DUNMAN SECONDARY SCHOOL

CANDIDATE NAME			
CLASS		**INDEX NUMBER**	

PRELIMINARY EXAMINATION 2024
SECONDARY 4 EXPRESS

BIOLOGY
Paper 2

6093/02
27 August 2024
1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

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

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.

Section A

Answer **all** questions.

1 Fig. 1.1 shows a drawing of an epithelial cell from the lining of the small intestine.

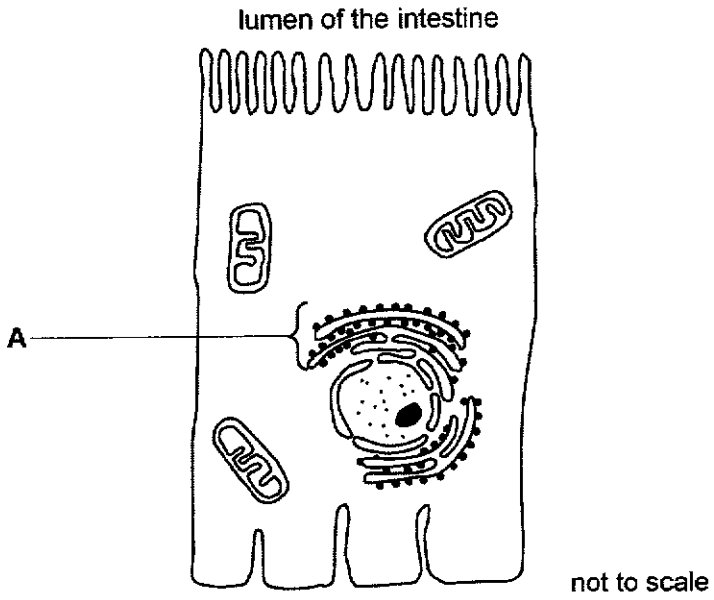

Fig. 1.1

(a) Identify structure **A** in Fig. 1.1 and describe its function in the intestinal epithelial cell.

A .....

function in the cell

.....

.....

[2]

(b) The cholera bacterium can survive in the small and large intestine. The bacterium releases a toxin that interacts with the cell membrane. The toxin stimulates the secretion of ion **X** out of the intestinal cell. Fig. 1.2 shows the effect of the toxin on the epithelial cells.

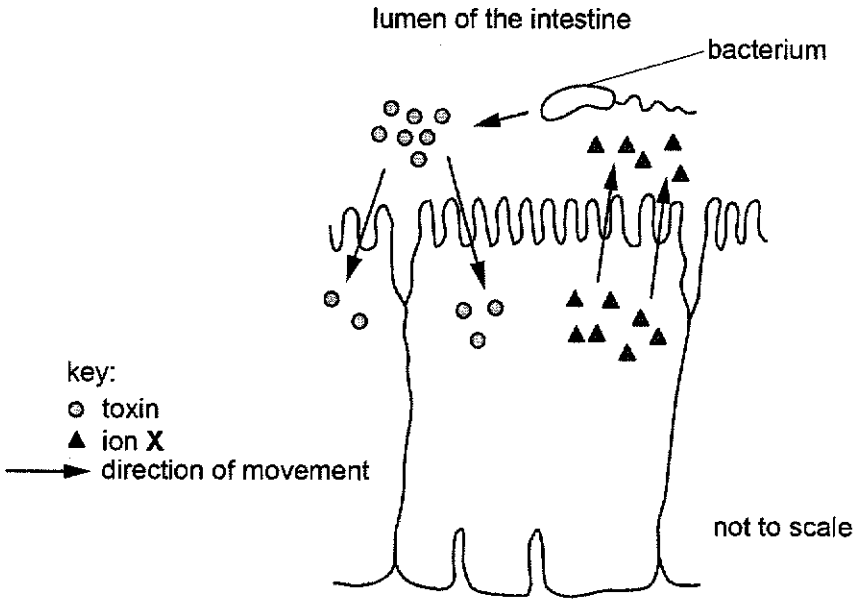

Fig. 1.2

(i) Secretion of ion **X** into the lumen of the small intestine can cause diarrhoea.

Using your understanding of the movement of substances, explain how secretion of ion **X** causes diarrhoea.

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..... [4]

(c) Cholera is an infectious disease spread through contaminated water and food. Cholera vaccines can be taken orally to reduce the risk of contracting cholera.

(i) Describe how the vaccine reduces the risk of contracting cholera.

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..... [2]

(ii) Suggest **two** other ways to prevent the spread of cholera.

1 .....

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2 .....

