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Name:	Index Number:	Class:
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YIO CHU KANG SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2024

SECONDARY FOUR EXPRESS



BIOLOGY

Paper 1

6093/01

1 hour

Additional Materials:
Optical Answer Sheet (OAS)

9 September 2024 (Monday)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil on the OAS.

Do not use staples, paper clips, glue or correction fluid.

Write your name, index number and class on the OAS in the spaces provided.

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 OAS.

Read the instructions on the OAS very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

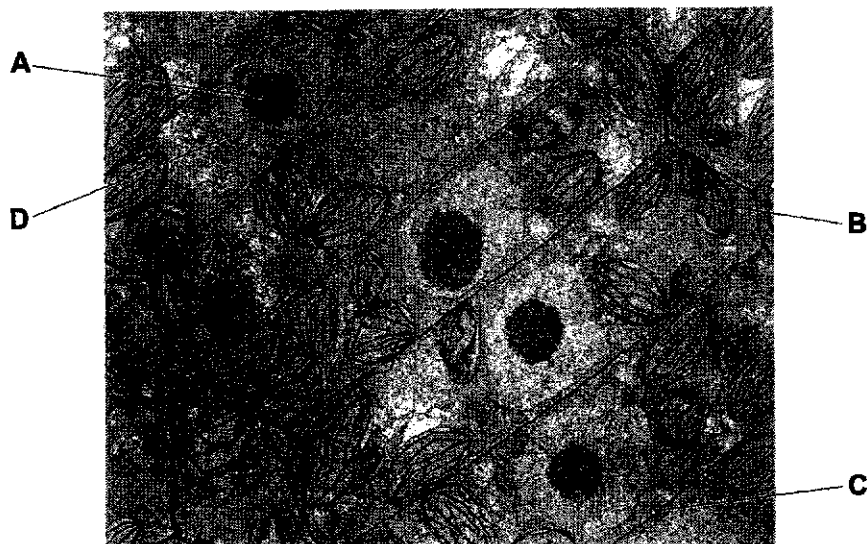
Any rough working should be done in this question paper.

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

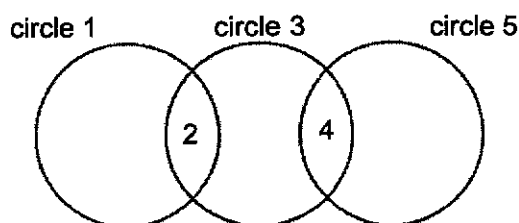
For Examiner's Use
40

- 1 The electron micrograph shows some cells from a plant.

Which cell structure is not usually found in cells from a root?



- 2 The diagram shows three circles, 1, 3 and 5, and the shared structures, 2 and 4.



Which row correctly identifies the three circles and some of the structures that are shared between them?

	circle 1	2	circle 3	4	circle 5
A	muscle cell	no nucleus	red blood cell	mitochondria	xylem vessel
B	muscle cell	cytoplasm	xylem vessel	cell membrane	red blood cell
C	red blood cell	cell membrane	muscle cell	chloroplast	xylem vessel
D	xylem vessel	no nucleus	red blood cell	cell membrane	muscle cell

- 3 What happens to the surface area to volume ratio of a cube when the length of each side is doubled?
- A** The ratio decreases by four times.
- B** The ratio halves.
- C** The ratio doubles.
- D** The ratio increases by four times.

- 4 Which row identifies how ions and molecules move by active transport?

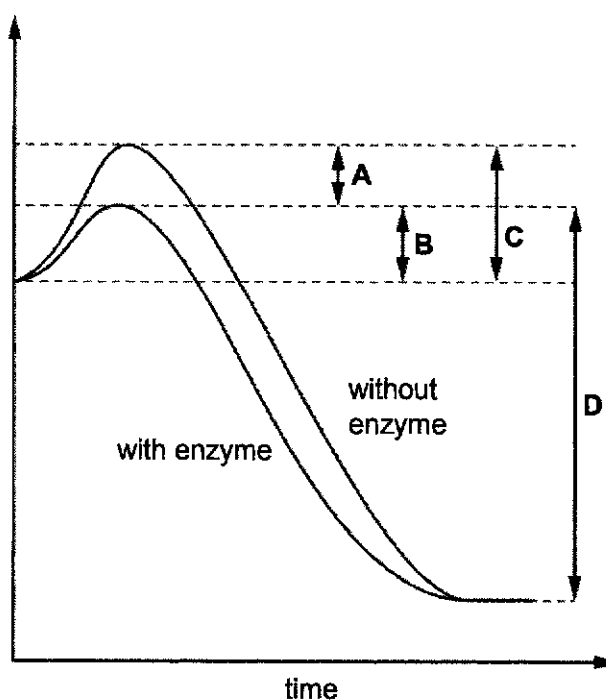
	against concentration gradient	down concentration gradient	through a membrane	requiring energy
A	✓	✗	✓	✓
B	✓	✗	✓	✗
C	✗	✓	✗	✗
D	✗	✓	✓	✓

- 5 Some health problems can be detected using chemical tests for protein and glucose in the urine.

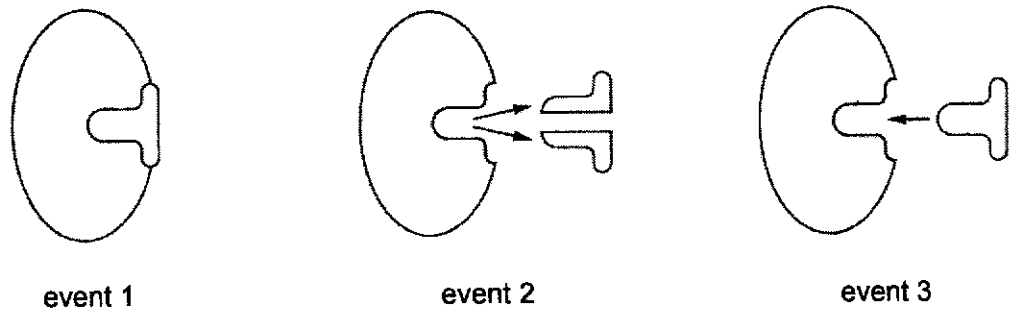
Which row shows the results for a person with protein and glucose in their urine?

	Benedict's solution	biuret reagent	ethanol	iodine solution
A	blue	blue	white emulsion	brown
B	blue	violet	colourless	blue-black
C	red	blue	white emulsion	blue-black
D	red	violet	colourless	brown

- 6 Which region on the graph shows the activation energy of an enzyme-catalysed reaction?



- 7 These diagrams show the interaction between an enzyme molecule and a substrate molecule. The diagrams were listed by number.



Four students were asked to match the descriptions to the diagrams. The descriptions were listed by letter.

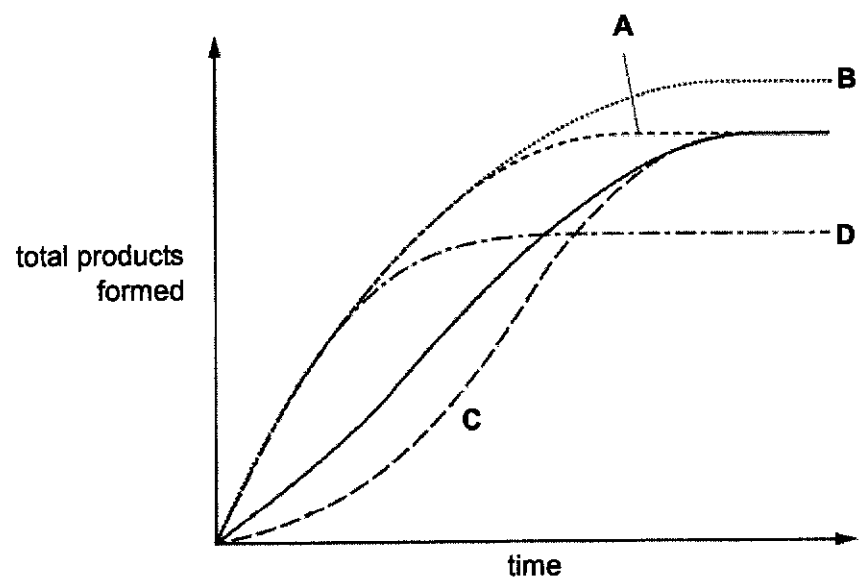
- V A chemical reaction occurred, and the substrate is broken down into its products.
- W Active site of enzyme is unoccupied, and substrate can fit in.
- X An enzyme-substrate complex is formed.
- Y Enzyme remained chemically unchanged at the end of the reaction.
- Z Only substrates complementary to the active site of the enzyme can fit in.

Which student correctly matched the event to the descriptions to the diagram?

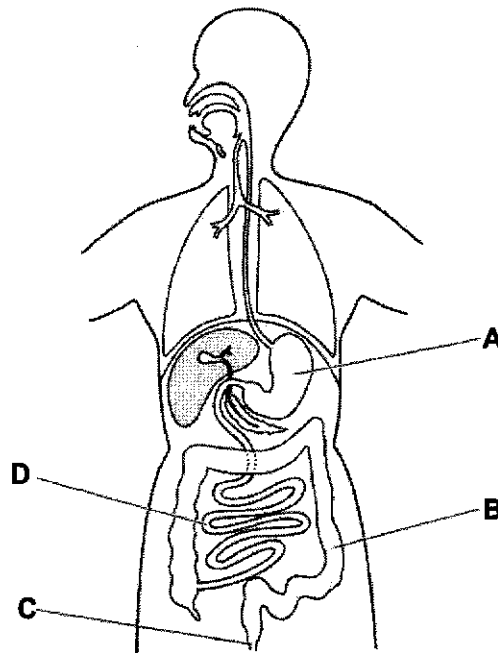
	event 1	event 2	event 3
A	V	W and Z	X and Y
B	W	X and Y	V and Z
C	X	V and Y	W and Z
D	Z	V and W	X and Y

- 8 The solid line on the graph represents the amount of products formed over time for a reaction in a cell.

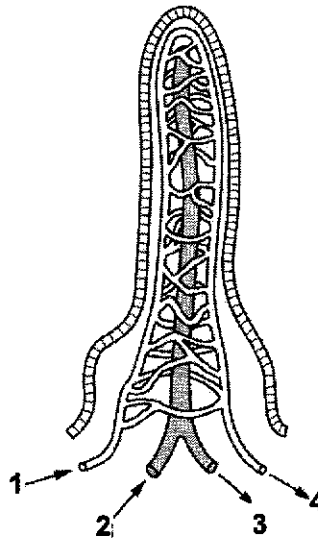
Which other line represents the effect of adding the enzyme for this reaction?



- 9 The diagram shows the digestive system. Which part absorbs the most water?



- 10 The diagram shows a villus. The arrows show the direction of flow within vessels associated with the villus.

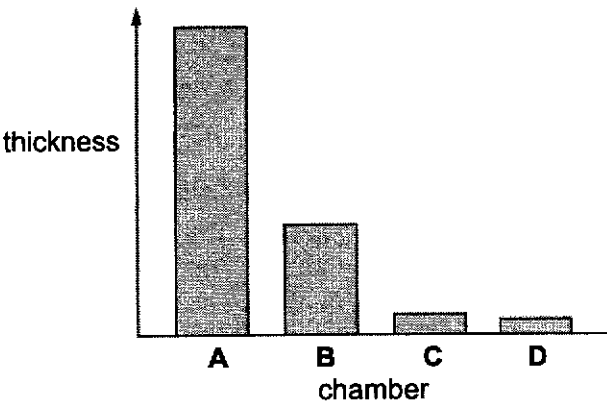


Which of the following correctly compared the concentration of substances transported in the vessels?

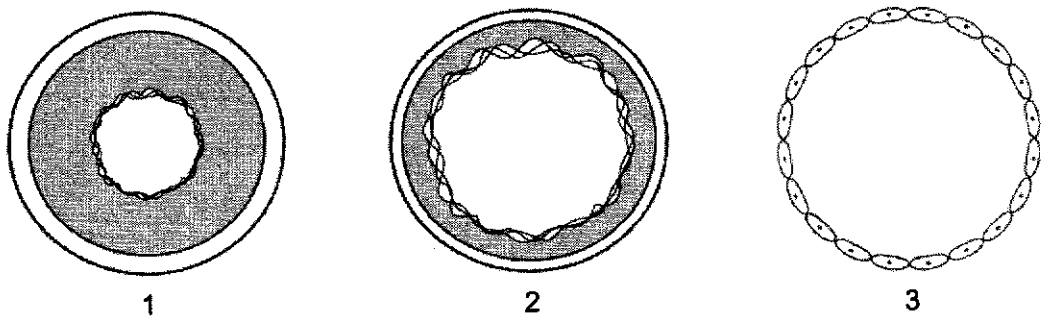
	concentration of glucose	concentration of amino acids	concentration of fats
A	highest in 2 and 3	highest in 1	lowest in 1 and 4
B	highest in 4	lowest in 1	highest in 2
C	lowest in 1	highest in 2	lowest in 2
D	lowest in 2 and 3	highest in 4	highest in 3

- 11 The graph shows the thickness of the muscular wall in each of the four chambers of the mammalian heart.

Which chamber is the right ventricle?



