Name:	Index Number:	Class:

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.

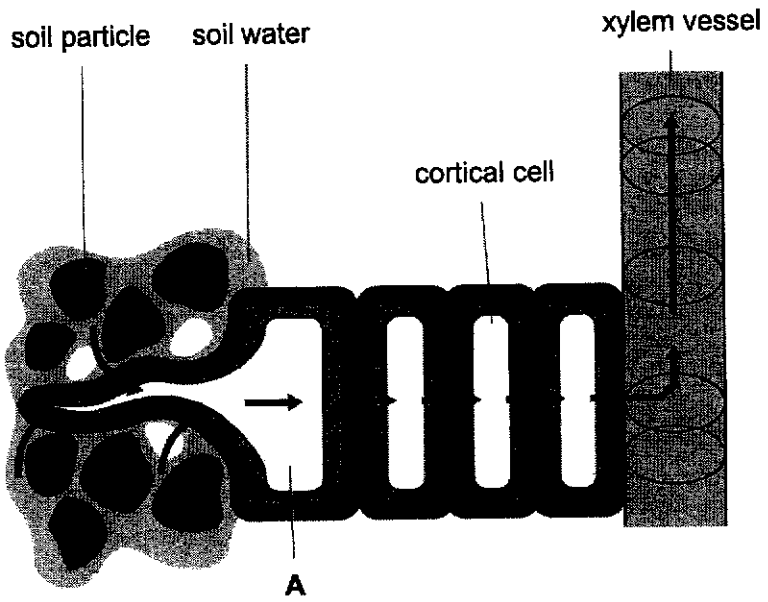

Fig. 1.1

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

name .....

adaptation .....

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..... [1]

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

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..... [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.

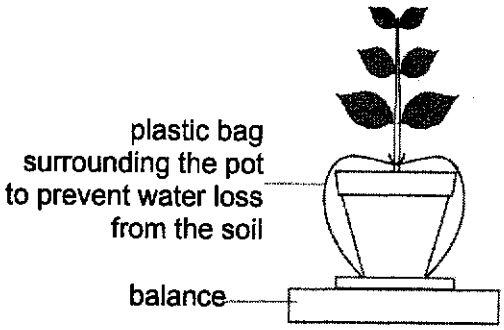

Fig. 1.2

- 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.

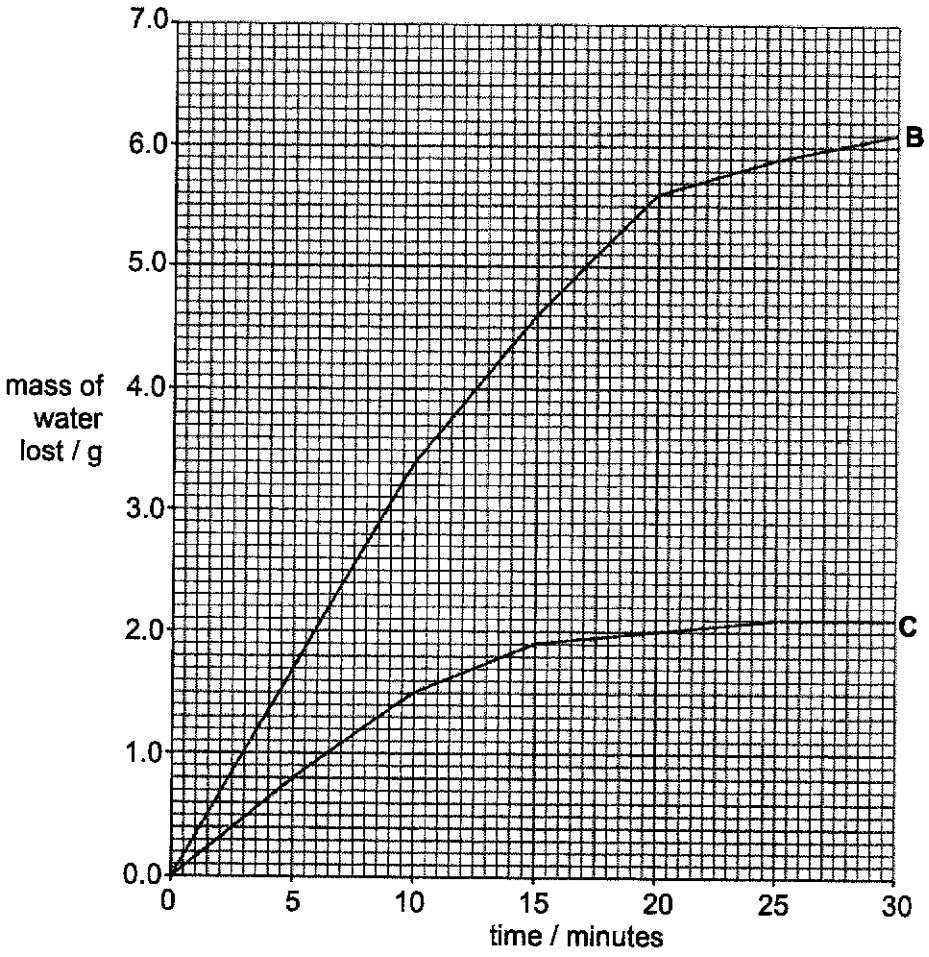

Fig. 1.3

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.