..... [2]

[Total: 10]

2 A man visits an eye doctor for a check-up. Fig. 2.1a shows a section of the eye on a poster in the clinic.

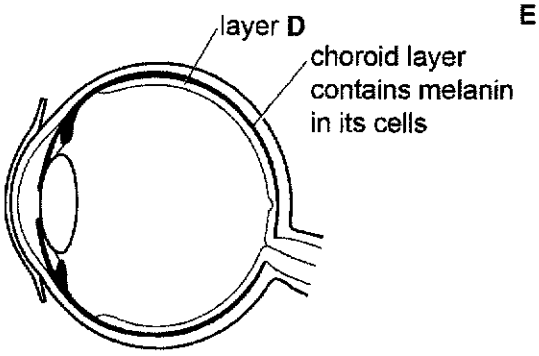

Fig. 2.1a

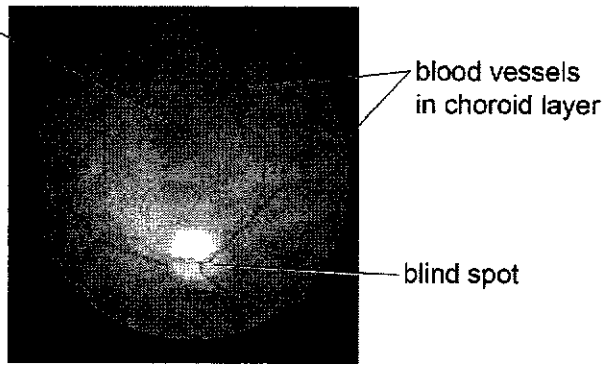

Fig. 2.1b

(a) During the eye check-up, the doctor shines a bright light into the eye and takes a picture. Fig. 2.1b shows layer **D** and the choroid layer behind it.

(i) Identify structures **D** and **E**.

D .....

E ..... [2]

(ii) Layer **D** does not contain blood vessels.

Explain how the blood vessels in the choroid layer are important for layer **D**.

.....

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..... [3]

(b) In another eye test, the change in the shape of the lens while the patient looks at a chart 10 m away and reads from a book was recorded. The results are shown in Fig. 2.2.

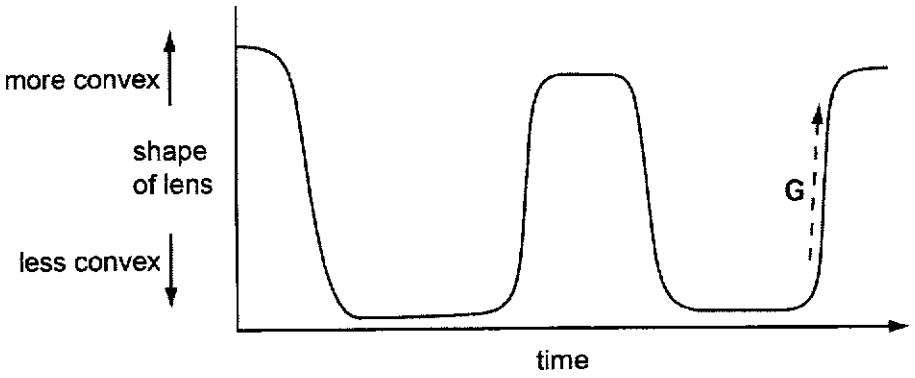

Fig. 2.2

(i) Write the letter **F** on Fig. 2.2 to show a time when the patient was looking at the chart that was 10 m away. [1]

(ii) Describe how the change in shape of the lens during the time **G** was brought about.

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..... [2]

(c) Receptors receive stimuli and convert them into electrical impulses. Fig. 2.3 shows the pathway taken by electrical impulses in a reflex action.

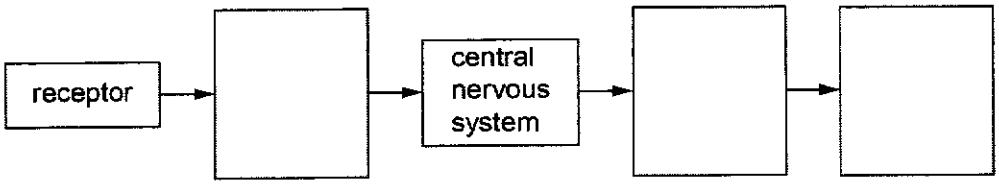

Fig. 2.3

Complete Fig. 2.3 by writing the names of the appropriate component in the empty boxes.

[2]

[Total: 10]

3 Huntington's disease (HD) is an inherited disorder. It is caused by a mutation in the gene for a protein called huntingtin. This protein damages nerve cells in the brain. HD is caused by a dominant allele.

(a) Define the term *dominant allele.*

.....

..... [1]

(b) **(i)** A man heterozygous for HD and a healthy woman have a child.

Complete the genetic diagram for this cross using the symbol **H** for the dominant allele and **h** for the recessive allele.

	father	x	mother	
genotypes of parents	.....		.....	
gametes	.....	.....	.....	.....
genotypes of offspring	.....	.....	.....	.....

[3]

(ii) Calculate the percentage chance of the child inheriting Huntington's disease.

Percentage chance of the child inheriting Huntington's disease ..... [1]

(c) Fig. 3.1 is a pedigree diagram showing the inheritance of Huntington's disease in one family.

