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Oxford Cambridge and RSA

H

Wednesday 18 November 2020 – Morning

GCSE (9–1) Biology A (Gateway Science)

J247/04 Paper 4 (Higher Tier)

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)

You can use:
- a scientific or graphical calculator
- an HB pencil

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if the answer is wrong.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **32** pages.

ADVICE
- Read each question carefully before you start your answer.

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SECTION A

Answer **all** the questions.

You should spend a maximum of 30 minutes on this section.

Write your answers to each question in the box provided.

1 Which of these is an **advantage** of using hydroponics for crop production?

A Fertilisers are not required for crop growth.

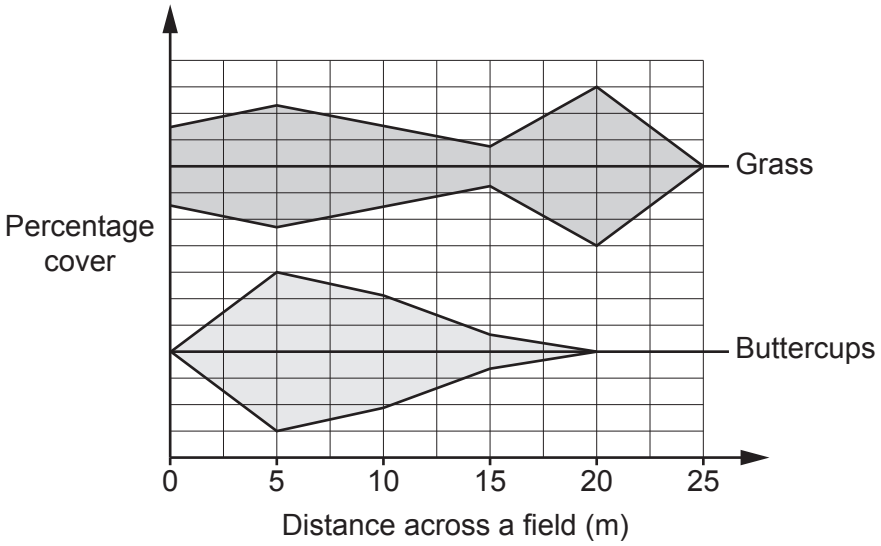
B The crops can be grown in areas where the soil is poor.

C The crop plants do not need extra support.

D The crops will not be eaten by pests.

Your answer ☐ **[1]**

2 A group of students collected some measurements from a field.
They plotted the measurements on this graph.



Which technique have the students used to collect the data?

A Capture-recapture

B Random quadrats

C Scaling up

D Transect line with quadrats

Your answer ☐ **[1]**

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3 Which is the correct definition of a parasite?

A An organism that is always at the top of a food chain.

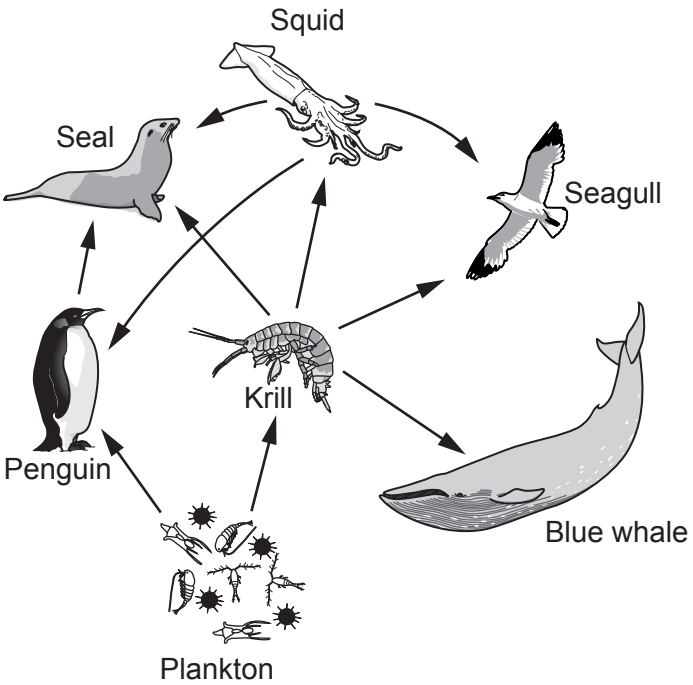
B An organism that kills and eats another organism.