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..... [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.

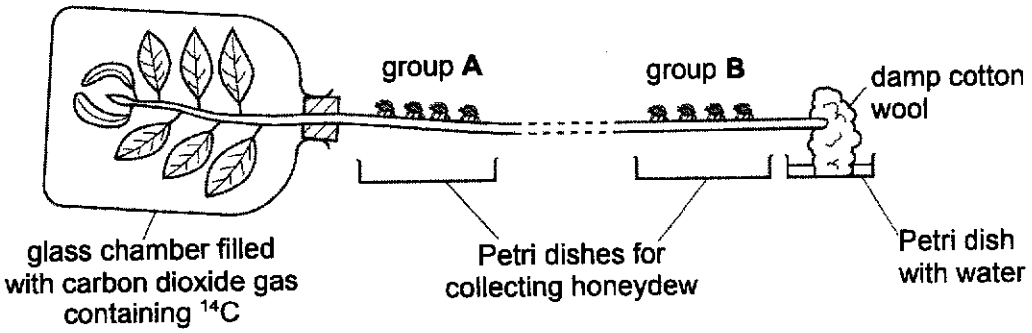

Fig. 1.4

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.

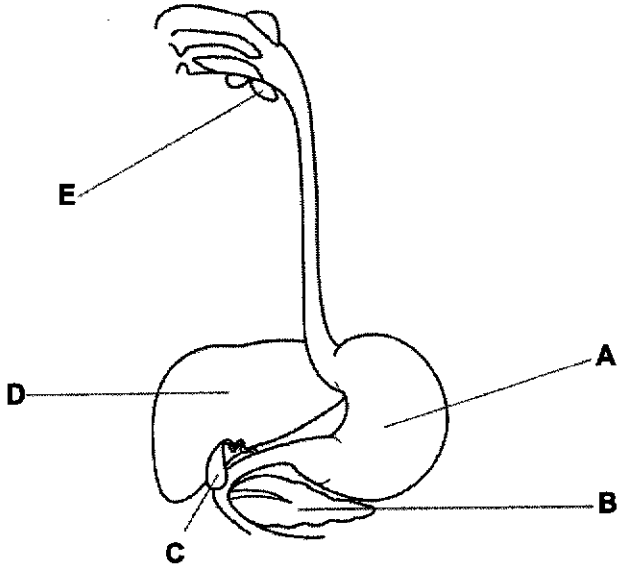

Fig. 2.1

(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.

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..... [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.

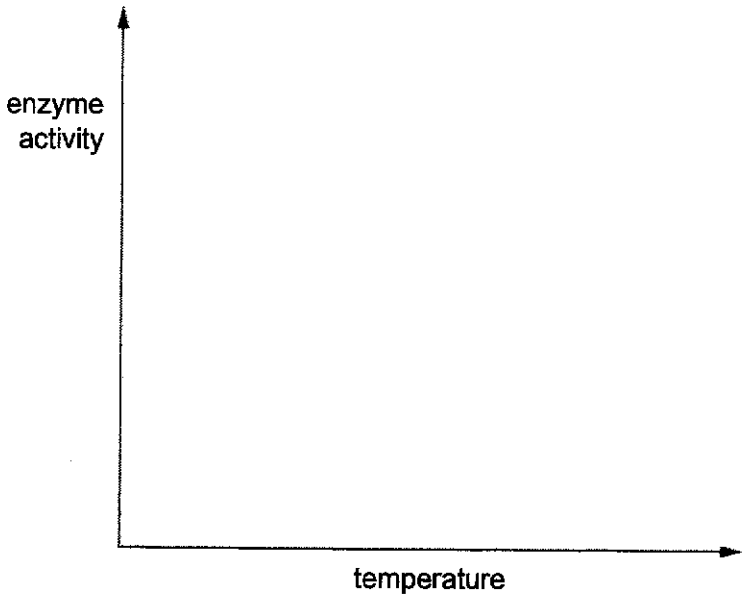

Fig. 2.2

[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.

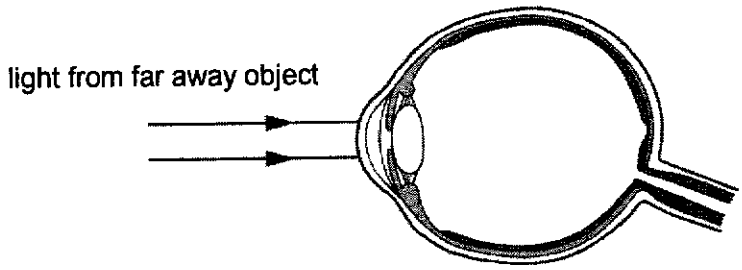

Fig. 3.1

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

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..... [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.