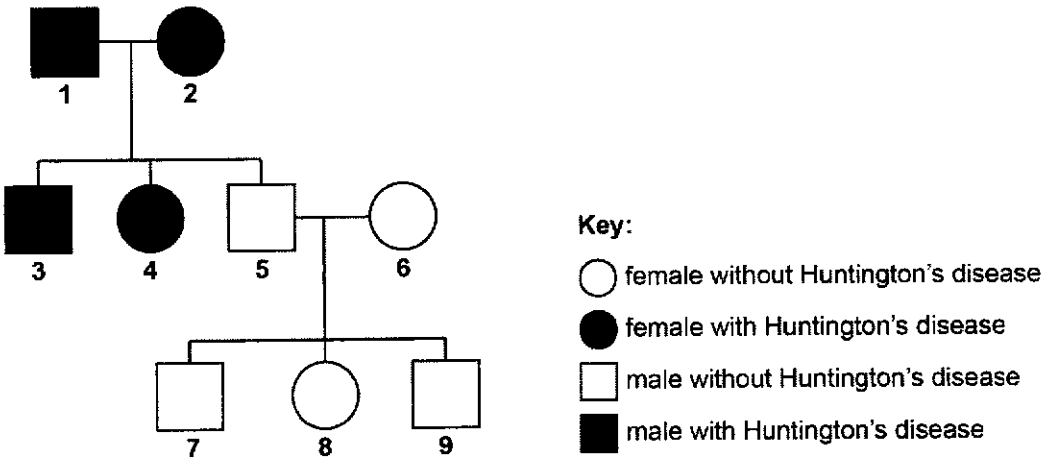

Fig. 3.1

(i) State the possible genotypes for person **3** in Fig. 3.1.

..... [1]

(ii) State the evidence from Fig. 3.1 that suggests that the allele for Huntington's disease is dominant.

.....

..... [1]

(d) A drug can reduce the damage to nerve cells in the brains of people with HD. The drug binds to messenger RNA produced by the mutated gene for huntingtin protein.

Suggest and explain the ways that the drug reduces damage to nerve cells in people with HD.

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..... [3]

[Total: 10]

4 Marimo moss balls are made up of green algae. They are found in lakes and are known to rise and fall during different times of the day. Fig. 4.1 shows some moss balls in a beaker of water.

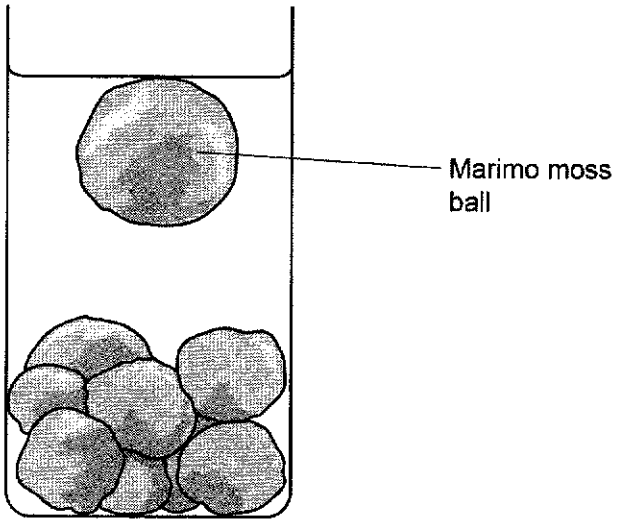

Fig. 4.1

(a) Scientists predict that the moss balls rise because they are covered in tiny bubbles of oxygen.

The scientists test their prediction by using a chemical that stops a biological process in the algae. When the chemical is added to some moss balls, they found that these moss balls did not rise.

(i) State the biological process affected by the chemical.

..... [1]

(ii) Explain why the moss balls did not rise.

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..... [2]

(b) The scientists then investigate how exposure to light affects a moss ball which had been in the dark.

- In Experiment 1, a moss ball is exposed to 12 h of light then 12 h of darkness.
- In Experiment 2, the moss ball is exposed to continuous light for 24 h.

Fig. 4.2 shows the results of the experiment.

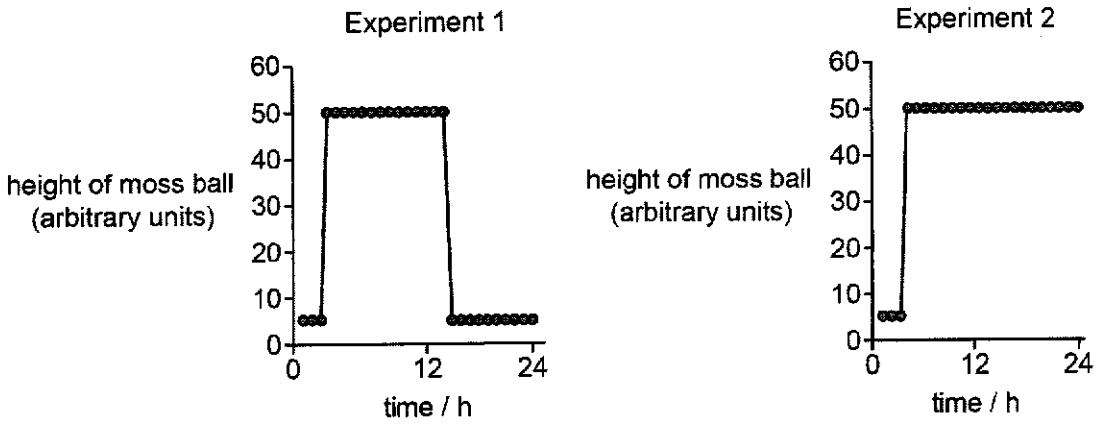

Fig. 4.2

(i) Describe the effect of light on the position of the moss ball in Experiment 1.

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..... [2]

(ii) Suggest an explanation for the differences between the two graphs.

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..... [2]

(c) Temperature is one environmental factor that affects plants.

Explain how increasing the temperature from 15 °C to 40 °C can affect plants.