C An organism that lives on another living organism so that they both benefit.

D An organism that lives on or in another living organism causing it harm.

Your answer ☐ **[1]**

4 The diagram shows a food web in the sea.



Not to scale

The number of penguins decreased in the area. This caused an increase in seal numbers.

What is a possible reason for the increase in seal numbers?

A Less seals were eaten.

B The krill numbers dropped.

C There were more plankton for the seals to eat.

D The seals had less competition for squid.

Your answer ☐ **[1]**

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5 Why are the effects of most mutations **not** observed?

A Most mutations do not affect the genotype or phenotype.

B Most mutations do not affect the phenotype.

C Mutations mainly affect internal body processes.

D Mutations often kill the organism.

Your answer ☐ **[1]**

6 Which of these is a **similarity** between selective breeding and natural selection?

A Cause a change in organisms' genotypes but not phenotypes.

B Humans decide which organisms will reproduce.

C Only some organisms reproduce.

D Take place over many thousands of years.

Your answer ☐ **[1]**

7 The table describes meiosis.

	Genetic description of cells made	**Genetic variation introduced**	**Type of cells made**
A	haploid	✓	body cells
B	diploid	✗	body cells
C	haploid	✓	gametes
D	diploid	✓	gametes

Which row in the table is correct?

Your answer ☐ **[1]**

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8 Darwin and Wallace both developed theories of natural selection. Both of their theories were developed after making observations on islands.

What is the most likely explanation for this?

A Conditions on neighbouring islands are very similar.

B Different characteristics were observed in organisms on islands compared to the mainland.

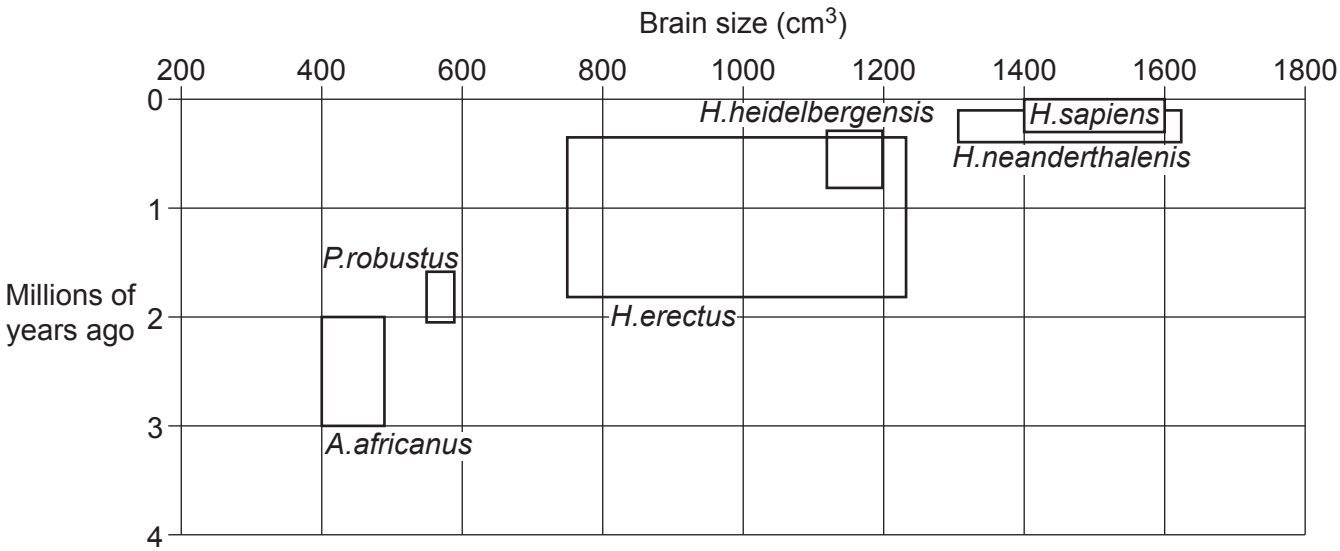
C There are no selection pressures for organisms on islands.