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..... [1]

[Total: 4]

4 Urea is a waste product formed in an organ.

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

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..... [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.

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..... [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.

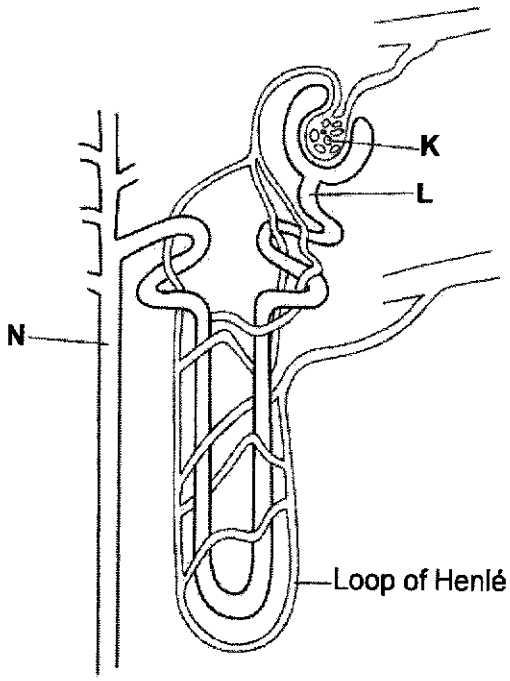

Fig. 4.1

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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..... [2]

[Total: 8]

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

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

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..... [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.

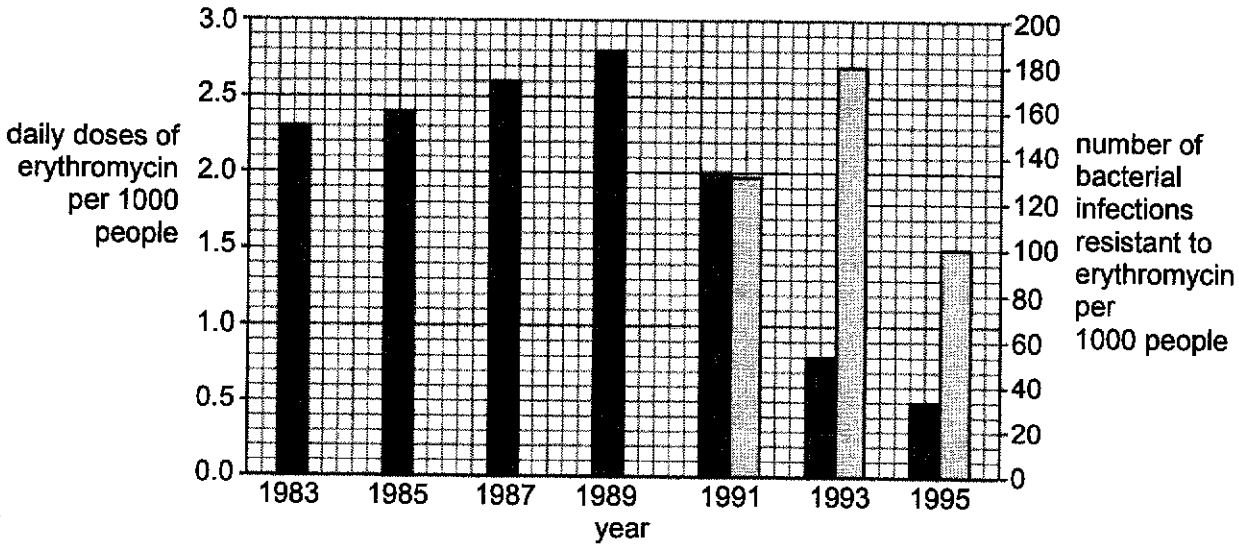

Fig. 5.1

(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.

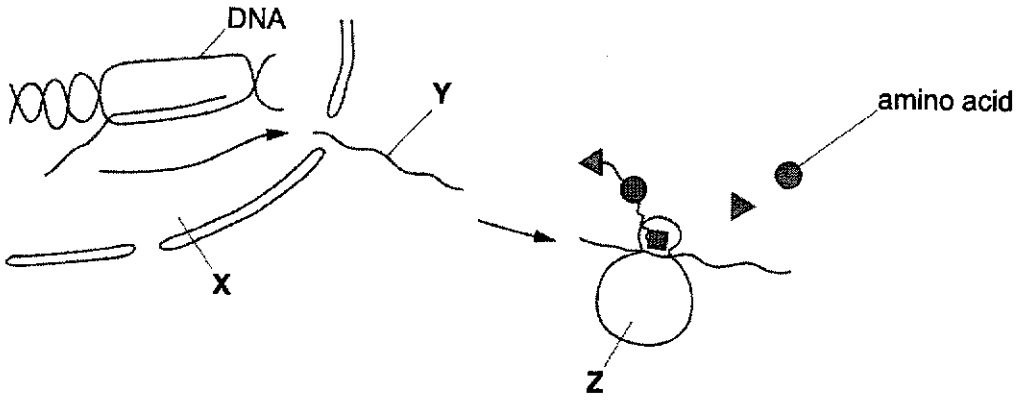

Fig. 6.1

(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.