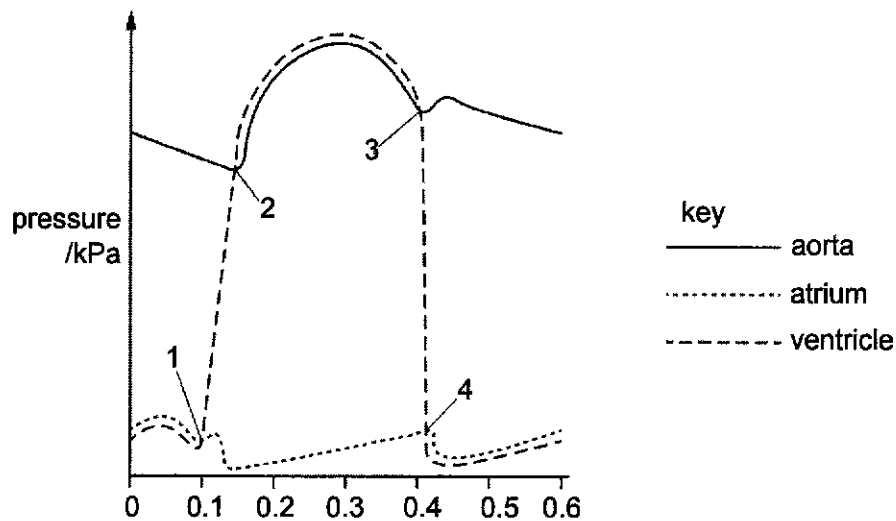
- 12 The diagrams show sections through three types of blood vessel. They are not drawn to the same scale.



Which of the following descriptions best represents the blood vessels?

	blood vessel 1	blood vessel 2	blood vessel 3
A	allows exchange of substances	most contains valves	can undergo vasodilation
B	can undergo vasodilation	allows exchange of substances	most contains valves
C	can withstand high blood pressure	most contains valves	allows exchange of substances
D	most contains valves	can undergo vasodilation	allows exchange of substances

- 13 The diagram gives information about blood pressure in the left side of the heart during the cardiac cycle.



Valves open and close at the points numbered.

Which row identifies the valves opening or closing at the points numbered?

	bicuspid valve opens	semilunar valve open	bicuspid valve close	semilunar valve close
A	1	3	4	2
B	2	4	3	1
C	3	1	2	4
D	4	2	1	3

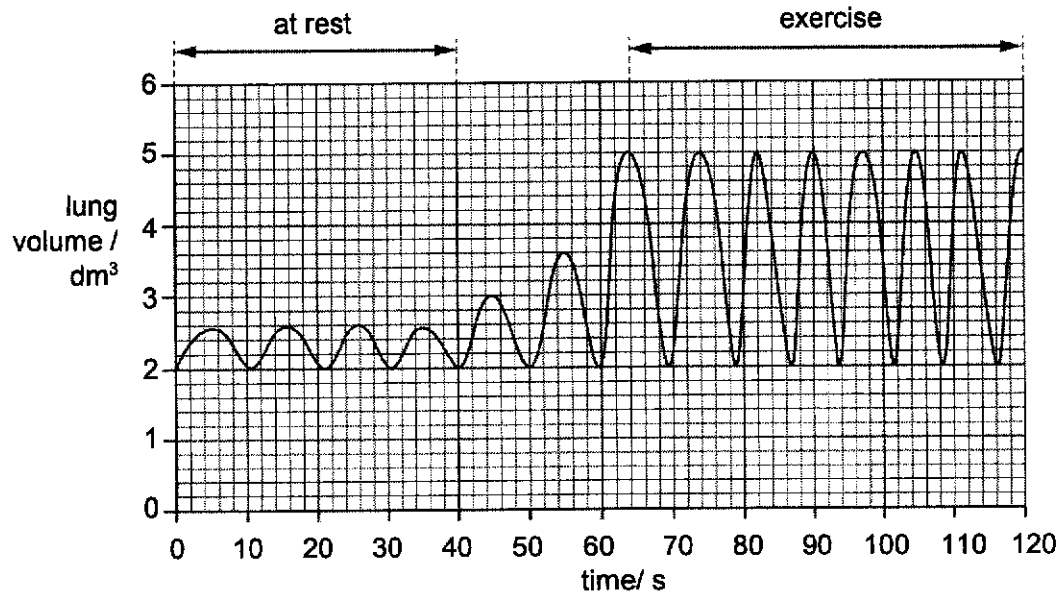
- 14 During inspiration, the processes listed take place.

- P volume of the thorax increases
- Q air rushes into the lungs
- R pressure in the thorax decreases
- S external intercostal muscles contract
- T diaphragm moves down, ribs move upwards and outwards

What is the correct sequence for these processes?

- A** Q → P → S → R → T
- B** S → T → P → R → Q
- C** Q → P → S → T → R
- D** S → Q → R → P → T

- 15 The graph shows the changes in lung volume during breathing when a person was at rest and then when they began to exercise.



From resting to exercise, the volume of air breathed in at each breath increased fromx..... dm^3 toy..... dm^3 .

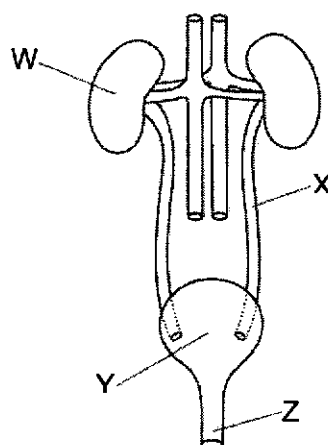
Looking at the graph, which numbers correctly complete the gaps in the sentence?

	x	y
A	0.5	3.0
B	0.5	5.0
C	2.0	5.0
D	5.0	2.0

- 16 Which row shows where glucose will be found in the body of a healthy human after eating a meal?

	renal artery	renal vein	glomerulus	nephron	ureter
A	no	yes	no	no	yes
B	yes	no	yes	yes	yes
C	yes	yes	no	no	no
D	yes	yes	yes	yes	no

- 17 The diagram shows parts of the body involved in excretion in humans.

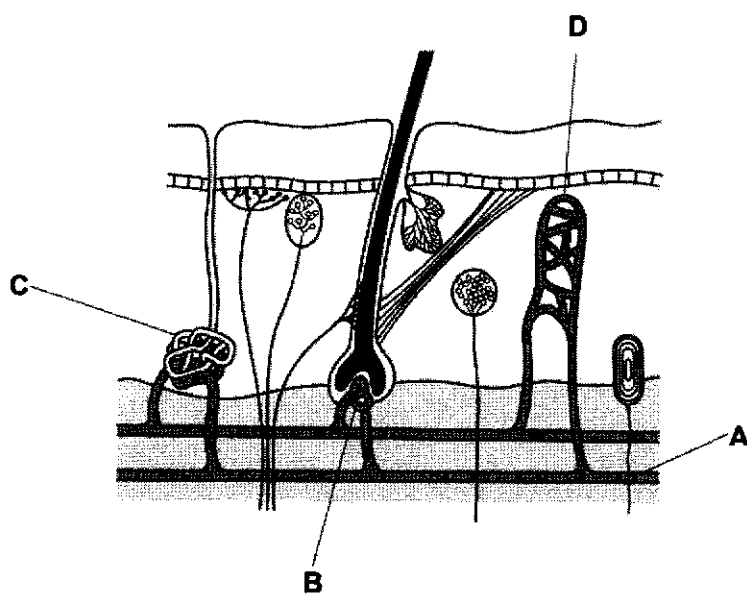


What are the labelled parts?

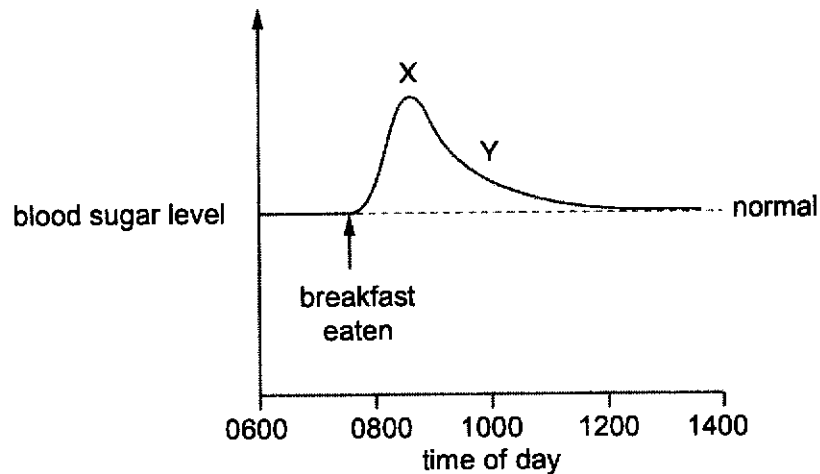
	W	X	Y	Z
A	bladder	ureter	kidney	urethra
B	bladder	urethra	kidney	ureter
C	kidney	ureter	bladder	urethra
D	kidney	urethra	bladder	ureter

- 18 The diagram shows the structure of the human skin.

Which structure constricts to reduce heat loss?



- 19 The graph shows the blood sugar level for a person over eight hours. He did not exercise during this time.



Which statement explains the shape of the graph between X and Y?

- A The pancreas produces glucagon which causes excess sugar in the blood to be converted to glycogen.
 - B The liver produces insulin which causes excess sugar in the blood to be converted to glycogen.
 - C The pancreas produces insulin which causes excess sugar in the blood to be converted to glycogen.
 - D The liver produces glucagon which causes excess sugar in the blood to be converted to glycogen.
- 20 Descriptions of the body's response to changes in temperature are listed.

- 1 Hair erector muscles contract.
- 2 Hair erector muscles relax.
- 3 Sweat evaporates from the skin.
- 4 Muscles contract spontaneously.

Which descriptions occur when the body loses heat?

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

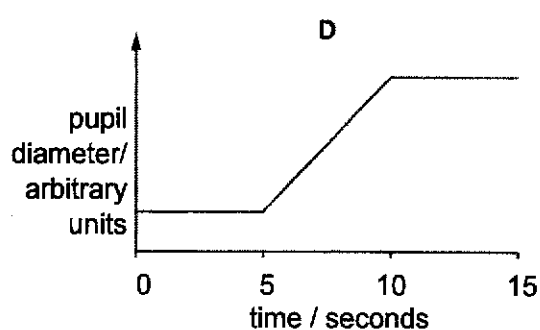
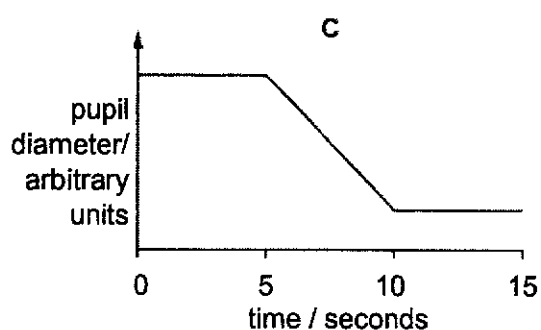
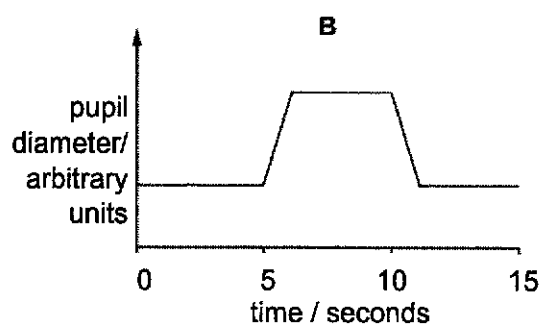
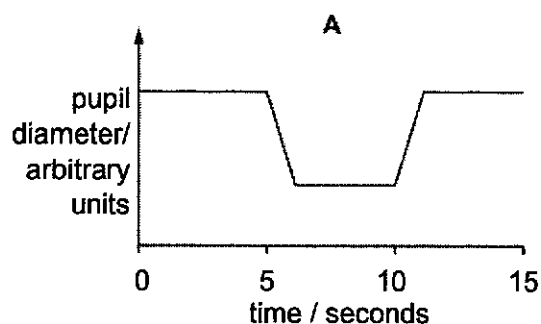
- 21** A student was asked to compare a typical spinal reflex action with a voluntary action. He has made one mistake in his comparison.

Which row shows the incorrect statement?