D There is no competition for food on islands.

Your answer ☐ **[1]**

9 Humans belong to the species *H.sapiens*.

H.sapiens have evolved from a number of possible ancestors. The graph shows five of these ancestors.



What conclusion about human evolution can be made from the graph?

A A larger brain meant that the species were better adapted to their environment.

B *H.sapiens* outcompeted the other species which then became extinct.

C In general, the more recently a species first appears, the larger its brain size.

D There is no correlation between brain size and when a species first appeared.

Your answer ☐ **[1]**

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10 The table shows estimated data about the global population and the number of deaths from HIV and tuberculosis (TB).

	Year	
	2000	**2017**
Total population in millions	6143.5	7464.0
Number of people with HIV in millions	36.1	36.8
Percentage of total population with HIV	0.6	0.5
Total number of HIV related deaths in millions	3.0	1.0
Total number of TB deaths in millions	2.2	1.6
Number of TB deaths in people with HIV in millions	0.5	0.3

Which is a correct conclusion from the data in the table?

A Half of HIV related deaths were due to TB in 2000.

B HIV became more life-threatening between 2000 and 2017.

C People with HIV are more likely to die from TB than people without HIV.

D The percentage of HIV in the population has increased between 2000 and 2017.

Your answer ☐ **[1]**

11 Doctors are able to offer a diagnosis and treatment targeted to a patient's genome, known as genomic medicine.

Which is an example of the type of treatment used in genomic medicine?

A Comparing patients' phenotypes so the best treatment can be given.

B Designing drugs that are specific to a particular variant of a gene.

C Using genetic engineering to produce new drugs.

D Using monoclonal antibodies to destroy pathogens.

Your answer ☐ **[1]**

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12 How can a mutation in non-coding DNA change the activity of a cell?

A It can change the amino acid sequence in a protein.

B The base sequence of mRNA may be altered.

C The shape of a protein may be changed.

D Transcription of mRNA may be stopped.

Your answer ☐ **[1]**

13 When a person has measles they are unlikely to be ill again with the disease for many years.

What is the reason for this?

A Antigens from the pathogen remain in the body.

B Memory cells remain in the blood and can release antibodies.

C The disease can now be treated with antibiotics.

D White blood cells engulf the pathogens before antibodies are made.

Your answer ☐ **[1]**

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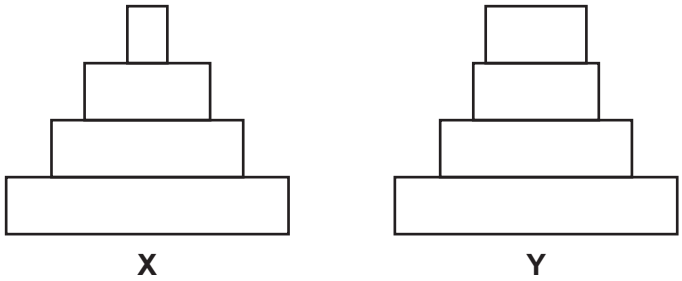
14 The diagram shows pyramids of biomass for two food webs, **X** and **Y**.



Which statement explains the difference between the two pyramids?

A In food web **X** there is a greater efficiency of transfer between primary consumer and secondary consumer than in **Y**.

B In food web **X** there is a greater efficiency of transfer between secondary consumer and tertiary consumer than in **Y**.