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..... [2]

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

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..... [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.

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..... [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.

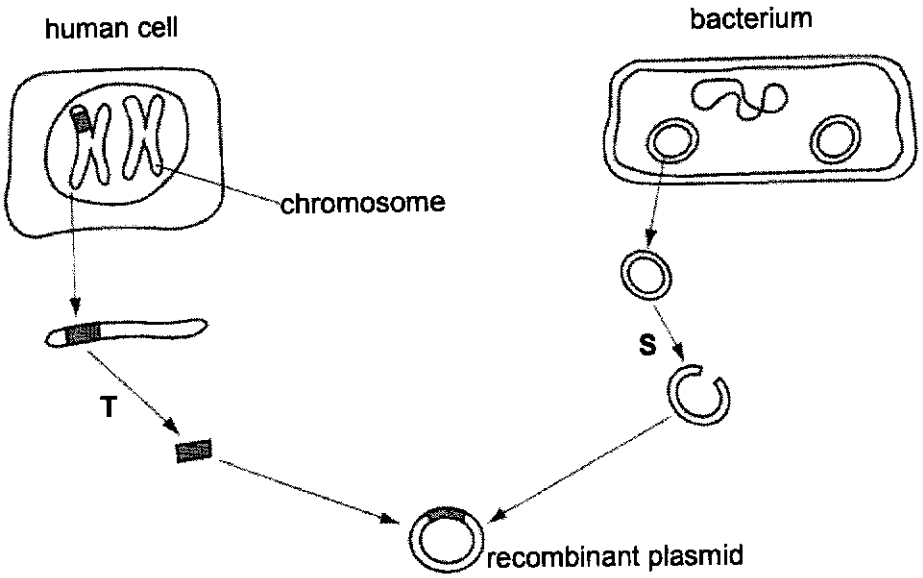

Fig. 6.2

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.