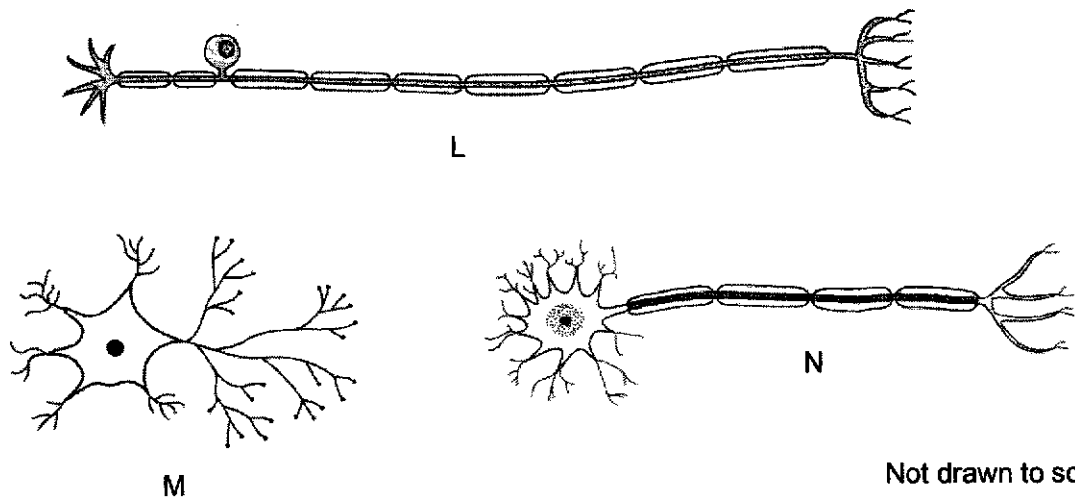
	reflex action	voluntary action
A	rapid response to a stimulus	response may be slow
B	initiated by the response of a receptor to a stimulus	initiated from the brain by conscious thought
C	the nervous impulse takes the longest pathway	the nervous impulse takes the shortest pathway
D	effectors are muscles or glands	effectors are muscles only

- 22** A person is sitting in a darkened room. After five seconds, a light is turned on. Five seconds after that, the light is turned off again.

Which graph shows the changes in the diameters of their pupils?

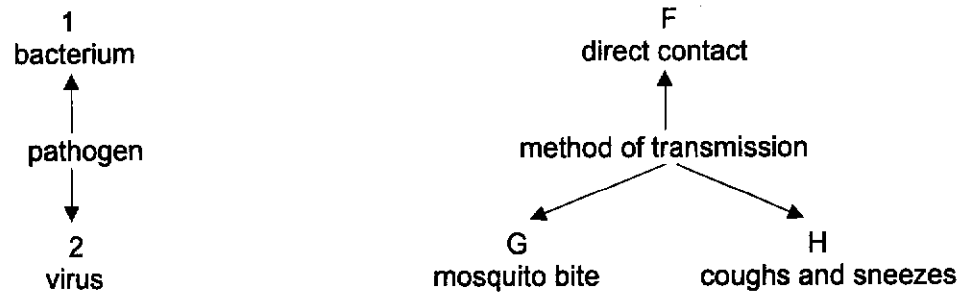


- 23 The diagrams show three types of neurones.



Which sequence shows the direction that impulses will travel during a reflex action?

- A $L \rightarrow M \rightarrow N$
- B $M \rightarrow L \rightarrow N$
- C $M \rightarrow M \rightarrow L$
- D $N \rightarrow M \rightarrow L$
- 24 The diagram shows some of the pathogens that cause disease in humans and some of the ways they are transmitted.

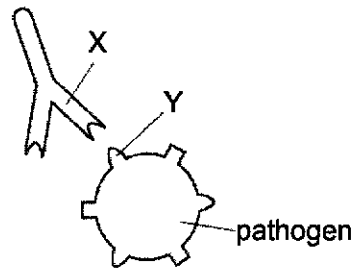


What is the correct pathogen and methods of transmission for influenza?

- A 1, F and H
- B 1, G and H
- C 2, F and G
- D 2, F and H

- 25** When a pathogen enters the blood, the immune system uses different mechanisms to destroy the pathogen.

The diagram shows one of these mechanisms.



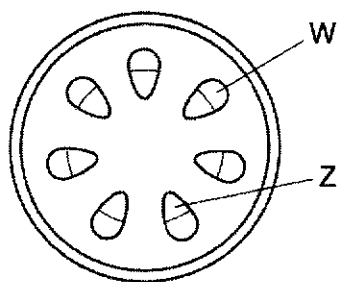
Which row describes the structures involved?

	structure X	X is made by	structure Y
A	antibody	lymphocytes	antibody
B	antibody	phagocytes	antigen
C	antigen	lymphocytes	antibody
D	antigen	phagocytes	antigen

- 26** What is an example of an infectious and non-infectious disease?

	infectious disease	non-infectious disease
A	AIDS	fatty liver
B	coronary heart disease	asthma
C	fatty liver	coronary heart disease
D	influenza	AIDS

- 27 The plan diagram of a transverse section through a dicotyledonous plant stem was drawn by a student. They had stained the section with a chemical that stains lignin.



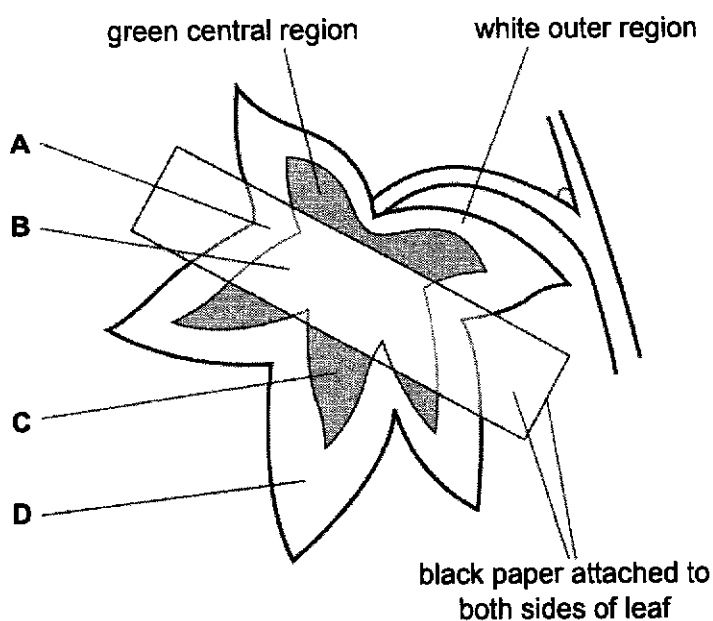
Which row is correct for tissues W and Z?

	W	Z	stained tissue
A	phloem	xylem	W
B	phloem	xylem	Z
C	xylem	phloem	W
D	xylem	phloem	Z

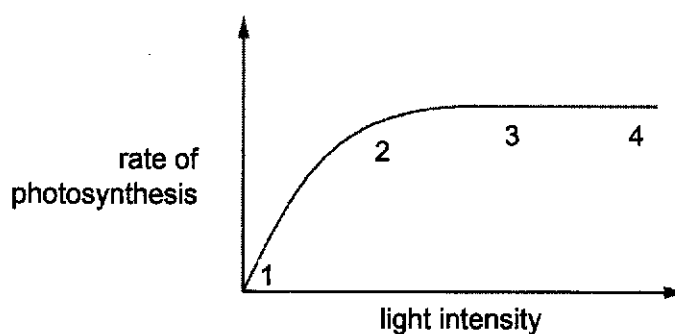
- 28 A plant with variegated leaves was placed in a dark cupboard for 48 hours so that all the starch was removed from the leaves.

The variegated leaves have green parts and white parts. Black paper was then fixed on one leaf and the plant was exposed to light.

After 24 hours, which region of the leaf contained starch?



- 29 The graph shows the rate of photosynthesis with increasing light intensity.

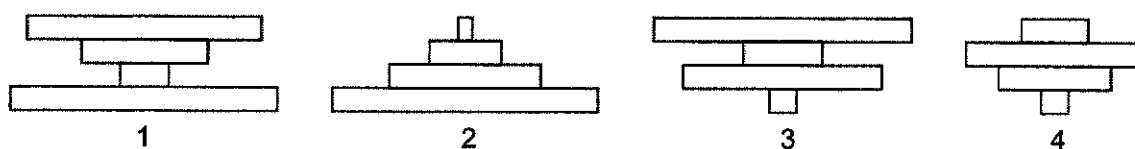


Where is light intensity a limiting factor for photosynthesis?

- A between 1 and 2
 B between 1 and 3
 C between 2 and 4
 D between 3 and 4
- 30 Which combination of environmental factors will cause the largest increase in the transpiration rate in a plant?

	humidity	temperature	light intensity
A	high	high	low
B	high	low	high
C	low	high	high
D	low	low	low

- 31 A tree has insect larvae burrowing in its leaves. The emerging insects are eaten by birds and the birds have parasitic fleas living amongst their feathers.



Which pyramid is a pyramid of biomass and which pyramid is a pyramid of numbers for this food chain?

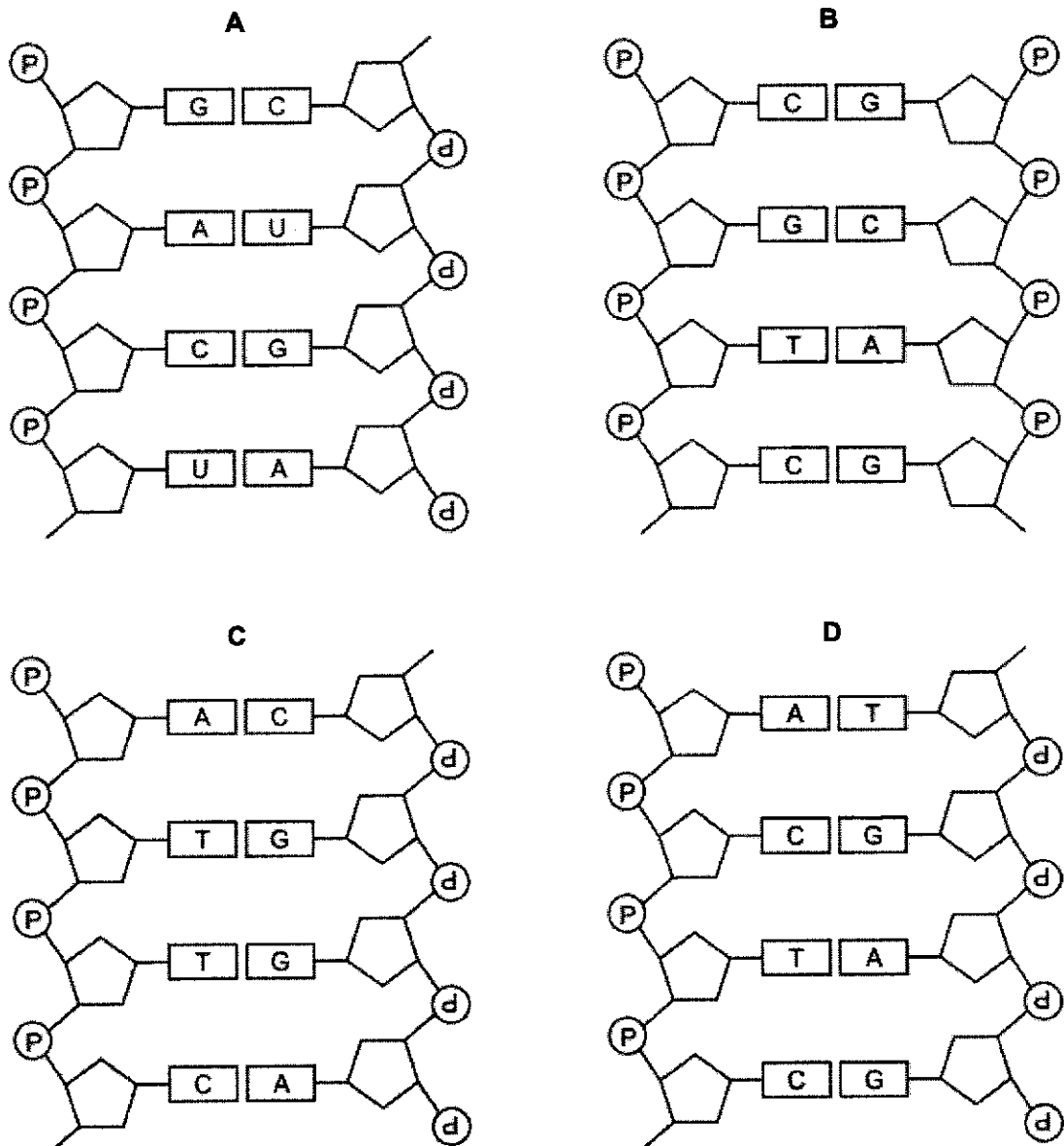
	pyramid of biomass	pyramid of numbers
A	1	3
B	1	4
C	2	3
D	2	4

- 32** The fossil fuels used as energy sources today developed from animal and plant remains buried millions of years ago.

What was the initial source of the energy in these fossil fuels?

- A** heat rising from the centre of the Earth trapped by the fuels
- B** heat released by decomposers feeding on dead animals and plants
- C** light energy absorbed by producers
- D** metabolic activity of the animals and plants in the oceans

- 33** Which diagram correctly shows the structure of a piece of DNA?



- 34** Sickle cell anaemia is caused by a mutation in an allele of the gene that codes for the β -globin polypeptide of haemoglobin.

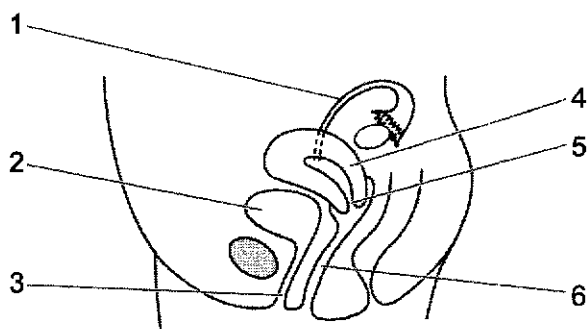
The diagram shows the sequence of bases in a small section of the template strand of DNA for both the Hb^A (normal) and Hb^S (sickle cell) β -globin alleles.