C In food web **X** there is a lower efficiency of transfer between primary consumer and secondary consumer than in **Y**.

D In food web **X** there is a lower efficiency of transfer between secondary consumer and tertiary consumer than in **Y**.

Your answer ☐ **[1]**

15 What is meant by the term phylogenetics?

A Classifying organisms using many common characteristics.

B Constructing diagrams to predict how characteristics are inherited.

C The study of evolutionary relationships based on molecular studies.

D Using a single common feature to determine evolutionary relationships.

Your answer ☐ **[1]**

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SECTION B

Answer **all** the questions.

16 **Fig. 16.1** shows the water cycle occurring in a lake.

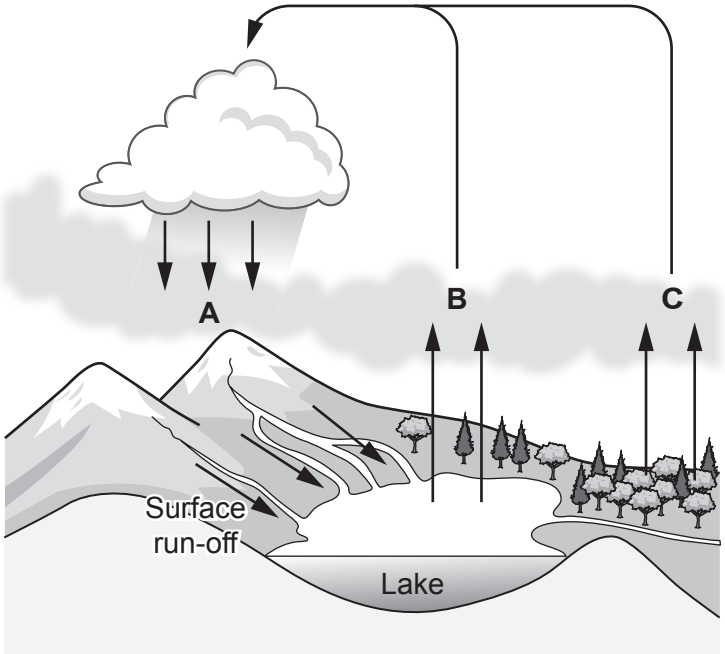

Fig. 16.1

(a) Draw a line to the correct name for the three processes labelled **A**, **B** and **C** in **Fig. 16.1**.

	Evaporation
A	
	Photosynthesis
	Precipitation
B	
	Respiration
	Translocation
C	
	Transpiration

[3]

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(b) Surface run-off water passes through soil and back into the lake.

Write down **one** reason why surface run-off water is important to organisms living in the lake.

.....

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

(c) Scientists investigate antibiotic pollution in two different lakes.

They collect samples of water from the two lakes. The scientists then use aseptic techniques to investigate how resistant the bacteria in the water are to antibiotics. **Fig. 16.2** shows the apparatus they use.