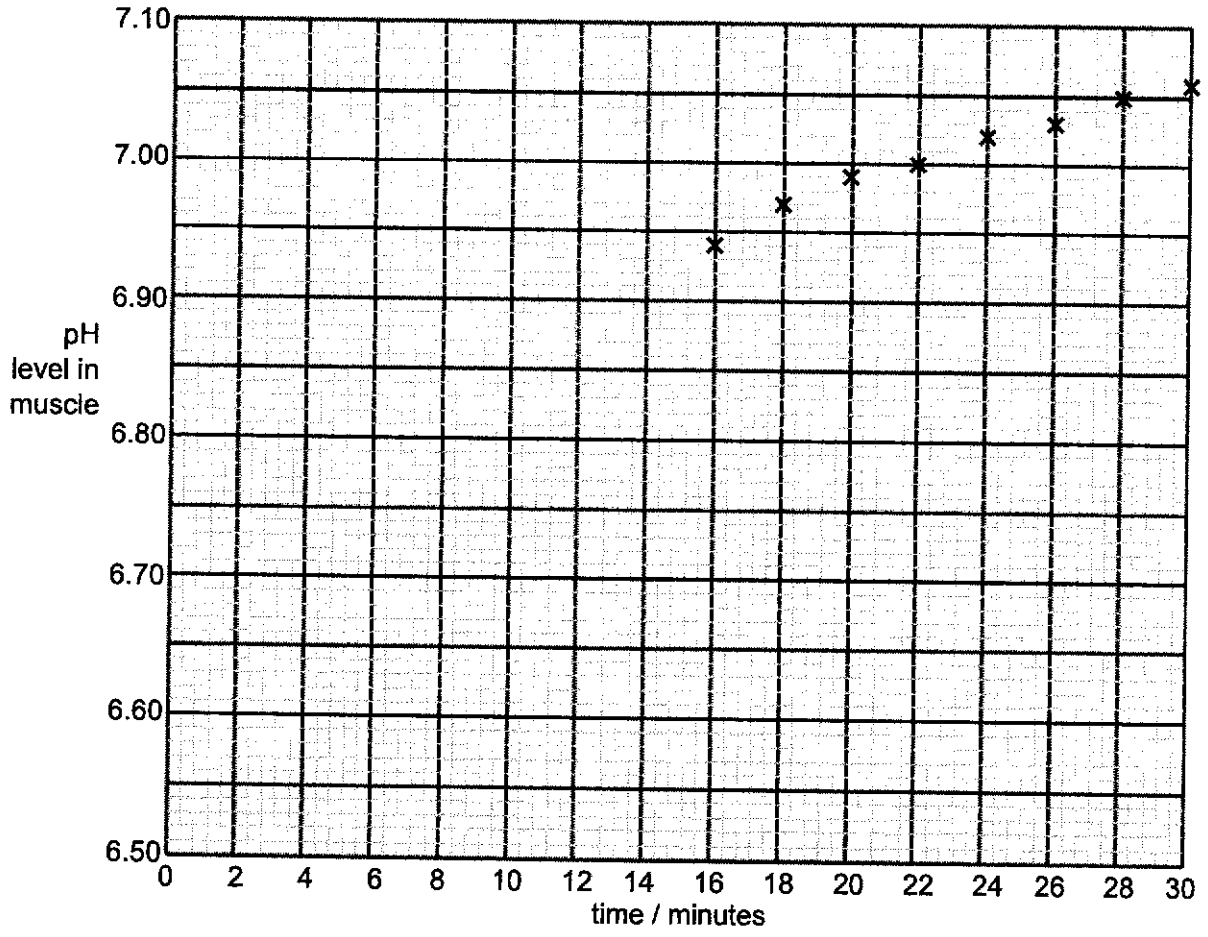

Fig. 7.1

[2]

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.

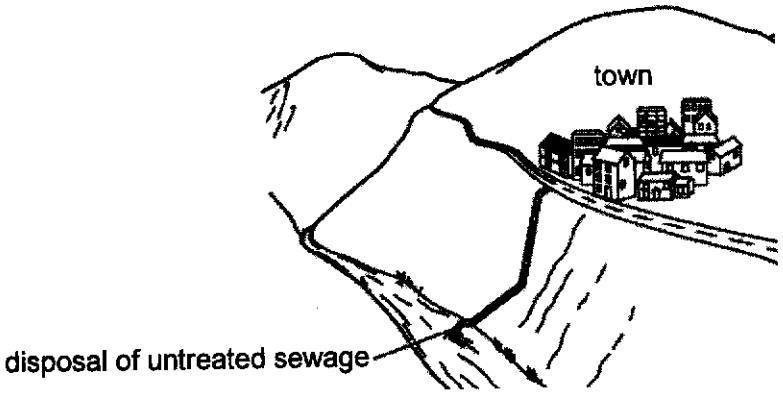

Fig. 8.1

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.

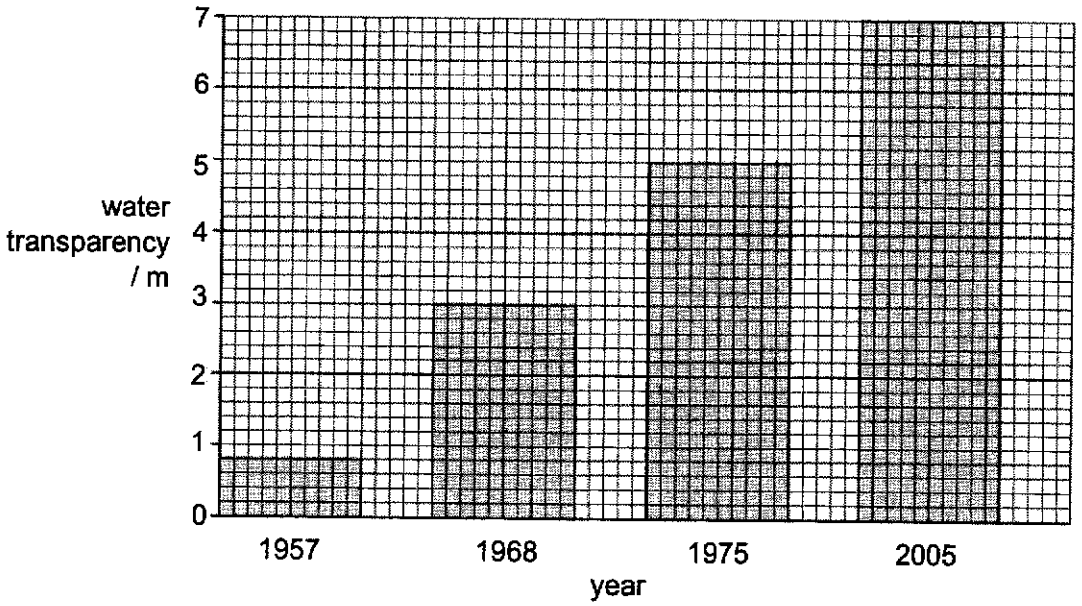

Fig. 8.2

(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.