Hb^A CTGACTCCTGAGGAGAAGTCT
Hb^S CTGACTCCTGTGGAGAAGTCT

Both the polypeptides for Hb^A and Hb^S are the same length.

How will the mutation in the allele result in the production of an altered version of the β -globin polypeptide?

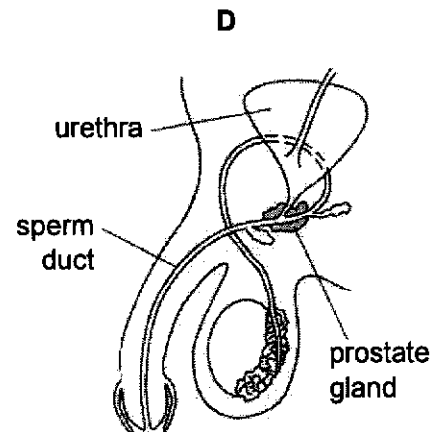
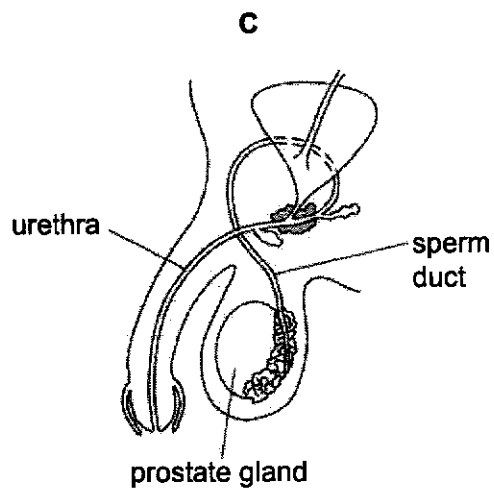
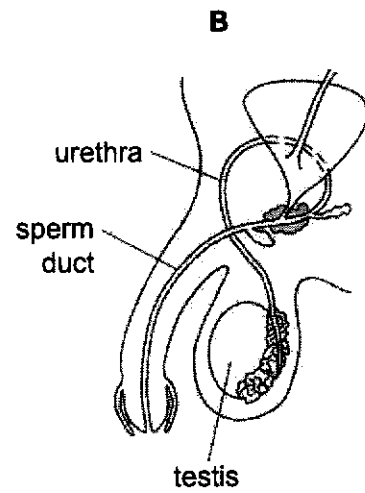
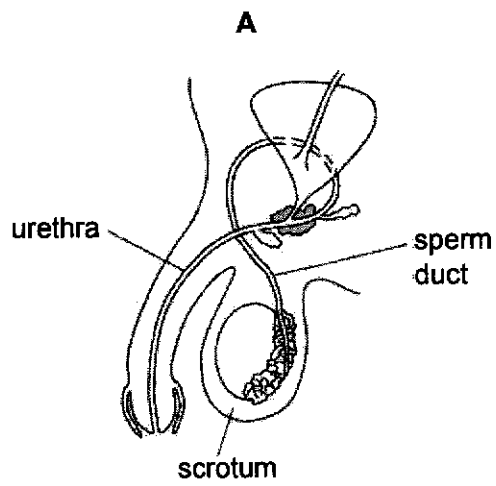
- A** All the amino acids coded for after the mutation will differ from those in the Hb^A protein.
- B** mRNA transcribed from the Hb^S allele will contain the codon CAC instead of the codon CTC.
- C** The mutation results in a different amino acid coded for in the Hb^S allele.
- D** The ribosome will be unable to continue translation of the Hb^S mRNA after the altered codon.
- 35** Two polynucleotide strands make up a DNA molecule. Which description is correct?
- A** The percentage of cytosine is 50% of that of guanine in the whole molecule.
- B** The percentage of cytosine is the same as that of guanine in the whole molecule.
- C** The percentage of cytosine is the same as that of guanine in each strand.
- D** The percentage of cytosine is the same in each strand of the molecule.
- 36** The diagram shows the female reproductive system.



Which row correctly labels the diagram?

	1	2	3	4	5	6
A	bladder	urethra	ureter	oviduct	uterus	cervix
B	oviduct	bladder	urethra	uterus	cervix	vagina
C	oviduct	bladder	urethra	ureter	uterus	cervix
D	urethra	bladder	ureter	uterus	cervix	vagina

37 Which diagram of the male reproductive system is correctly labelled?



38 Chlamydia, gonorrhoea and syphilis are sexually transmitted infections (STIs).

The table shows the numbers of people infected with these STIs in one country from 2014 to 2018.

year	number of people infected		
	chlamydia	gonorrhoea	syphilis
2014	1 400 000	350 000	19 000
2016	1 600 000	468 000	27 000
2018	1 800 000	583 000	35 000

The list shows some conclusions.

- 1 In 2014, there were 1050000 more people infected with chlamydia than were infected with gonorrhoea in 2014.
- 2 In 2016, the number of people infected with chlamydia was three times greater than the number of people infected with gonorrhoea.
- 3 In 2018, more people were infected with syphilis than with gonorrhoea.
- 4 The number of people with STIs has increased each year.
- 5 Between 2016 and 2018, the number of people infected with syphilis increased by 16000.

Which of the following are the correct conclusions?

- A** 1, 2 and 4
- B** 1 and 4
- C** 2, 3 and 5
- D** 4 and 5

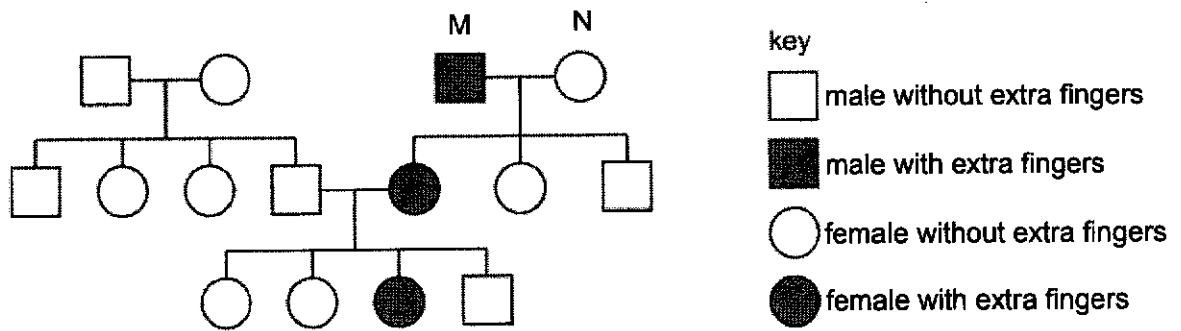
39 Which types of variation can be inherited?

	variation caused by genes	variation caused by the environment
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

key

✓ = yes
✗ = no

- 40 The diagram shows the inheritance of the allele, **E**, for polydactyly (having extra fingers) which is dominant over the allele for no extra fingers, **e**.



What are the genotypes of persons M and N?

	M	N
A	EE	ee
B	Ee	Ee
C	Ee	ee
D	ee	ee

END OF PAPER

Name:	Index Number:	Class:
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**YIO CHU KANG SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2024
SECONDARY FOUR EXPRESS**



BIOLOGY

Paper 2

6093/02

1 hour 45 minutes

9 September 2024 (Monday)

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on the cover page.

Write in dark blue or black ink.

You may use a soft pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Section A

Answer **all** questions in the spaces provided.

Section B

Answer **one** question in the spaces provided.

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

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

For Examiner's Use

Section A	/ 70
Section B	/ 10
Total	/ 80

SECTION A

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

- 1 Fig. 1.1 shows a diagram showing the pathway of water into a plant. The arrows show the direction of water movement.

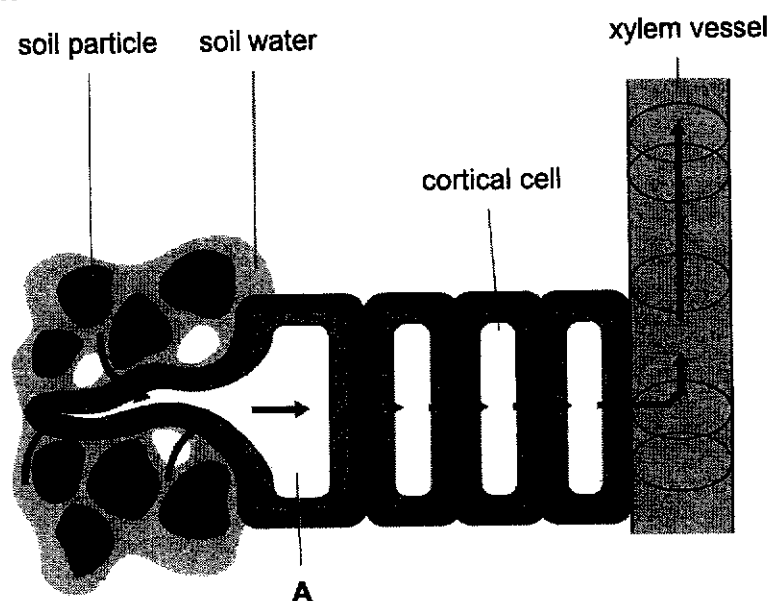


Fig. 1.1

- (a) (i) State the name of cell A and describe how it is adapted for absorption of water.

name

adaptation

[1]

- (ii) Explain the movement of water from the soil water to the xylem vessel shown in Fig. 1.1.

[3]

- 1 (b) A student investigated the rate of transpiration in a plant.

Fig. 1.2 is a diagram of the apparatus used in the investigation.

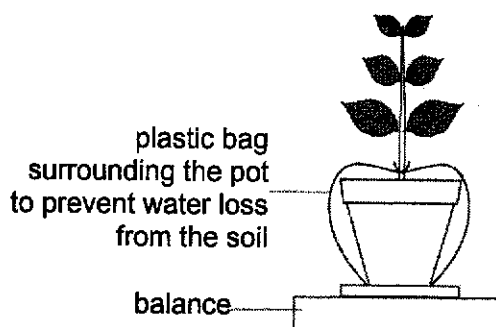


Fig. 1.2

- The student watered the plant before the investigation started.
- She measured the mass of water lost every five minutes.
- The mass of water lost represents the rate of transpiration.
- She took measurements in **still air** and **with moving air** surrounding the plant.
- She plotted her results on a graph with lines labelled **B** and **C**.

Fig. 1.3 shows the results.

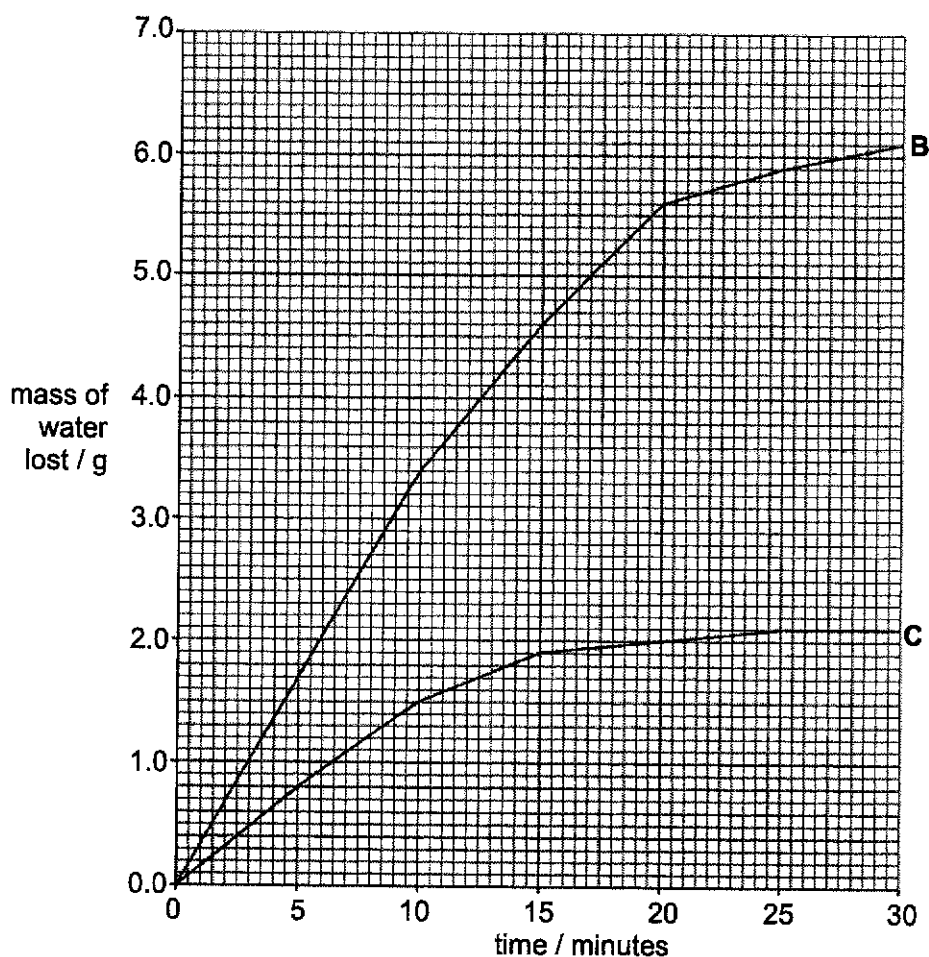


Fig. 1.3

- 1 (b) (i) Identify the set-up which represents graph **B** and **C**.

set-up with still air: graph

set-up with moving air: graph

[1]

- (ii) Explain the results in Fig. 1.3.