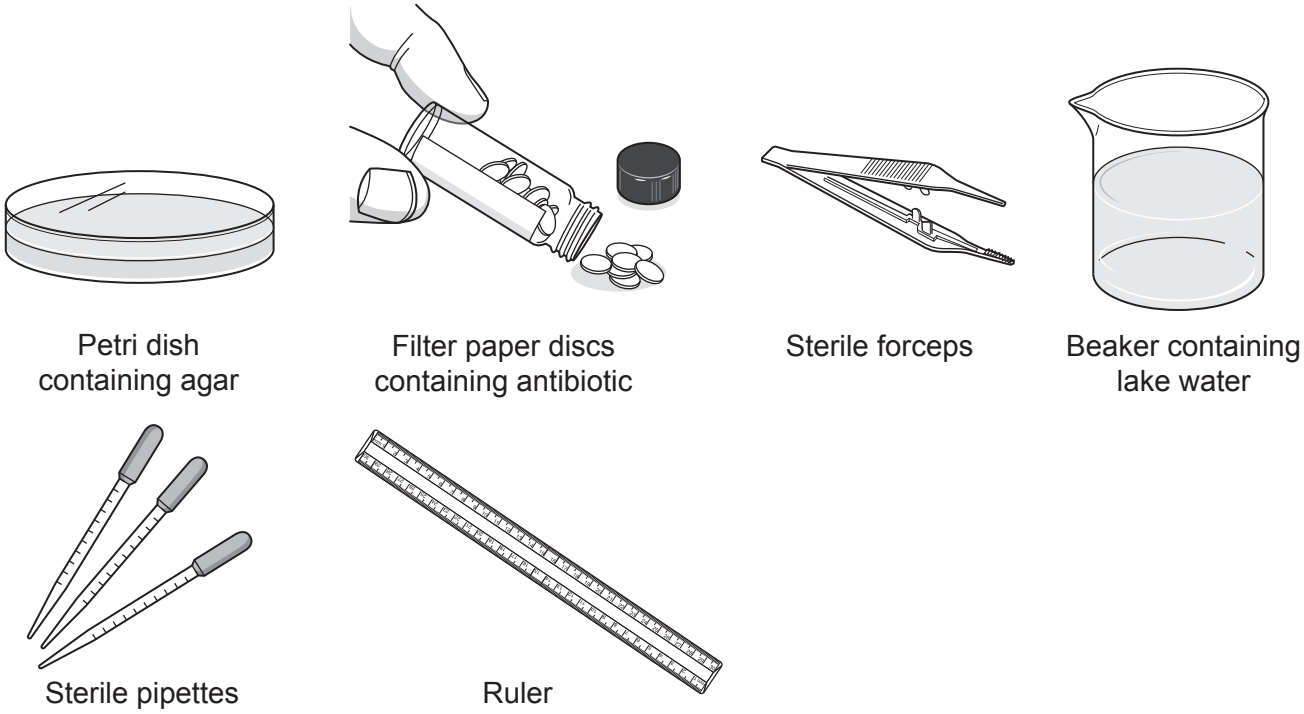

Fig. 16.2

Describe how the scientists could use **this** apparatus to **measure** how resistant the bacteria are to antibiotics.

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(d) The scientists also counted how many species of bacteria were resistant to antibiotics and how many species of bacteria were killed by antibiotics.

The scientists found these results.

	Number of different species of bacteria	
	In Lake Bellandur	In Lake Jakkur
Resistant to antibiotics	53	35
Killed by antibiotics	28	37

Which lake has the **highest** levels of antibiotic pollution?

Tick (✓) **one** box.

Lake Bellandur ☐

Lake Jakkur ☐

Explain your answer.

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..... **[2]**

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17 Zebras (**Fig. 17.1**) have evolved to live in hot grassland in Africa.

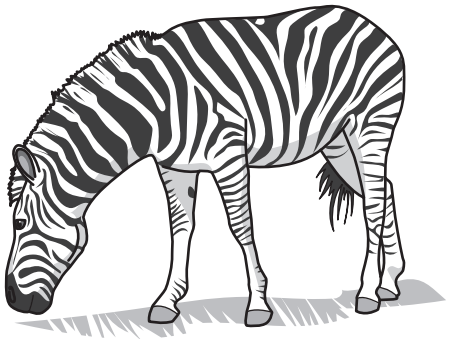

Fig. 17.1

(a) Scientists have tried to find out why zebras have evolved stripes on their body.

One theory is that the stripes help to keep the zebra cooler than other colours. Scientists did an experiment to test this theory. They covered barrels of cold water with the skin of different animals. Then they measured the temperature of the water several hours later.

The results are shown in **Fig. 17.2**.