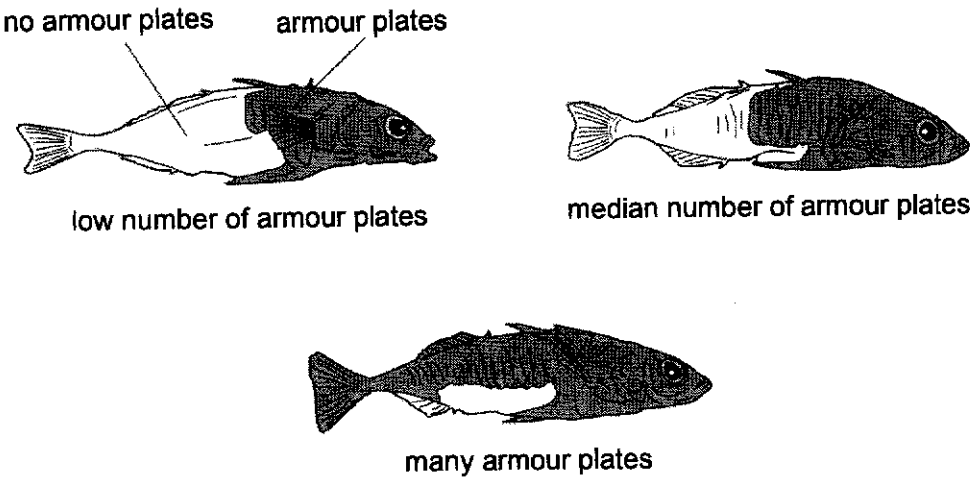

Fig. 8.3

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.

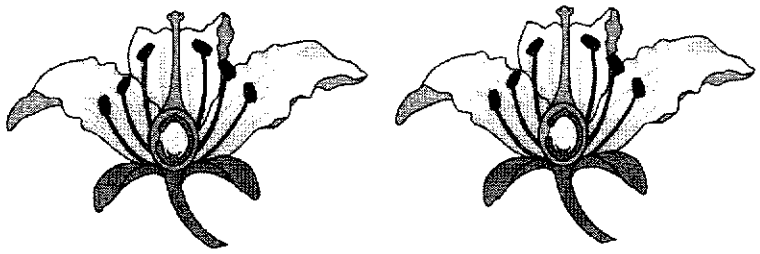

Fig. 9.1

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.

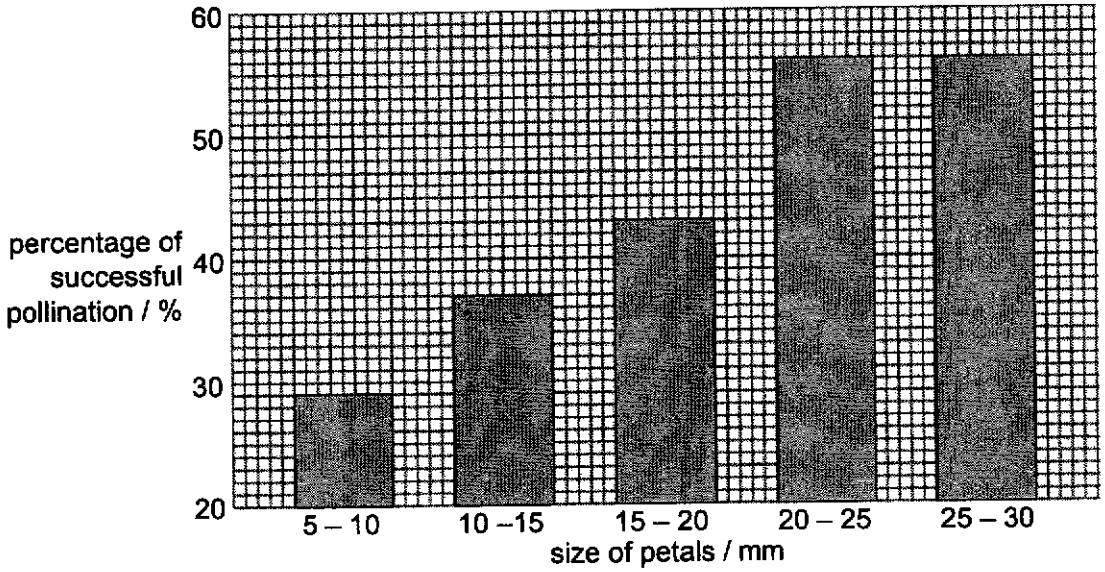

Fig. 9.2

(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.

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..... [1]

(d) Two flowers were cross pollinated.