.....

.....

.....

.....

.....

..... [3]

- (c) Aphids have been used to investigate the translocation of sucrose in phloem tissue. While they are feeding on phloem sap, aphids excrete a sucrose-rich fluid known as honeydew.

In an investigation, two groups of four aphids were placed at intervals along the stem of a young willow plant, as shown in Fig. 1.4.

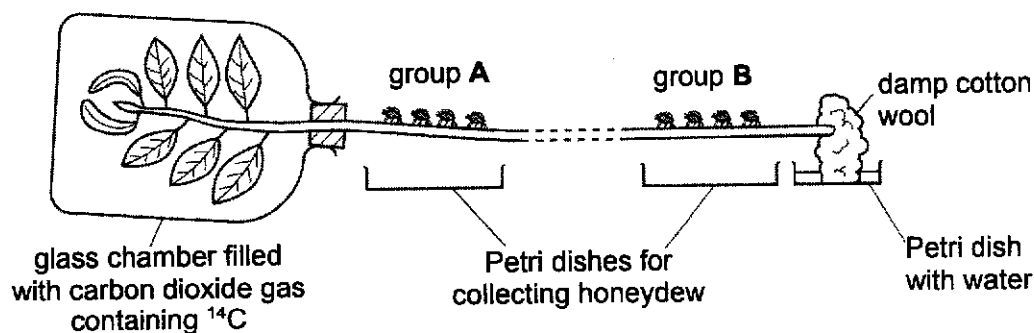


Fig. 1.4

The leaves were enclosed in an airtight glass chamber. A special form of carbon dioxide gas that contained radioactive carbon-14 (^{14}C) was supplied to the leaves for a short period of time.

Samples of honeydew were collected at intervals from the two groups of aphids. The time taken for sucrose containing ^{14}C to travel the distance between group **A** and group **B** was recorded.

The investigation was repeated twice using a fresh stem and different groups of aphids for each trial. The results are shown in Table 1.1.

- 1 (c) (i) Complete Table 1.1 by calculating the rate of movement of ^{14}C in trial 3.

Table 1.1

trial	distance between group A and group B on the stem/mm	time taken for ^{14}C to travel between group A and group B /minutes	rate of movement of ^{14}C / mm per hour
1	650	120	325
2	340	75	272
3	630	150	

[1]

- (ii) Outline how ^{14}C in carbon dioxide gas becomes incorporated into the sucrose molecules that are translocated in the phloem.

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..... [3]

[Total: 12]

- 2 Fig. 2.1 shows part of the alimentary canal and some of the associated organs.

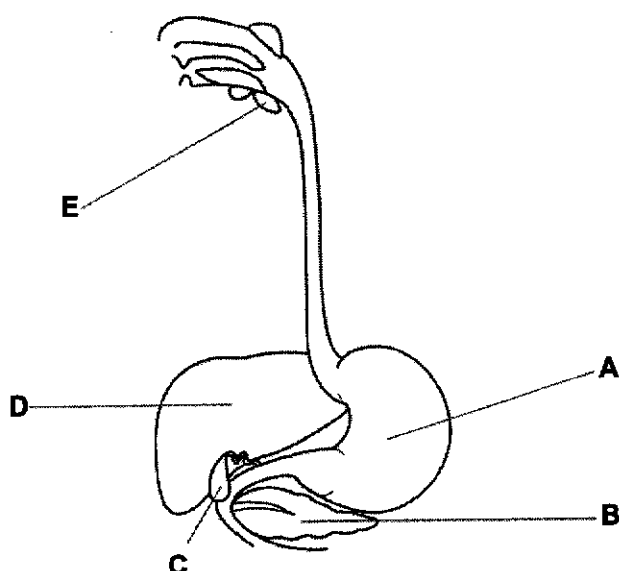


Fig. 2.1

- (a) State the letter that represents the organ which produces bile.

.....

[1]

- (b) A student investigated the effect of bile on the digestion of fat in milk.

He set up three different test-tubes:

- test-tube 1 contained milk and bile
- test-tube 2 contained milk and lipase
- test-tube 3 contained milk, lipase and bile.

He used an indicator that is pink in alkaline solutions and colourless in acidic solutions. He added the same volume of indicator to each test-tube.

The student observed and recorded the colour of the contents of each test-tube at 0 minutes, 20 minutes, and 40 minutes.

Table 2.1 shows the results of the investigation.

Table 2.1

test-tube	indicator colour observed		
	0 minutes	20 minutes	40 minutes
1	pink	pink	pink
2	pink	pink	colourless
3	pink	colourless	colourless

- 2 (b) (i) Explain the results for test-tubes 2 and 3 in Table 2.1.

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..... [3]

- (ii) Explain the purpose of test-tube 1 in Table 2.1.

.....

..... [1]

- (c) The action of lipase is affected by temperature.

Fig. 2.2 shows the axes for a graph of the effect of temperature on the activity of lipase.

Complete the graph by:

- drawing a line graph to show the expected effect of temperature on the activity of lipase
- adding a label line and a label to show the point at which all the lipase has been denatured.

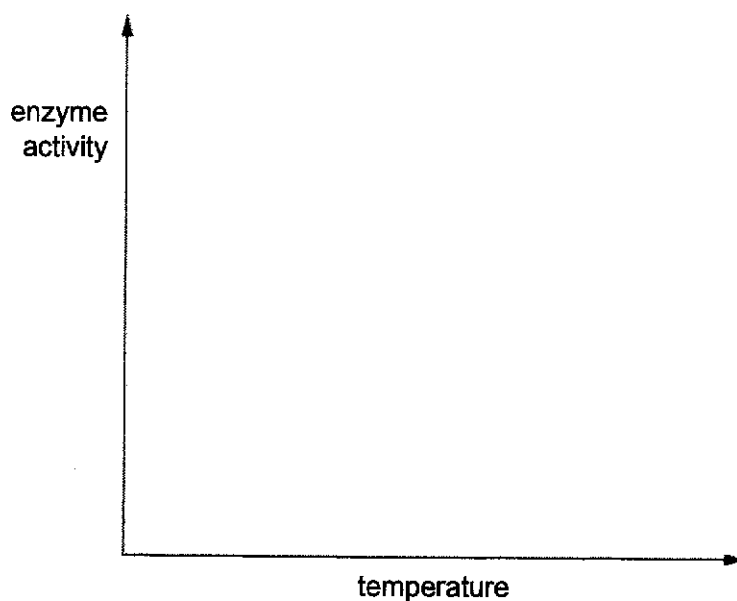


Fig. 2.2

[2]

[Total: 7]

- 3** Myopia is an eye condition. If a person has myopia, near objects can be seen clearly but not those that are far away.

It can happen when the eyeballs grow slightly too long as shown in Fig. 3.1.

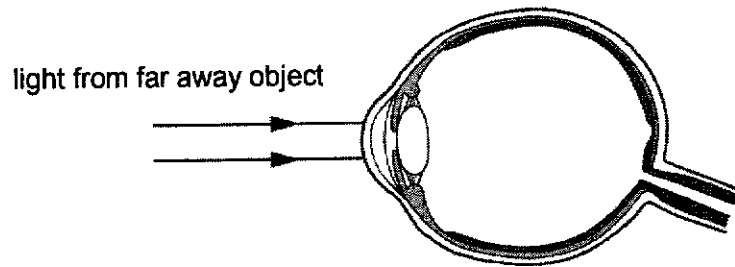


Fig. 3.1

- (a)** Explain how parts of the eye are involved in producing a clear image of a near object.

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.....

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.....

..... [3]

- (b)** Suggest why individuals with long eyeballs cannot see far-away objects clearly.

You may draw on the diagram of the eye in Fig. 3.1.

.....

..... [1]

[Total: 4]

4 Urea is a waste product formed in an organ.

(a) (i) Describe how urea is formed in the organ.

.....

 [1]

(ii) Describe the route taken by a molecule of urea formed in the organ to the kidneys.

Your answer should include all the blood vessels and organs involved.

.....

 [3]

(b) Kidneys are involved in the excretion of urea in urine.

Fig. 4.1 shows a drawing of a nephron in the human kidney and associated blood vessels.

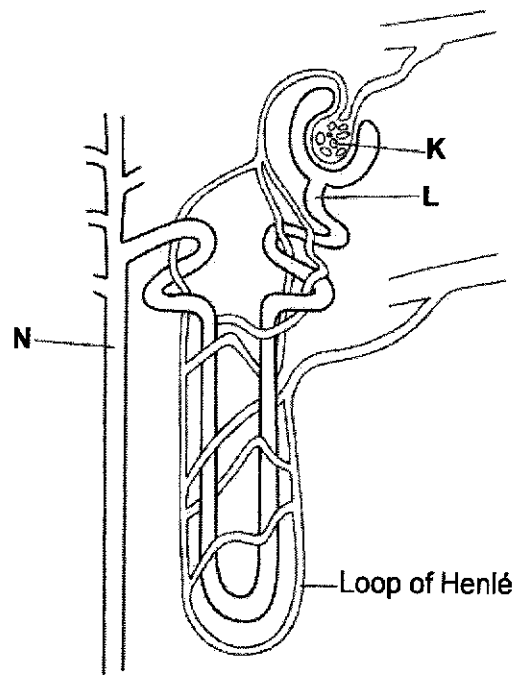


Fig. 4.1

- 4 (b) (i) Describe how structures **K** and **L** in Fig. 4.1 produce urine.

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.....

..... [2]

- (ii) Explain how anti-diuretic hormone (ADH) affects structure **N** to produce urine with a high concentration of urea.

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.....

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..... [2]

[Total: 8]

5 The discovery of antibiotics is a breakthrough in modern medicine.

(a) State **one** way how antibiotics is effective against bacteria.

.....
 [1]

(b) Antibiotic resistance is an increasing problem worldwide.

Erythromycin is an antibiotic.

Fig. 5.1 shows the daily doses of erythromycin per 1000 people over a 13-year period.

The number of bacterial infections resistant to erythromycin per 1000 people is also shown.

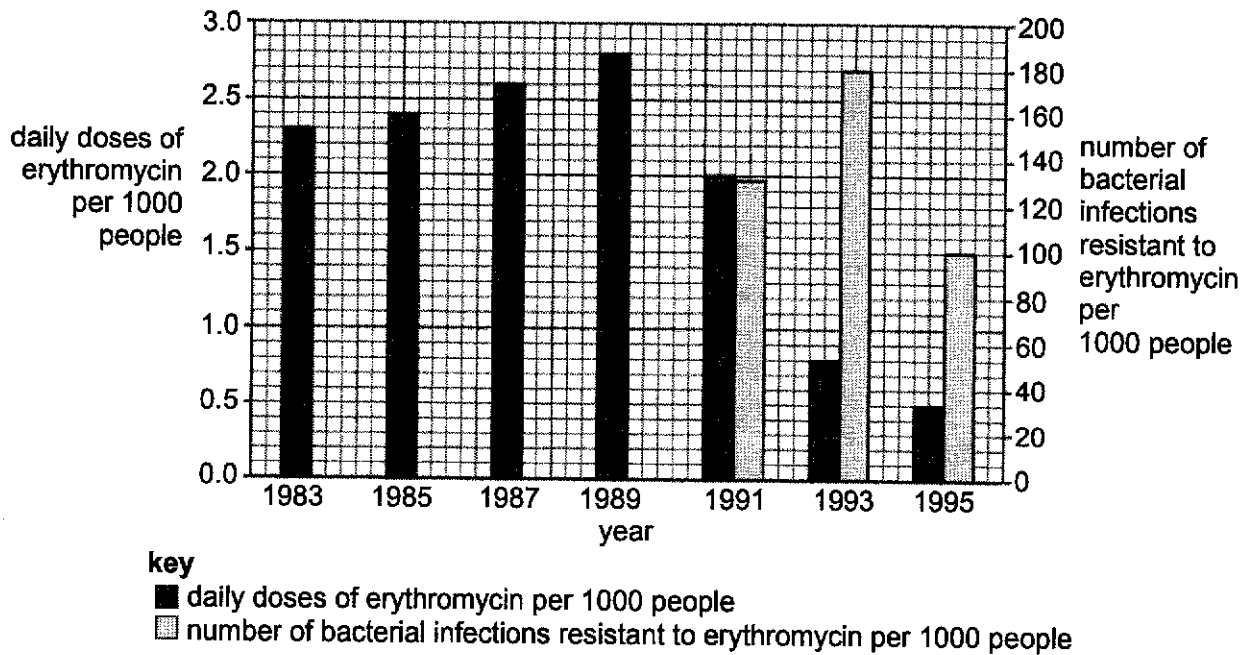


Fig. 5.1

(i) Calculate the percentage change in the number of bacterial infections resistant to erythromycin per 1000 people between 1993 and 1995.

Give your answer to two significant figures.

Show your working.

..... % [2]

- 5 (b) (ii) Describe the data shown in Fig. 5.1.

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..... [3]

- (iii) Suggest reasons for the change in the number of bacterial infections resistant to erythromycin from 1993 to 1995 shown in Fig. 5.1.

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..... [2]

- (c) The discovery of vaccines is another breakthrough in modern medicine.

Suggest **one** reason why the use of vaccine is more effective than the use of antibiotics.