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..... [3]

[Total: 10]

5 Fig. 5.1 shows a food web on a coral reef.

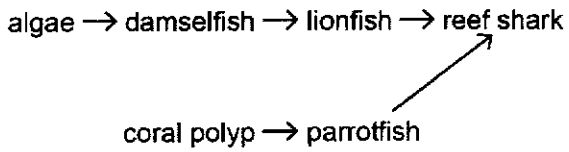

Fig. 5.1

(a) Use Fig. 5.1 to explain why the removal of corals decreases the biodiversity of this coral reef.

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.....

.....

..... [2]

(b) Suggest **two** advantages of using a pyramid of energy rather than a pyramid of biomass to represent a food chain.

1 .....

.....

2 .....

..... [2]

(c) It is estimated that eight million tonnes of plastic trash enter the oceans every year.

(i) Describe the effects of plastic pollution on organisms in oceans.

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..... [3]

(ii) The combustion of plastics releases carbon dioxide gas into the atmosphere.

Describe the consequences of releasing this carbon dioxide gas into the atmosphere.

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..... [3]

[Total: 10]

6 **(a)** Pregnant human females have a placenta.

(i) The placenta is connected to the amniotic sac.

State **two** functions of the amniotic fluid that is found in the amniotic sac.

1 .....

.....

2 .....

..... [2]

(ii) Name a hormone that is produced by the placenta.

..... [1]

(b) The placenta is often described as "a lung and a kidney".

Explain how the placenta functions like each of these organs.

lung .....

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.....

.....

kidney .....

.....

.....

..... [4]

(c) The placenta can be a barrier to toxins and pathogens. A study was done on donated placentas with part of the umbilical cord attached. The maximum size of particles that can pass through the placenta and enter the umbilical cord was investigated.

Beads with a diameter of 0.5 µm were inserted into blood vessels in the placenta. After 3 hours, the percentage of beads found in the blood in the placenta and in the umbilical cord were recorded. The tests were repeated using beads with different diameters. Their results are shown in Fig. 6.1.

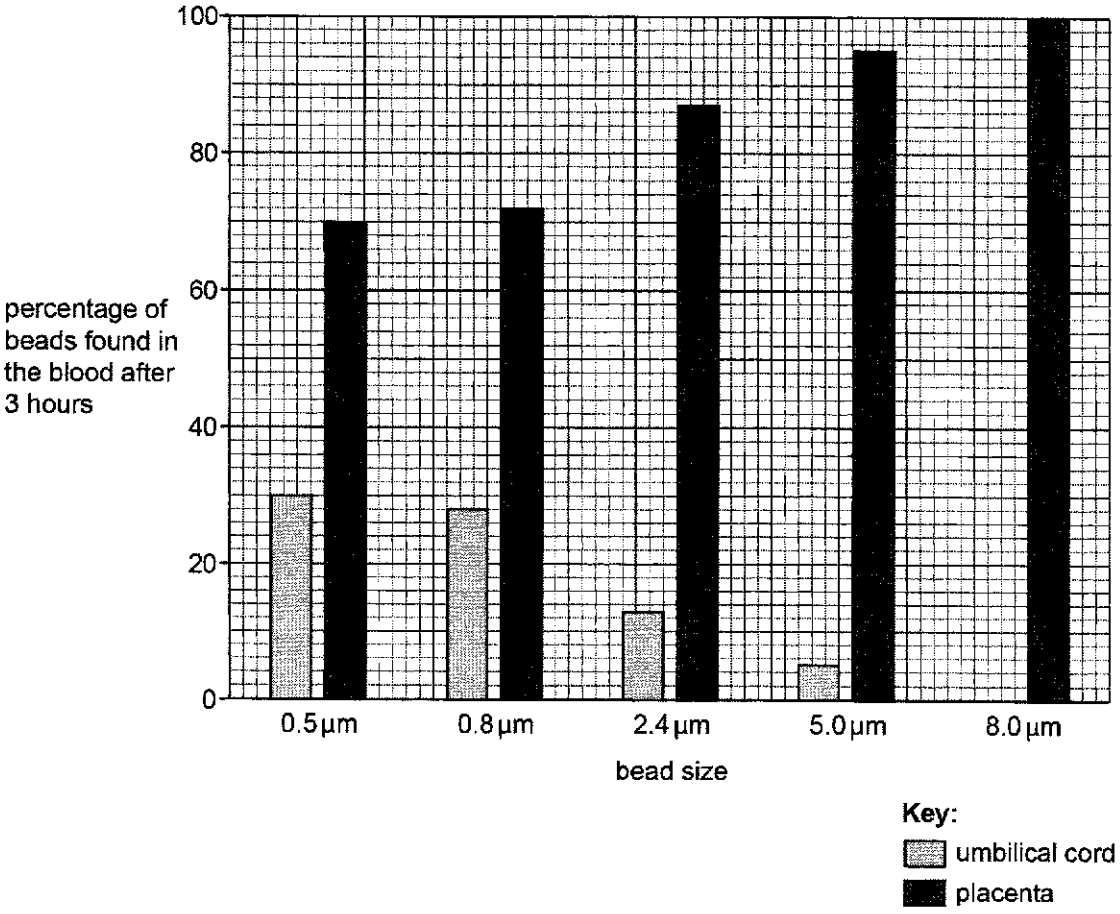

Fig. 6.1

(i) One million beads with a diameter of 2.4 µm were injected into the placenta.