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

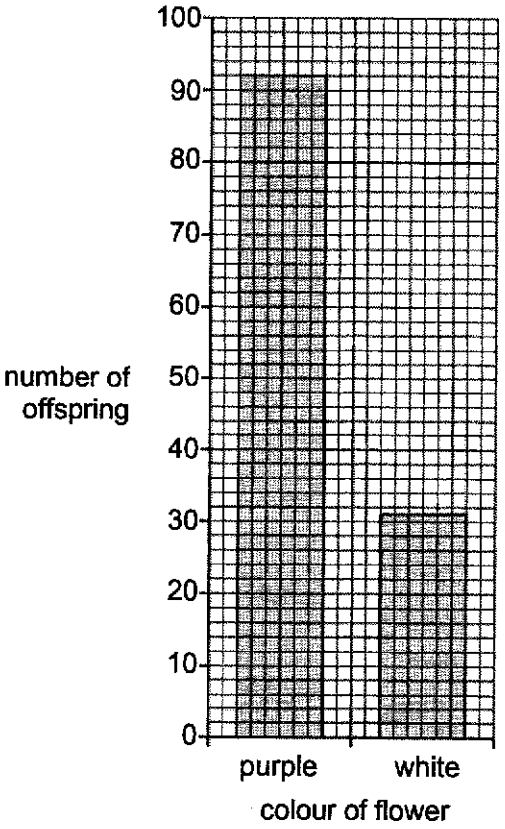

Fig. 9.3

(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.

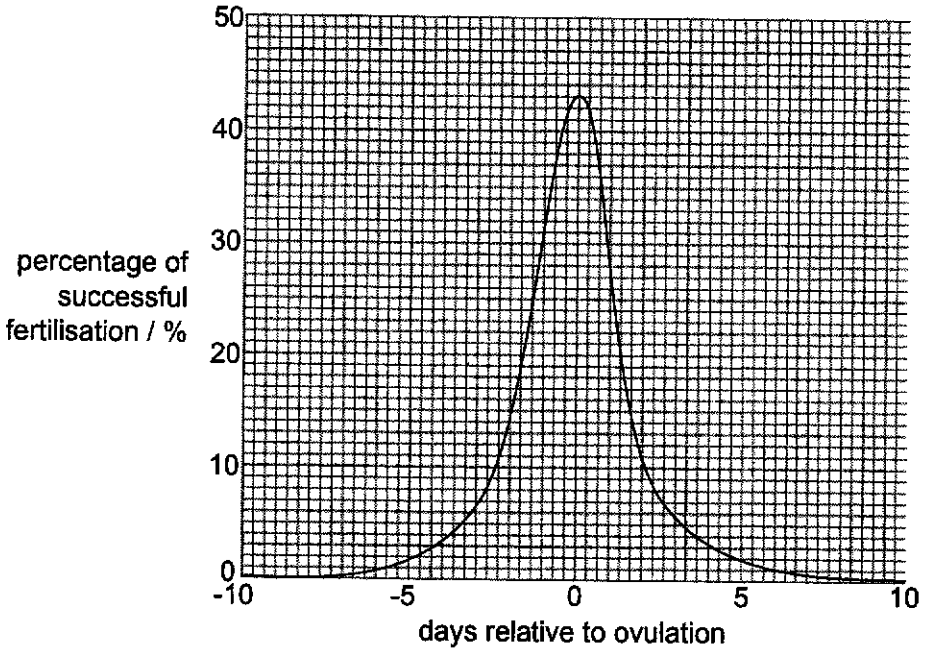

Fig. 10.1

(a) Define fertilisation in humans.

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..... [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 (.....) (.....)

F_1 genotype : ....

F_1 phenotype : ....

....

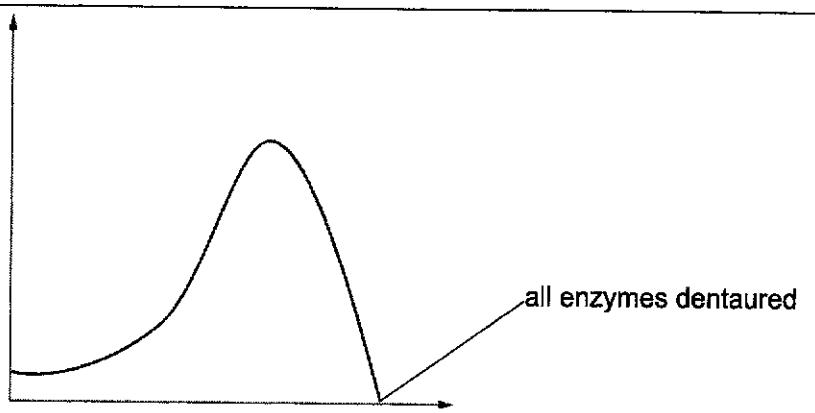
F_1 phenotype ratio : .....

Probability of Rh positive child: .....