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..... [1]

[Total: 9]

- 6 (a) Fig. 6.1 shows the stages involved in the production of insulin hormone.

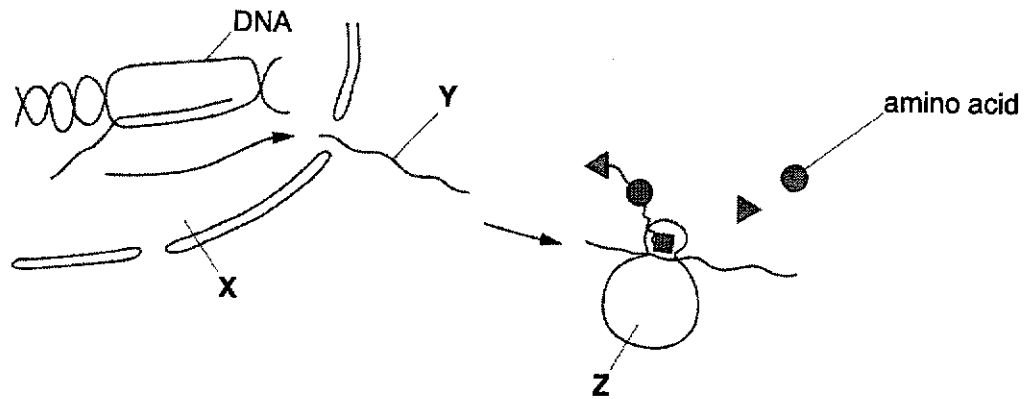


Fig. 6.1

- (a) (i) State the names of the parts labelled X, Y and Z in Fig. 6.1.

X

Y

Z

[3]

- (ii) With reference to Fig. 6.1, describe how an insulin hormone is produced.

.....

 [2]

- (iii) Suggest what determines the sequence of the amino acids in the insulin hormone that is produced.

.....
 [1]

- (iv) The stages involved in the production of insulin hormone is similar to the production of proteins.

Suggest why the sequence of amino acids is important in the production of antibodies.

.....

 [2]

- 6 (b) Fig. 6.2 shows the stages involved in the formation of a recombinant plasmid before it is inserted back into a bacterium.

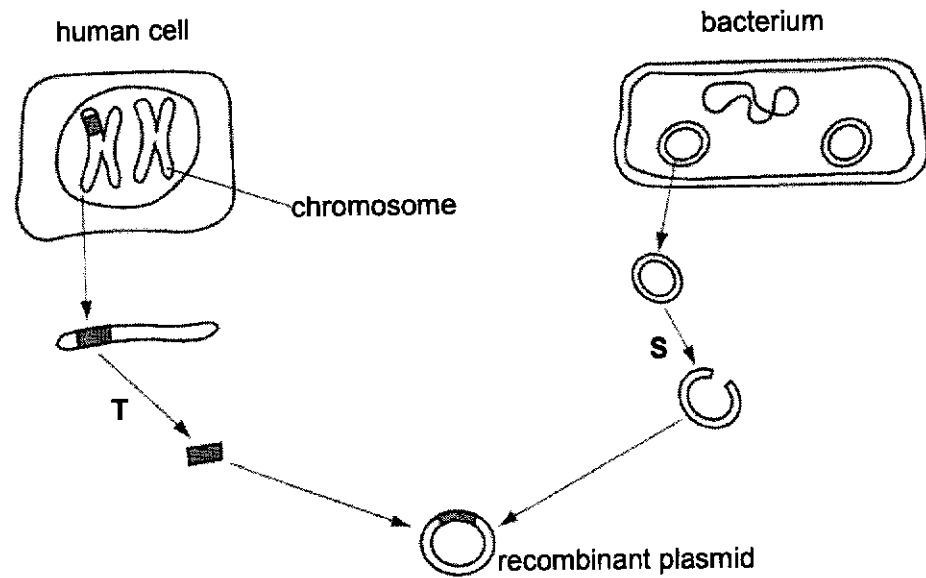


Fig. 6.2

Explain what happened at stages **T** and **S** to form a recombinant plasmid.

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..... [2]

[Total: 10]

- 7 A scientist monitored the changes in the pH in muscles of a student before, during and after two minutes of vigorous exercise, for a total of 30 minutes.

Tables 7.1a and 7.1b show the changes in pH in muscles.

Table 7.1a

time / minutes	pH in muscles
0	7.07
2	6.55
4	6.65
6	6.72
8	6.77
10	6.82
12	6.87
14	6.91

Table 7.1b

time / minutes	pH in muscles
16	6.94
18	6.97
20	6.99
22	7.00
24	7.02
26	7.03
28	7.05
30	7.06

- (a) (i) The data in Table 7.1b has been plotted in Fig. 7.1. Complete the line graph by plotting the data in Table 7.1a on the same axes on Fig. 7.1.

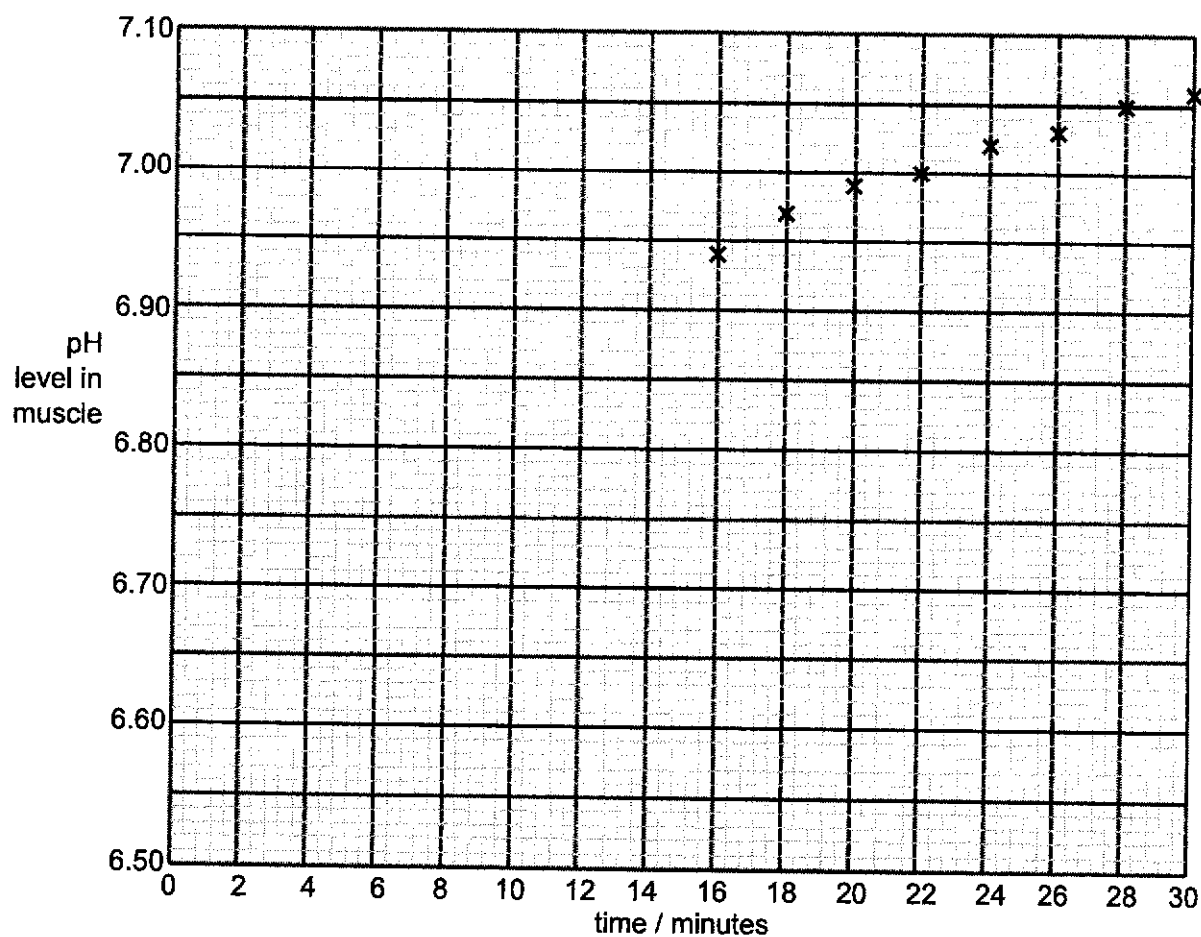


Fig. 7.1

- 7 (a) (ii) With reference to Fig. 7.1, explain the changes in pH in muscles for 0 to 2 minutes, and

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..... [3]

2 to 30 minutes.

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..... [2]

- (b) A scientist monitored the changes in the pH in muscles of another student, who is fitter.

On Fig. 7.1, draw a graph to show the changes in pH in the muscles of this student during and after two minutes of vigorous exercise.

[1]

[Total: 8]

- 8 Fig. 8.1 shows a town next to a freshwater river.

Between 1941 and 1963, an increasing amount of untreated sewage polluted the river.

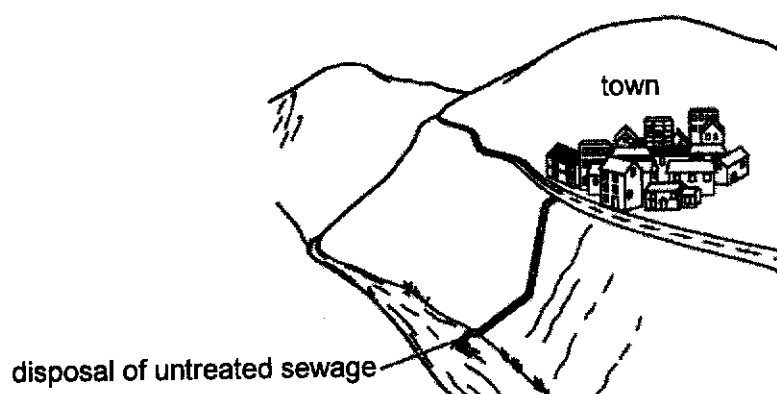


Fig. 8.1

- 8 (a) The disposal of untreated sewage in the river resulted in eutrophication.
Explain the effect of eutrophication on the river ecosystem.

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..... [3]

Between 1963 and 1968, new sewage treatment facilities were constructed.

By 1968, the amount of untreated sewage entering Lake Washington was reduced to zero.

Fig. 8.2 shows how the transparency of water in the lake has changed over time.

Water transparency is a measure of how far light travels through water.

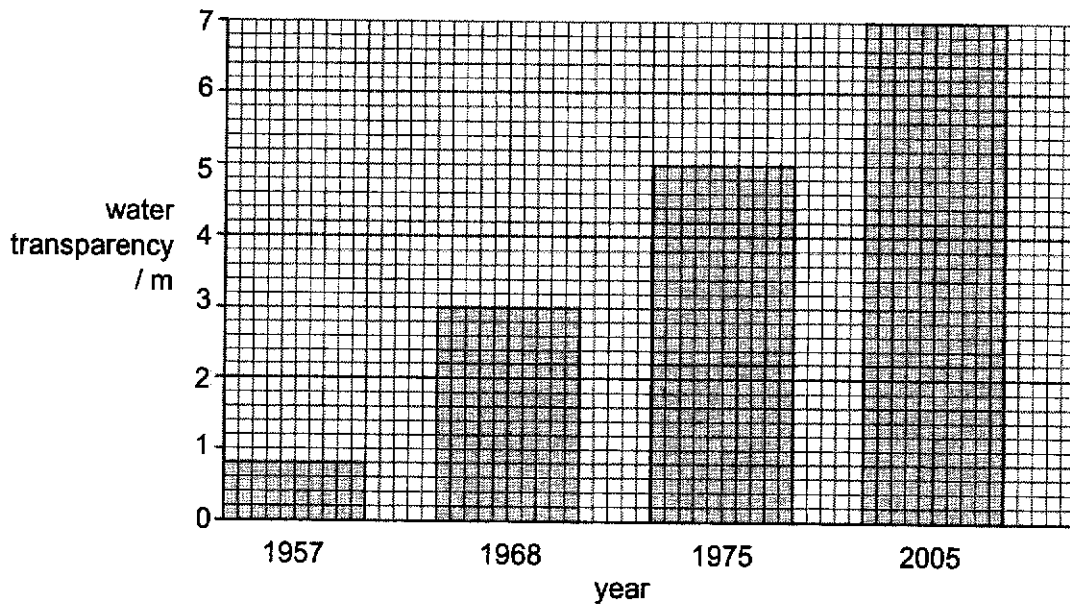


Fig. 8.2

- (b) Calculate the percentage increase in water transparency between 1957 and 1968.

.....% [1]

- 8 (c) One species of fish that lives in Lake Washington is the Three Spined Stickleback.

Fig. 8.3 shows three different distribution patterns of armour plates on the skin of these fish.