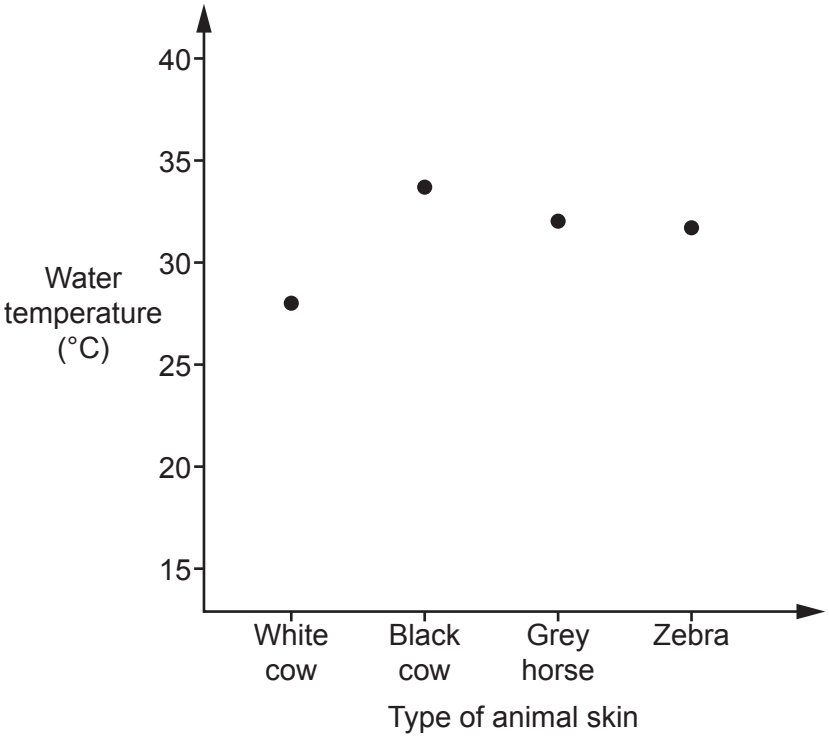

Fig. 17.2

(i) Do the results in **Fig. 17.2** support the theory that stripes keep zebras cool? Explain your answer.

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

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(ii) The scientists were aiming to investigate if it was **only** the colour of the skin that affected temperature regulation.

Suggest **one** improvement the scientists could make to ensure they **only** investigate the **colour** of the skin.

Explain your answer.

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

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(b) Another theory says that the stripes make a zebra less likely to be bitten by insects.

To test this theory scientists made models of zebras and covered them with sticky tape. One model was black. The other models had different widths of stripes.

Fig. 17.3 shows the number of insects that stuck to the tape.