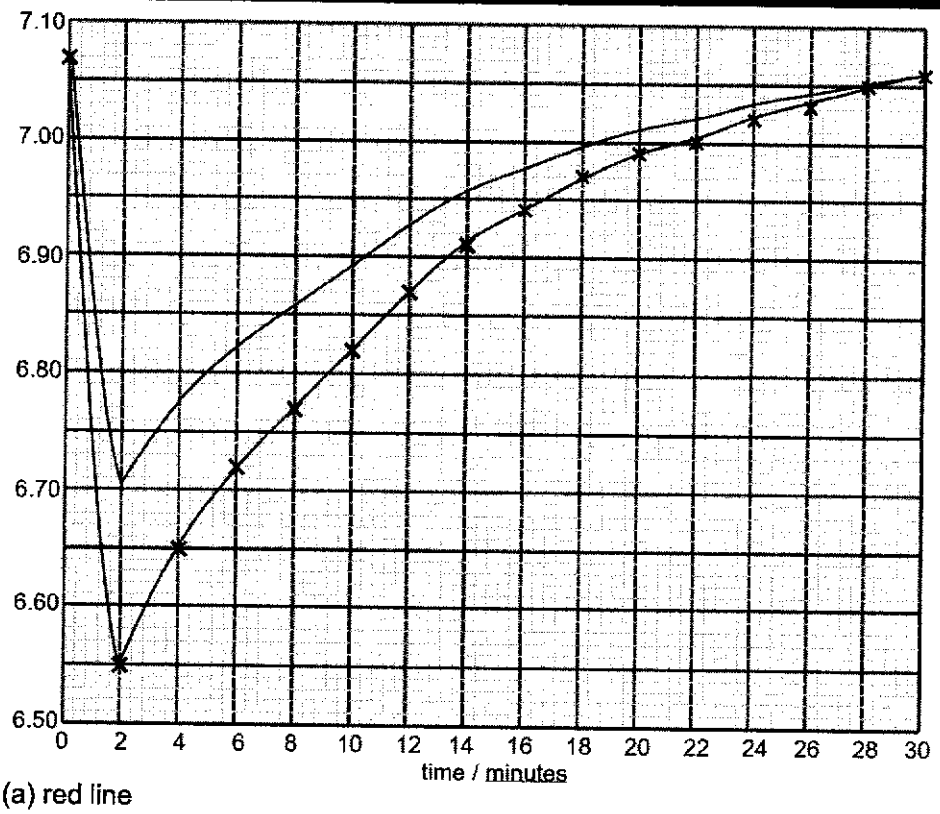
[4]

[Total: 10]

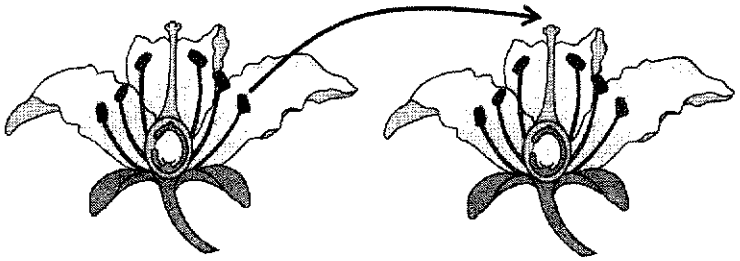
END OF PAPER

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 too much 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 hepatic vein from the liver / organ D to the right atrium of the heart via the vena cava 2 From right atrium, the molecule of urea then enters right ventricle and exit to the lungs via the pulmonary artery and returns to the left atrium of the heart via pulmonary vein 3 From left atrium, the molecule of urea then enters the left ventricle and exit the heart via the aorta to the kidney via the renal artery	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] x 100% = – 44%	1 1
5(b)(ii)	Any three from: 1 daily doses / use (of erythromycin), peak, 1989 / at 2.8 doses per 1000 people 2 (bacterial) infections (resistant to erythromycin) peak, in 1993 / at 180 bacterial infections per 1000 people 3 no record of resistant 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

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 supply of oxygen to the muscles cells is unable to meet the increased demand of oxygen of the muscle cells. 3 Hence, muscle cells undergo anaerobic respiration and produces lactic acid which lowers the pH from 7.07 to 6.55. 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 mutation / 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 selection pressure. 3 Fish with many plates were better / best protected against predation compared to fish with median number of plates followed by low number of armour plates. 4 Hence, more fish with many plates survived to reproductive age which passed on their alleles to their offspring 5 Over time, the frequency of alleles that code for many armour plates in the population increases.	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><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	2

9(d)(ii)	1 The ratio of the offspring shown in Fig. 9.3 is 3 purple to 1 white flower 2 This indicates that allele for white flower is recessive and allele for purple flower is dominant 3 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)	1 After fertilisation, zygote / fertilised ovum undergoes mitosis to form an embryo, a ball of cells 2 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: 1 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 2 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 3 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 4 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 : **d** **d** x **D** **d** F_1 genotype : **Dd** **Dd** **Dd** **dd** F_1 phenotype : **Rh positive** **Rh positive** **Rh positive** **Rh negative** F_1 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