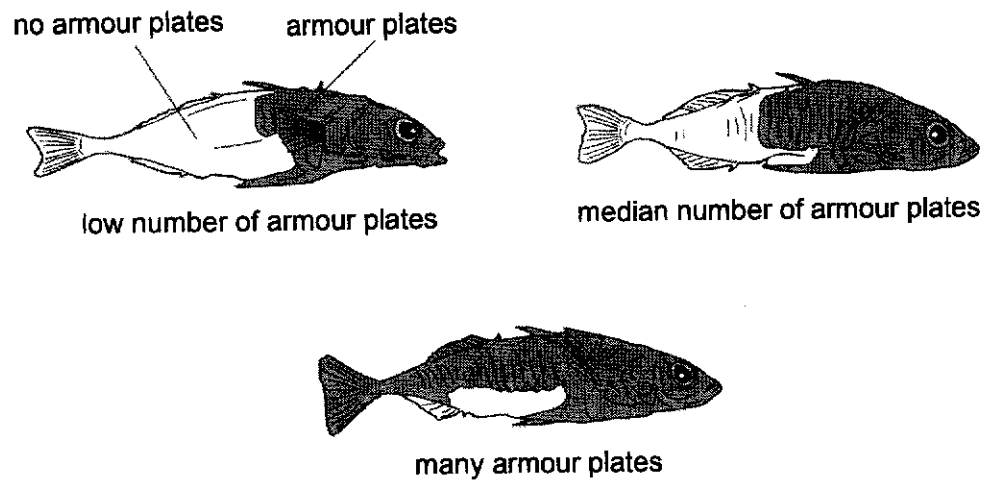


Fig. 8.3

Table 8.1 shows how the distribution patterns of armour plates on the skin of Three Spined Sticklebacks have changed over time.

Table 8.1

year	percentage of fish with each distribution		
	low number of armour plates	median number of armour plates	many armour plates
1957	91	9	0
1968	69	25	6
1975	25	35	40
2005	16	35	49

- (i) Use data from Table 8.1 to describe how the distribution patterns of armour plates have changed over time.

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..... [3]

- 8 (c) (ii) Armour plates on the skin of a Three Spined Stickleback protect it from predators.

With reference to Fig. 8.2 and 8.3, explain how the process of natural selection may have caused these changes in the distribution of plates over time as shown in Table 8.1.

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..... [5]

[Total: 12]

SECTION B

Answer only **one** question in this section in the spaces provided.

- 9 Fig. 9.1 shows the parts of two flowers from two different plants of the same species.

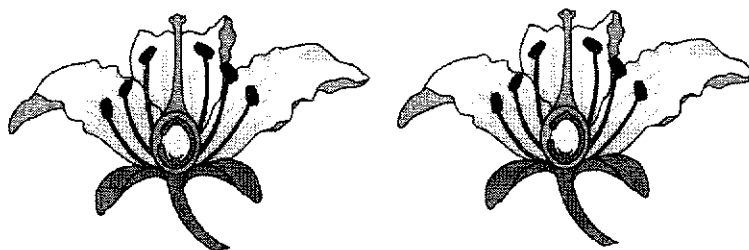


Fig. 9.1

Within the same species of flower, there are variations in the size of the petals.

Fig. 9.2 shows the relationship between the size of petals and the chance of successful cross pollination by bees in this species of flower.

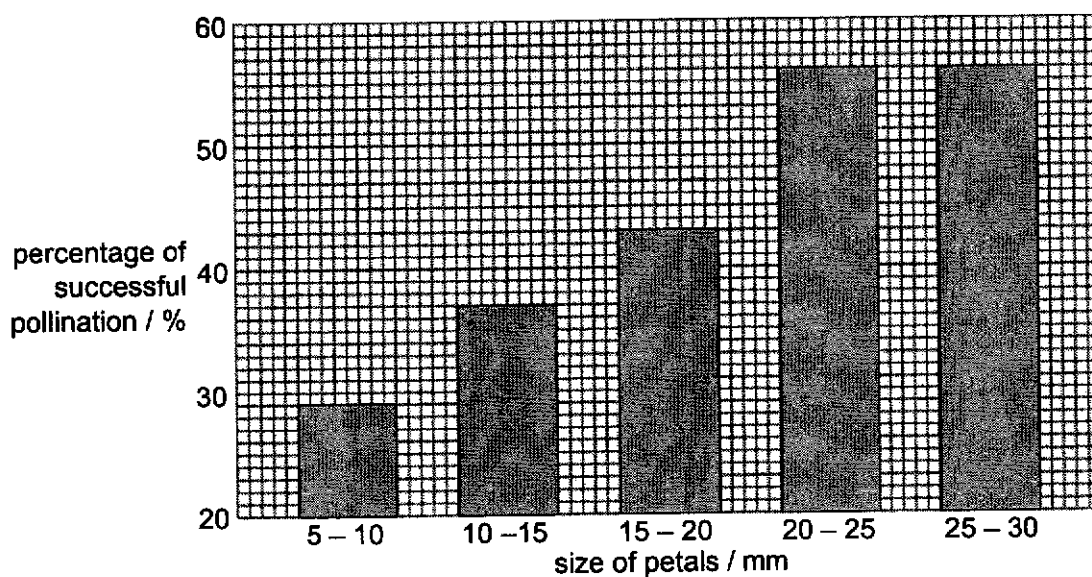


Fig. 9.2

- (a) (i) On Fig. 9.1 draw an arrow to show the pathway of the pollen grain during cross pollination. [1]
- (ii) Outline the events that lead to fertilisation after pollination.

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[3]

- 9 (b) Suggest why the rate of pollination increased as the size of petals increased from 5 to 20 mm.

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 [1]

- (c) Suggest why the rate of pollination remained constant as the size of petals increased from 20 to 30 mm.

.....
 [1]

- (d) Two flowers were cross pollinated.

Fig. 9.3 shows the number of offspring produced by the two parent plants.

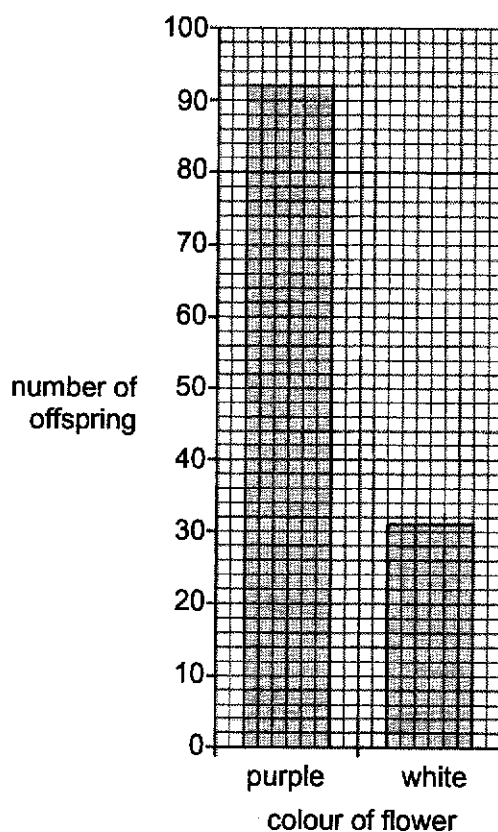


Fig. 9.3

- (i) State the phenotype and genotype of the parent plants in Table 9.1.

Table 9.1

	parent plant 1	parent plant 2
phenotype		
genotype		

[2]

- 9 (d) (ii) With reference to Fig. 9.3, explain how you derived your answer in (d)(i).

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..... [2]

[Total: 10]

- 10 The percentage of successful fertilisation in humans varies throughout a typical 28-day menstrual cycle.

Fig. 10.1 shows the percentage of successful fertilisation in humans relative to ovulation on day 14.

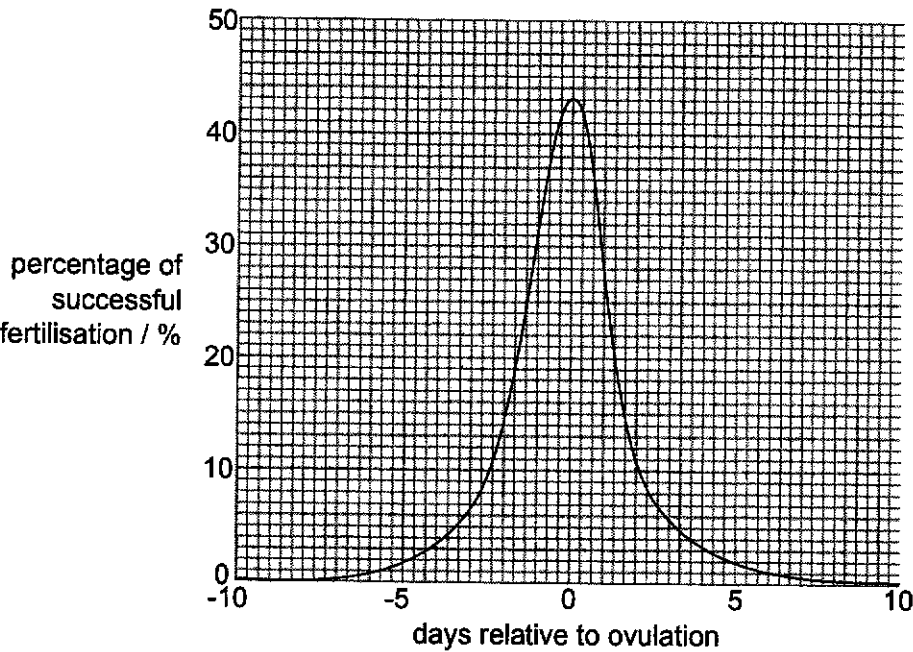


Fig. 10.1

- (a) Define fertilisation in humans.
-
- [1]
- (b) Outline the events that lead to the early development of zygote after fertilisation.
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-
-
-
- [2]

- 10 (c) Explain the percentage of successful fertilisation shown in Fig. 10.1.

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..... [3]

- (d) The Rhesus (Rh) factor is a protein that is found on the surface of red blood cells in some people. If the protein is present, then the individual is Rh positive. If the protein is absent, then the individual is Rh negative.

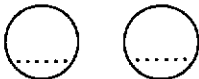
The allele for the presence of the Rh factor is dominant and is represented by the letter **D**. The recessive allele is represented by the letter **d**.

A Rh negative mother and a heterozygous Rh positive father have a child.

Complete the genetic diagram **and** determine the probability of the child being Rh positive.

parental phenotype : Rh negative mother x heterozygous Rh positive father

parental genotype : x

gametes :  x 

F₁ genotype : x
.....

F₁ phenotype :
.....

F₁ phenotype ratio :

Probability of Rh positive child:

[4]

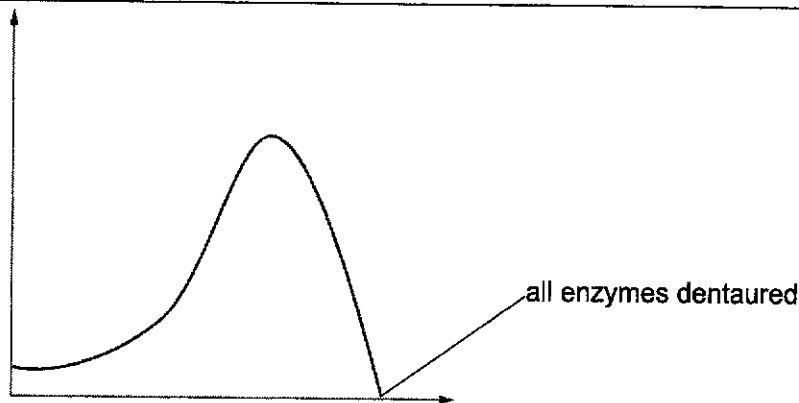
[Total: 10]