Calculate the number of these beads in the umbilical cord after 3 hours.

..... beads [2]

(ii) Table 6.1 shows a range of substances and their diameters.

Table 6.1

toxins and pathogens	diameter / μm
nicotine	2.0×10^{-2}
drug **X**	3.0×10^{-2}
Rubella virus	5.0×10^{-2}
Vibrio cholera	8.0×10^{-1}
Trypanosoma brucei	1.8 x 10

State **all** the toxins and pathogens listed in Table 6.1 that could pass through the placenta and enter the umbilical cord.

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..... [1]

[Total: 10]

7 Gardeners often turn dead plant material from their gardens into compost and add it to the soil where they are growing plants. Compost can be made in a composting bin. In the bin aerobic bacteria turn dead plant material into compost. Some people use a different way of making compost, called bokashi. In this process the compost is made anaerobically.

Fig. 7.1 shows a normal composting bin and a bokashi bin.

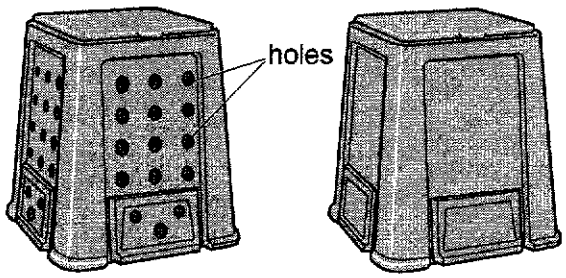

Fig. 7.1

(a) Explain the difference in the design of the two composting bins.

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..... [2]

(b) Scientists investigated the two methods of making compost with the following steps:

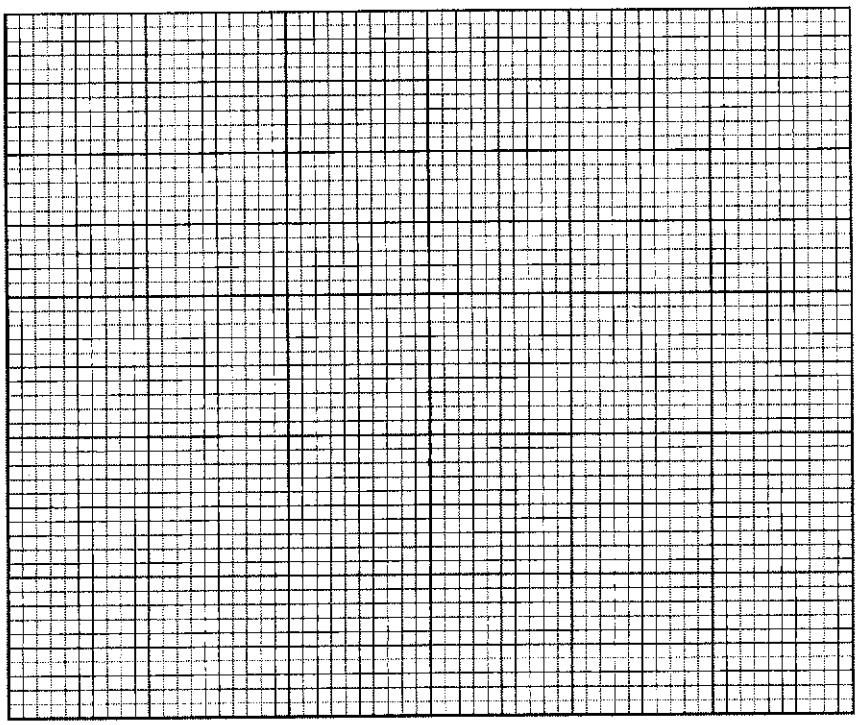
- Take a pile of dead plant material and divide it into two smaller samples of equal mass.
- Place one sample into the normal composter and the other into the bokashi composter.
- Measure the temperature in each composter every 10 days.
- After 40 days, measure the mass of the compost.

Table 7.1 shows the results of the experiment.

Table 7.1

time / days	temperature of the compost / °C	
	normal compost	bokashi compost
0	26	26
10	70	27
20	53	29
30	42	31
40	28	28

(i) Plot the results on the grid provided.



[4]

(ii) Explain the temperature changes in the normal compost bin.

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..... [2]

(iii) Explain the difference in the temperature changes between the normal compost and the bokashi compost.

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..... [2]

[Total: 10]

Candidate Name:	Class:	Index No:

Section B

Answer **one** question from this section.

8 The Three Spined Stickleback is a species of fish that lives in Lake Washington. Fig. 8.1 shows three distribution patterns of armour plates on the skin of these fish.

