioxide;**
d. **Blood returns to the left atrium via the pulmonary vein**
e. **Blood is pumped to body tissues / systemic circulation from the left ventricle at high pressure;**
f. **To deliver oxygen / glucose (to body tissues) and collects carbon dioxide;**
g. **Blood returns to the right atrium via the vena cava at low pressure**

(b) Describe the structure of a capillary and the transfer of a named material between capillaries and tissue fluid. **[4]**[K]

a. **Capillary walls are one cell thick;**
b. **With small lumen to allow a RBC to flow through**
c. **It has pores/leaky walls**

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d. This allows for diffusion of oxygen and glucose from capillaries to tissue cells and carbon dioxide and urea from tissue cells to capillaries.

10 OR

(a) Describe the roles of enzymes in human digestion. Give examples in your answers. **[4]^{K}**

a. Biological catalyst to speed up the rate of digestion; [1]
b. Named enzyme and substrate in correct locations in the alimentary canal; E.g. pepsin in stomach breaks down proteins into polypeptide chains [2]
c. Ref to optimal pH for different enzymes; [1]

(b) Describe the sequence of events that occur after a human egg cell is fertilised which enable it to develop and survive in the uterus. **[6]^{U}**

a. Zygote divides by mitosis to form an embryo in the oviduct;
b. The contraction of the oviduct pushes the embryo to the uterus where it will implant into the uterine lining;
c. Embryonic villi will grow into the wall of the uterus and placenta is formed from the embryonic villi and uterine lining;
d. Nutrients (glucose and amino acids), gases (oxygen, carbon dioxide) and waste products (urea) are exchanged between the developing foetus and the mother;
e. Antibodies are also passed from mother to foetus to protect foetus against diseases;
f. An amnion filled with amniotic fluid forms around the foetus;
g. Allows for support and cushioning of the foetus against physical injury/shock OR also allows the fetus to move freely during growth promoting muscular development;

[must mention both functions of placenta and amniotic sac to get full marks]

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