END OF PAPER

Secondary 4 Biology**2024 Preliminary Examination Suggested Answer**

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

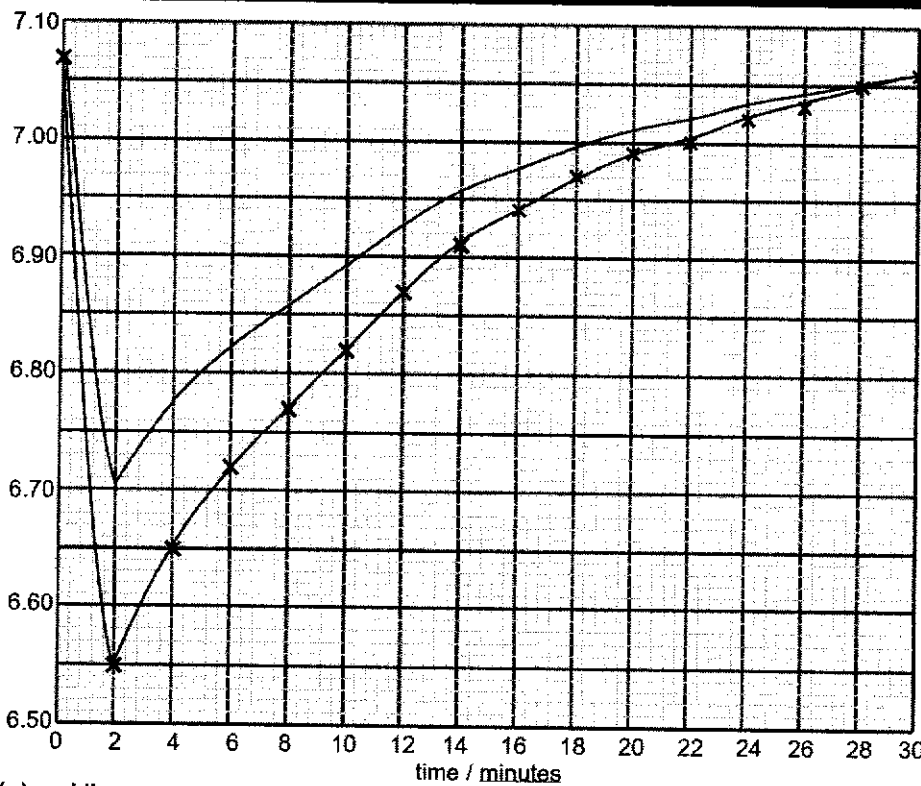
1(a)(i)	root hair cell + long and narrow protrusion	1
1(a)(ii)	1 soil water has a higher water potential than the cell sap of root hair cell / cell A 2 hence, water molecules moved from soil water to the cell sap of root hair cell / cell A via osmosis through a partially permeable membrane 3 cell sap of root hair cell now has a higher water potential than cell sap of cortical cells leading to water molecules moving into the cell sap of cortical cells 4 this process continues until water molecules reaches the xylem vessel	3
1(b)(i)	still air: graph C moving air: graph B	1
1(b)(ii)	1 In the presence of moving air, there is a greater mass of water lost from 0 to 30 minutes, where the greatest mass of water lost is $(6.1 - 2.1 =) 4.0$ g at 30 min 2 Moving air removes the layer of water vapour immediately outside the leaves, reducing / lowering the concentration gradient of water vapour between the intercellular air spaces and the atmospheric air compared to the plant in still air 3 Hence, there is a higher net rate of water vapour diffusing out of the intercellular air spaces (through the stomata) to the atmospheric air in the plant exposed to moving air	3
1(c)(i)	252	1
1(c)(ii)	any three from: 1 (carbon dioxide / ^{14}C) enters (leaf), through stoma(ta) / by diffusion and diffuses into the chloroplast 2 photosynthesis occurs and radioactive carbon dioxide is converted to glucose in the presence of light energy and chlorophyll 3 excess glucose is then converted to sucrose for transportation	3
[Total: 12]		
2(a)	D	1
2(b)(i)	1 test-tube 3 contained bile but test-tube 2 did not. Bile emulsifies large fat droplets into smaller fat droplets 2 increases surface area to volume ratio of fats for a faster rate of digestion by lipase into fatty acids and glycerol in test-tube 3 than 2 3 since fatty acids are acidic, hence, pH in test-tube 3 decreases faster / at an earlier time than test-tube 2	3
2(b)(ii)	any one from: 1 shows that bile, does not (chemically) digest fats / does not make solution acidic ; 2 shows that, lipase / enzyme, is required (for breakdown of fats into fatty acids and glycerol)	1

2(c)(i)	 line drawn showing that decrease after optimum is steeper than increase ; 1 line does not have to start at the origin or end at the x-axis label line to point where line meets the x-axis and label indicating that all the lipase is denatured / AW ; 2 line must meet the x-axis	2
[Total: 7]		
3(a)	1 light is refracted / bent by cornea 2 ciliary muscles / body contract + suspensory ligaments become slack 3 lens becomes more convex + light rays refracted / bent (more) by lens formed on retina	3
3(b)	lens bends / refracts light rays <u>too much</u> so they meet before retina / drawn on diagram ;	1
[Total: 4]		
4(a)(i)	1 Amino groups of excess amino acids are deaminated and converted to urea	1
4(a)(ii)	1 The molecule of urea is transported by the <u>hepatic vein</u> from the liver / organ D to the right atrium of the <u>heart</u> via the <u>vena cava</u> 2 From right atrium, the molecule of urea then enters right ventricle and exit to the lungs via the <u>pulmonary artery</u> and returns to the left atrium of the heart via <u>pulmonary vein</u> 3 From left atrium, the molecule of urea then enters the left ventricle and exit the heart via the <u>aorta</u> to the kidney via the <u>renal artery</u>	3
4(b)(i)	1 ultrafiltration happens at the glomerulus / K where the high hydrostatic pressure of blood forces small molecules such as water / glucose / urea / ions into proximal convoluted tubule / L 2 selective reabsorption occurs at proximal convoluted tubule / L, where all glucose and amino acids are reabsorbed while urea and some water are not reabsorbed if no description of ultrafiltration and selective reabsorption is mentioned = 1m	2

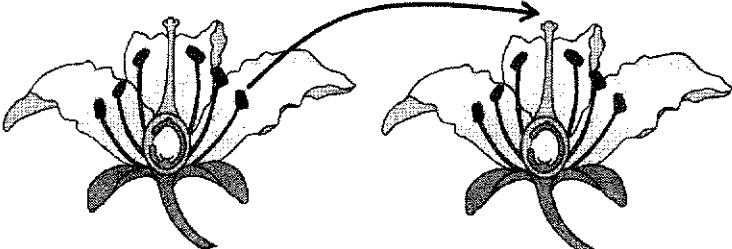
4(b)(ii)	1 An increased concentration of ADH stimulates the increased permeability of the collecting duct to water molecules 2 Hence, more water molecules are reabsorbed into the blood capillaries, resulting to a lower volume of water in the collecting duct	2
[Total: 8]		
5(a)	Any one from: 1 Inhibits the synthesis of bacterial cell walls 2 Inhibit cell membrane function 3 Inhibits protein synthesis in ribosome 4 Inhibits enzyme action in cytoplasm	1
5(b)(i)	$[(100 - 180) / 180] \times 100\%$ $= -44\%$	1 1
5(b)(ii)	Any three from: 1 daily doses / use (of erythromycin), peak, 1989 / at 2.8 doses <u>per 1000 people</u> 2 (bacterial) infections (resistant to erythromycin) peak, in 1993 / at 180 <u>bacterial infections per 1000 people</u> 3 no record of <u>resistant</u> infections, until 1991 / from 1983 to 1989 / first 6 years 4 delay (of 4 years) between peak of doses and peak of (resistant) infections	3
5(b)(iii)	any two from: 1 fewer doses of erythromycin used 2 development of new, antibiotics / treatments / vaccines (or any example that would cause a reduced usage of antibiotics) 3 more, awareness / education about, overuse of antibiotics / antibiotic resistance 4 improved, detection / screening (of pathogens to avoid spread) (reference to improved, cleanliness / hygiene or more people vaccinated / population has reached herd immunity) 5 isolating infected individuals	2
5(c)	any one from: 1 vaccines are able to stimulate the production of WBCs in the body which provides longer term of protection against the disease while antibiotics does not provide long term protection as it does not stimulate the production of WBCs 2 vaccines are able to provide protection against bacteria and viruses while antibiotics are only able to provide cure for bacterial infections 3 vaccines help to provide prevention to the onset of a disease while antibiotics help to cure a bacterial infection after the onset of the disease	1
[Total: 9]		
6(a)(i)	X: nucleus Y: mRNA Z: ribosome	3

6(a)(ii)	1 Gene controlling the production of insulin is <u>transcribed</u> into an mRNA in the <u>nucleus</u> 2 mRNA diffuses / exit the nucleus and attaches to the ribosome in the <u>cytoplasm</u> where it is <u>translated</u> into a <u>polypeptide</u>	2
6(a)(iii)	sequence of nitrogenous bases / nucleotides on the mRNA	1
6(a)(iv)	1 (the sequence of amino acids) determines the specific shape of the antibodies produced 2 so that it is complementary / specific, to the shape of the antigens found on (surface of) pathogens to destroy them	2
6(b)	1 The same restriction enzyme is used to cut the insulin gene, and the bacterial plasmid to create complementary 'sticky ends' 2 The cut insulin gene and cut plasmid are mixed with DNA ligase to join the complementary 'sticky ends'	2

[Total: 10]

7(a)(i) 7(b)	 (a) red line all plots correct award 1m line drawn award 1m (c) blue line award 1m as long as graph is above red graph + end at same point	2
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7(a)(ii)	0 to 2 minutes: 1 During vigorous exercise, muscle tissues contract more vigorously and the demand of energy of muscle cells increases. 2 However, the <u>supply of oxygen</u> to the muscles cells is <u>unable to meet the increased demand of oxygen</u> of the muscle cells. 3 Hence, muscle cells undergo <u>anaerobic respiration</u> and produces <u>lactic acid</u> which <u>lowers the pH</u> from <u>7.07</u> to <u>6.55</u>. 2 to 30 minutes: any two from: 1 After exercise, the pH increases gradually from 6.55 to 7.06 because lactic acid is transported away from the muscle cells to the liver. 2 Lactic acid is oxidised to harmless substances in the liver. 3 During this time, breathing rate and heart rate remained high to take in more oxygen for oxidation of lactic acid and to transport lactic acid at a faster rate to the liver	5
[Total: 8]		
8(a)	any three from: 1 the high concentration of nitrates / phosphates in untreated sewage encouraged the rapid growth of producers / plants / algae on the surface of the river 2 this blocked the sunlight entering the river, resulting in the death of fully submerged producers / plants / algae 3 the dead producers / plants / algae then decomposed / fed on by bacteria 4 leading to reduced oxygen / not enough oxygen (in water / environment) that resulted in the death of marine animals	3
8(b)	275	1
8(c)(i)	any three from: 1 from 1957 to 2005, percentage of fish with low plates decreases from 91 % to 16 % 2 from 1957 to 2005, percentage of fish with many plates increases from 0 % to 49 % 3 from 1957 to 1975, percentage of fish with medium plates increases from 9 % to 35 % and remained constant at 35 % from 1975 to 2005 4 percentage of fish with low plates from highest to lowest % of stickleback population ; 5 percentage of fish with many plates from lowest / 0 to highest % of stickleback population ;	3

8(c)(ii)	1 Random <u>mutation</u> / genetic change resulted in the variation of armour plates on the (Three Spined Stickleback) fish. 2 From 1957 to 2005, there was an increased water transparency from 0.8 m to 7 m, which allowed the fish to be more visible to predators, which acted as / increases the <u>selection pressure</u>. 3 Fish with many plates were <u>better</u> / best protected against predation compared to fish with median number of plates followed by low number of armour plates. 4 Hence, <u>more</u> fish with many plates <u>survived to reproductive age</u> which <u>passed on their alleles</u> to their offspring 5 Over time, the <u>frequency of alleles that code for many armour plates in the population increases</u>.	5									
[Total: 12]											
9(a)(i)	 any anther to stigma between two flowers	1									
9(a)(ii)	1 sugary fluid stimulates growth of pollen tube down the style by producing enzymes to digest the tissues of the stigma, style and ovary 2 pollen tube reaches the opening to the ovule, the micropyle, in the ovary, absorbs sap and burst to release male gametes 3 nucleus of male gamete then fuses with nucleus of female gamete to form a zygote	3									
9(b)	any one of the following: 1 The larger the petals, the easier for the insects to land on (and move into the flower's nectary) / pollinators require a larger landing platform 2 The larger the petals, the more attractive to the pollinators	1									
9(c)	any one of the following: 1 above 20 mm, the size of petal is large enough and does not affect how well the pollinators land on 2 above 20 mm, the level of attractiveness to the pollinators are the same	1									
9(d)(i)	<table border="1" data-bbox="338 1662 906 1832"> <tr> <td></td><td>parent plant 1</td><td>parent plant 2</td></tr> <tr> <td>phenotype</td><td>purple</td><td>purple</td></tr> <tr> <td>genotype</td><td>heterozygous</td><td>heterozygous</td></tr> </table> 1 mark per correct row		parent plant 1	parent plant 2	phenotype	purple	purple	genotype	heterozygous	heterozygous	2
	parent plant 1	parent plant 2									
phenotype	purple	purple									
genotype	heterozygous	heterozygous									

9(d)(ii)	- The ratio of the offspring shown in Fig. 9.3 is 3 purple to 1 white flower - This indicates that allele for white flower is recessive and allele for purple flower is dominant - In order to achieve a 3 purple : 1 white ratio, the parent plants must both be heterozygous so that there will be a possibility (or 50% chance) for both parents to pass down the allele for white flower / recessive allele to its offspring	3
[Total: 10]		
10(a)	Fusion of nucleus of the male gamete with the nucleus of the female gamete to form a diploid zygote	1
10(b)	- After fertilisation, zygote / fertilised ovum undergoes mitosis to form an embryo, a ball of cells - embryo will be transported through the oviduct towards the uterus, by the sweeping action of cilia in the oviduct, where it implants itself into the uterine lining	2
10(c)	any three of the following: - The percentage of successful fertilisation is zero 10 days before ovulation as menstruation has just ended / is still ongoing, hence, there is no egg cell present for fertilisation - The percentage of successful fertilisation increases as the number of days draw nearer / is closer to ovulation because when an egg cell is released, it has a higher chance of being fertilised by the sperm cell as sperm cells can survive 3 to 5 days in the female reproductive system - After ovulation, the percentage of successful fertilisation decreases sharply as the egg cell can only survive for 1 to 2 days in the female reproductive system 10 days after ovulation, the percentage of successful fertilisation is almost zero as the egg cell would not be viable	3
10(d)	parental phenotype : Rh negative mother x heterozygous Rh positive father parental genotype : dd x Dd gametes :  x F₁ genotype : Dd Dd Dd dd F₁ phenotype : Rh positive Rh positive Rh positive Rh negative F₁ phenotype ratio : 3 Rh positive : 1 Rh negative Probability of Rh positive child: 0.75 1m: parental genotype & gametes 1m: F₁ genotype & F₁ phenotype 1m: ratio 1m: probability	4