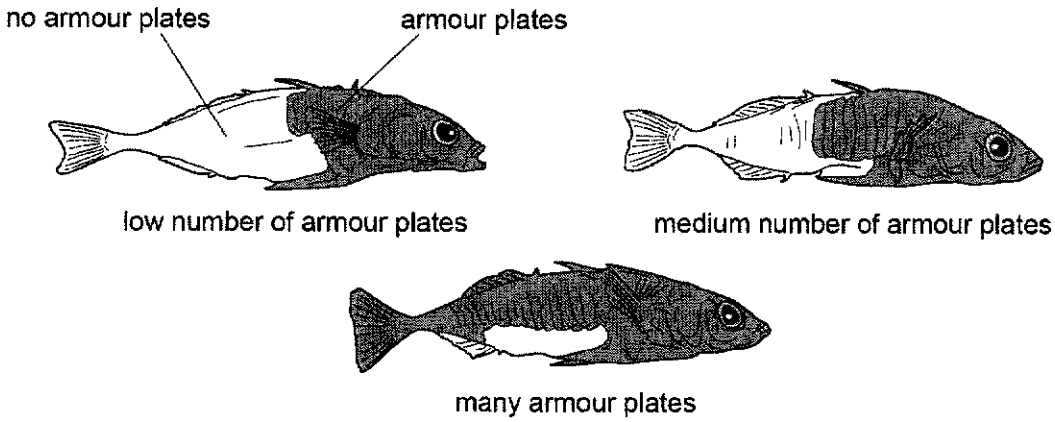

Fig. 8.1

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

Table 8.1

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

(a) Explain why the distribution patterns of armour plates is considered a form of discontinuous variation.

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..... [1]

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

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..... [4]

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

Describe how the process of natural selection may have caused these changes in the distribution of plates over time.

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..... [5]

[Total: 10]

9 Pathogens cause diseases.

(a) Fig. 9.1 shows some cells that are part of the human immune system. These cells are responding to one type of pathogen.

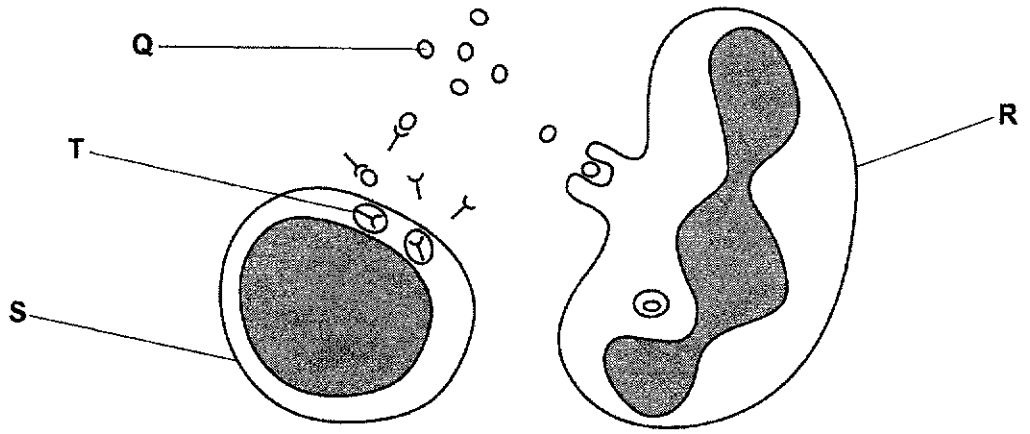

Fig. 9.1

Explain how the immune system responds to an invasion of pathogens. Use the letters in Fig. 9.1 in your answer.

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..... [6]

(b) A vaccine was introduced in 1942 for a particular disease. Fig. 9.2 shows the effect of introducing the vaccine on the number of cases of the disease in one country.

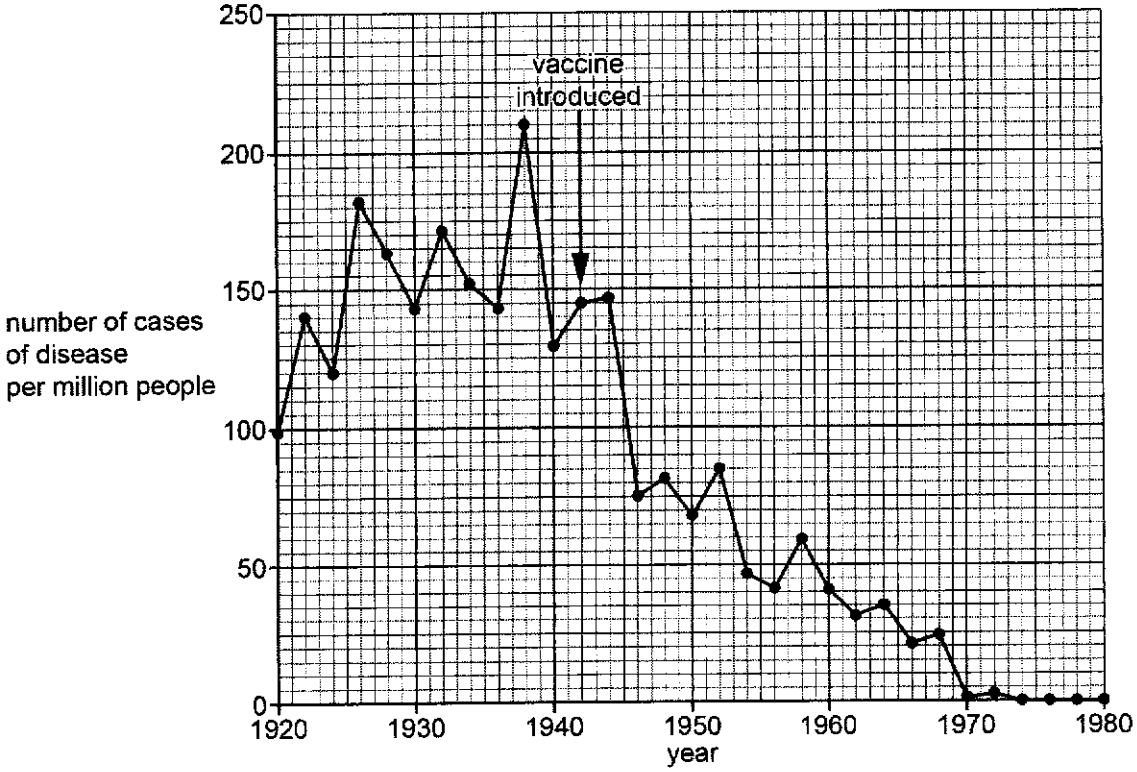

Fig. 9.2

In 1946, the government of the country concluded that the vaccine was successful.

Discuss the evidence, shown in Fig. 9.2, for **and** against this conclusion.

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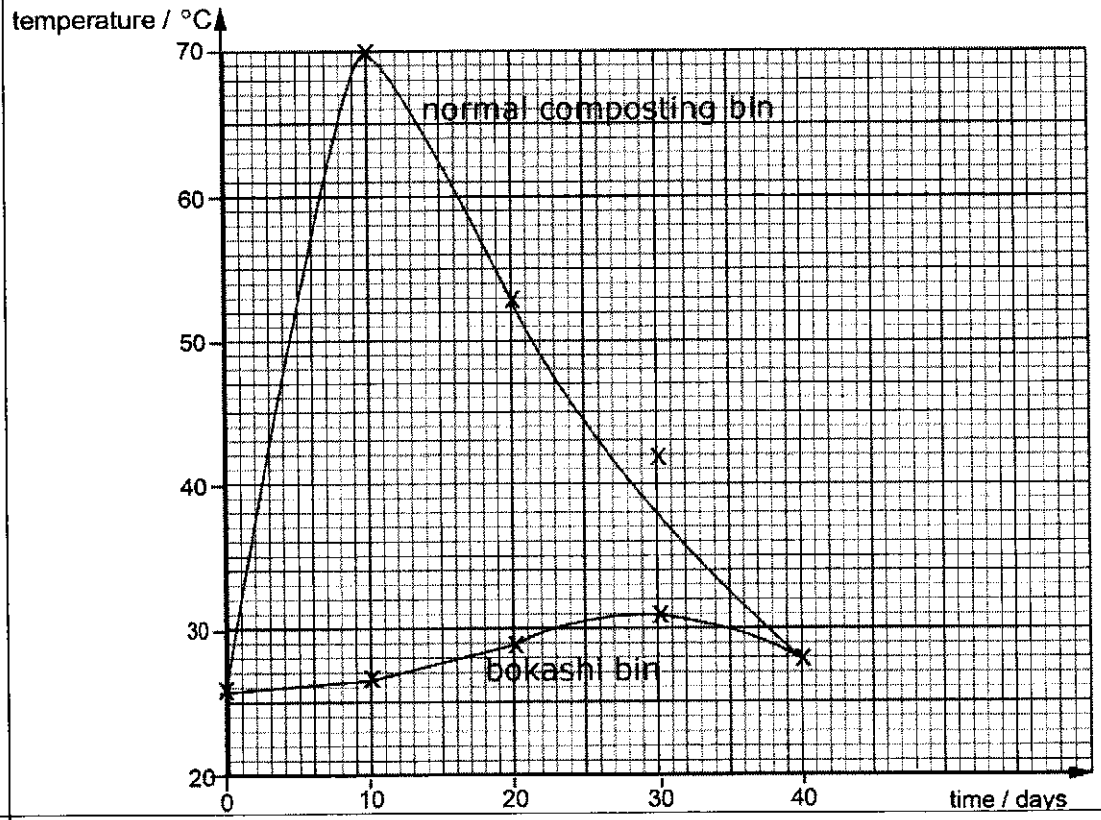
..... [4]

[Total: 10]

	(b)	(i)	father x mother genotypes of parents .....Hh..... .....hh..... gametes ....H.... ....h.... ....h.... ....h.... genotypes of offspring ... Hh .... Hh .... hh .... hh .... [1] for each correct row of answers
		(ii)	2/4 x 100% = 50% [1]
	(c)	(i)	HH, Hh [1]
		(ii)	1 and 2 with HD having child 5 without HD [1]
	(d)		Ribosome cannot attach and move along the mRNA that is bound to the drug [1] OR bound mRNA cannot be used to synthesise proteins [1] by ribosomes [1] Less mRNA to synthesise polypeptide of huntingtin protein [1] Less huntingtin protein to cause damage to nerve cells [1]
4	(a)	(i)	Photosynthesis
		(ii)	it stops the process/photosynthesis and no oxygen is produced [1] algal balls are more dense [1]
	(b)	(i)	With light, sharp increase in height, moss ball floats at highest height of 50 arbitrary units [1] Aft 12 hours, no light, it sinks to 5 arbitrary units;
		(ii)	In experiment 1, rate of Respiration is more than the rate of photosynthesis using up the oxygen after 12 h [1] In experiment 2, an increase in duration of light exposure, the higher the rate of photosynthesis /release oxygen which makes the ball float for a longer period of time beyond 12 h. [1]

	(c)		An increase in temperature to the optimum temperature can increase the rate of photosynthesis [1] as it is an enzyme-catalysed reaction [1] Beyond the optimum temperature, the rate of photosynthesis can decrease as the enzymes denature [1] The rate of transpiration increases as the evaporation of water from the spongy mesophyll cells into the intercellular air space and out of the leaf through the stomata increases [1] Any three
5	(a)		Any two coral / algae, are producers so less energy (enters the food web) / AW [1] less substrate for algae to grow on [1] (fewer parrotfish because) parrotfish lose a food source [1] fewer damselfish, due to lack of shelter / protection (from coral) / less algae [1] fewer lionfish, as reef shark eat more lionfish / fewer damselfish for lionfish to eat [1] fewer sharks due to, fewer parrotfish / fewer lionfish, (to eat) [1]
	(b)		any two: shows actual energy transfer so allows comparison of food chains [1] not all biomass of organisms have the same energy content so comparison of food chain is not accurate [1]
	(c)	(i)	Harmful chemicals from plastics may be leached into oceans and poison wildlife in the ocean [1] Harmful to marine organisms/ e.g., turtles, fish that eat them Microplastic ingested by marine organisms can accumulate in their bodies and lead to biomagnification along the food chain [1]
		(ii)	Carbon dioxide is a greenhouse gas that can cause global warming [1] Rise in seawater temperature may result in a loss of biodiversity [1] More atmospheric carbon dioxide dissolving in sea water makes it more acidic which can dissolve the calcium compound in the shells of shellfish and make the shell weak and the shellfish more vulnerable to predators [1]
6	(a)	(i)	- it supports and cushions the fetus before birth - it is a shock absorber

			- it cannot be compressed, it protects the fetus against physical injury - it allows the fetus a certain degree of movement which promotes muscular development - during birth, it lubricates and reduces friction in the vagina or birth canal Any 2 points
		(ii)	Progesterone or Oestrogen
	(b)	(i)	13% x 1 000 000 [1] = 130 000 [1]
		(ii)	nicotine, drug **X**, Rubella virus, *Vibrio cholera* [1]
	(c)		The placenta is <u>like the lungs</u> as it allows the <u>transport of oxygen from the mother's blood to the fetal blood [1]</u> and <u>carbon dioxide from the fetal blood to the mother's blood</u>. [1] The placenta is <u>like the kidney</u> as it allows <u>transport of urea / nitrogenous waste [1] from the fetal blood to the mother's blood</u>. [1]
7	(a)		Holes in normal composting bin allow more oxygen to enter so that aerobic respiration of bacteria can occur [1] Lack of holes in bokashi bin does not allow oxygen to enter therefore anaerobic respiration of bacteria can occur when the oxygen in the bin is used up. [1]

	(b)	(i)	 Correct scale such that graph occupies at least half of the grid space [1] Best-fit lines labelled or with a key [1] Axes with correct units [1] Plot all data points correctly [1]
		(ii)	Any two: Temperature increases from 26°C to 70°C for first 10 days as the bacteria release heat / energy from respiration. [1] The temperature decreases after 10 days as the rate of aerobic respiration of bacteria decreases / decomposition slows down.[1] Accept temperature starts to drop as enzymes involved in respiration denature beyond the optimal temperature of the enzyme. [1]
		(iii)	Aerobic respiration of bacteria in normal composting bin releases more heat compared to anaerobic respiration of the bacteria in the bokashi bin [1] ORA Rate of respiration in normal bin occurs faster in normal composting bin than in bokashi bin [1] ORA

8	(a)		The distribution of armour plates among the fish are in groups that are easily distinguishable without any intermediate forms [1] A: distinct / clear-cut phenotypes
	(b)		% with low plates decreases from 1957 to 2005 [1] % with many plates increases from 1957 to 2005 [1] from 1957 to 1975, % with medium plates increases [1] from 1975 to 2005, % with medium plates remains constant [1]
	(c)		variation of individuals with more armour plate distribution in the population can be due to random mutation [1] fish with more plates survive [1] as more plates protects fish and results in less predation / ORA [1] reproduction of surviving fish with more armour plates produce offspring / produce next generation [1] pass on allele for many plates to the offspring [1]
	9(a)		**Q** / pathogen, have specific / unique antigen that is complementary to antibodies [1] **S** / lymphocyte produces antibodies [1] **T** / antibodies bind to, antigen / pathogen [1] to cause clumping or agglutination [1] **R** / phagocytes, engulf, pathogens / antigens [1] **R** / phagocytes, have enzymes / digest pathogens OR antigens [1]
	9(b)		*support of conclusion:* general decrease, from 1942 / vaccination [1] cases do not return to pre-vaccine levels / AW [1] no cases from 1974 [1] *against conclusion (max 3):* number of cases increased, (during the 2 years) after the vaccine was introduced / until government made its conclusion [1] took 32 years after vaccine introduced before no cases of disease [1]

			but there are (small) peaks (in cases) / fluctuation (in cases) [1] comparative data quote [1] Any 4 points

Abbreviations, annotations and conventions used in the detailed Mark Scheme

[1]	separates marking points
/	alternative and acceptable answers for the marking point
Reject	answers which are not credit worthy
Accept	answers that can be accepted
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
ORA	Or reverse argument