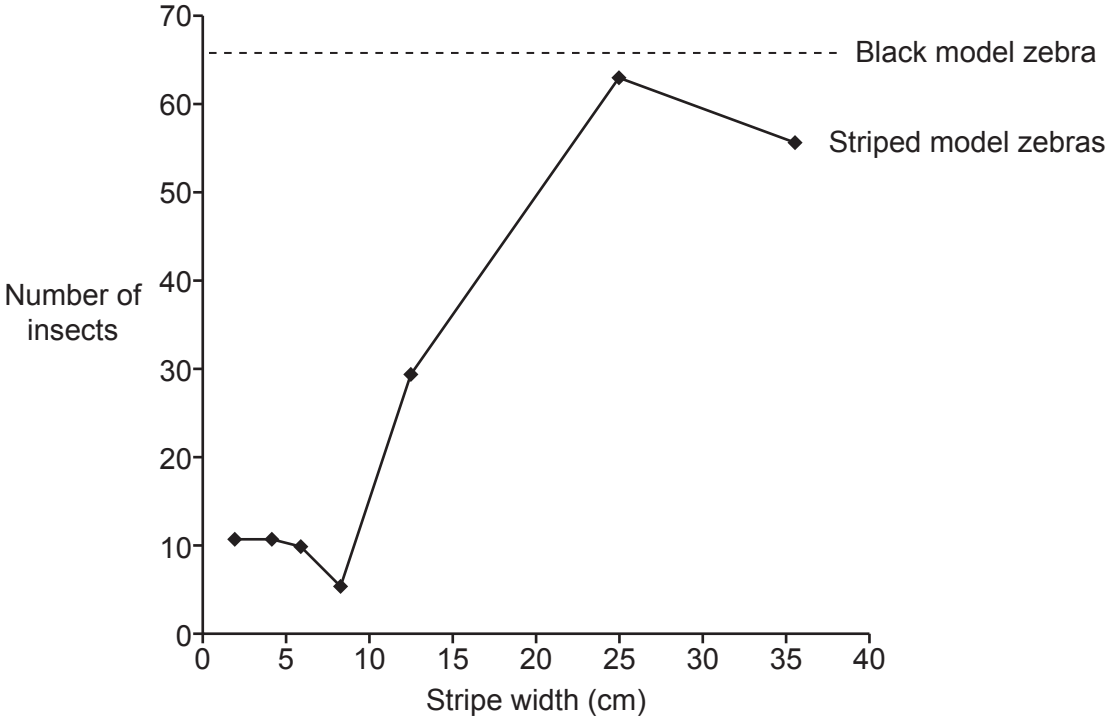

Fig. 17.3

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(i) Describe what **Fig. 17.3** shows about the link between zebra stripes and protection from insects.

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..... **[2]**

(ii) Horse blankets are used to cover horses when they are outside. Companies have started to produce horse blankets with zebra stripes.

Use the information in **Fig. 17.3** to suggest what width of stripe should be used to reduce insect bites.

Explain your answer.

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

(iii) Biting insects can spread pathogens between animals.

Use the theory of natural selection to explain how zebra stripes could have developed.

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18 Gardeners often turn dead plant material from their garden into compost. They then add this compost to the soil where they are growing plants.

(a) Why do gardeners add compost to their soil?

Tick (✓) **one** box.

Bacteria in the compost kill disease causing fungi. ☐

The compost is sterile and so is aseptic. ☐

The compost provides carbon dioxide for photosynthesis. ☐

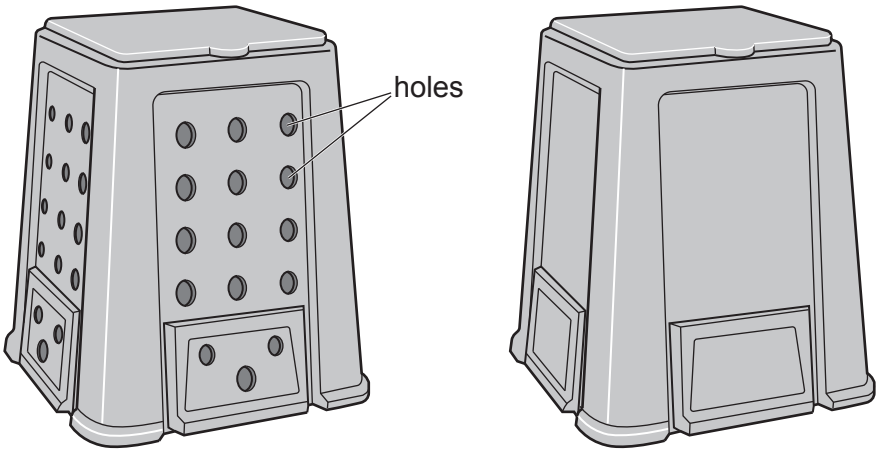
The compost provides minerals for the plants. ☐

[1]

(b) 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**.

The drawings show a normal composting bin and a bokashi bin.



Normal composting bin Bokashi bin

Explain the difference in the design of the two composting bins.

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..... **[2]**

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(c) Scientists investigate the two methods of making compost.

This is their method:

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

Write down **one** way that the scientists make sure that they can draw valid conclusions.

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

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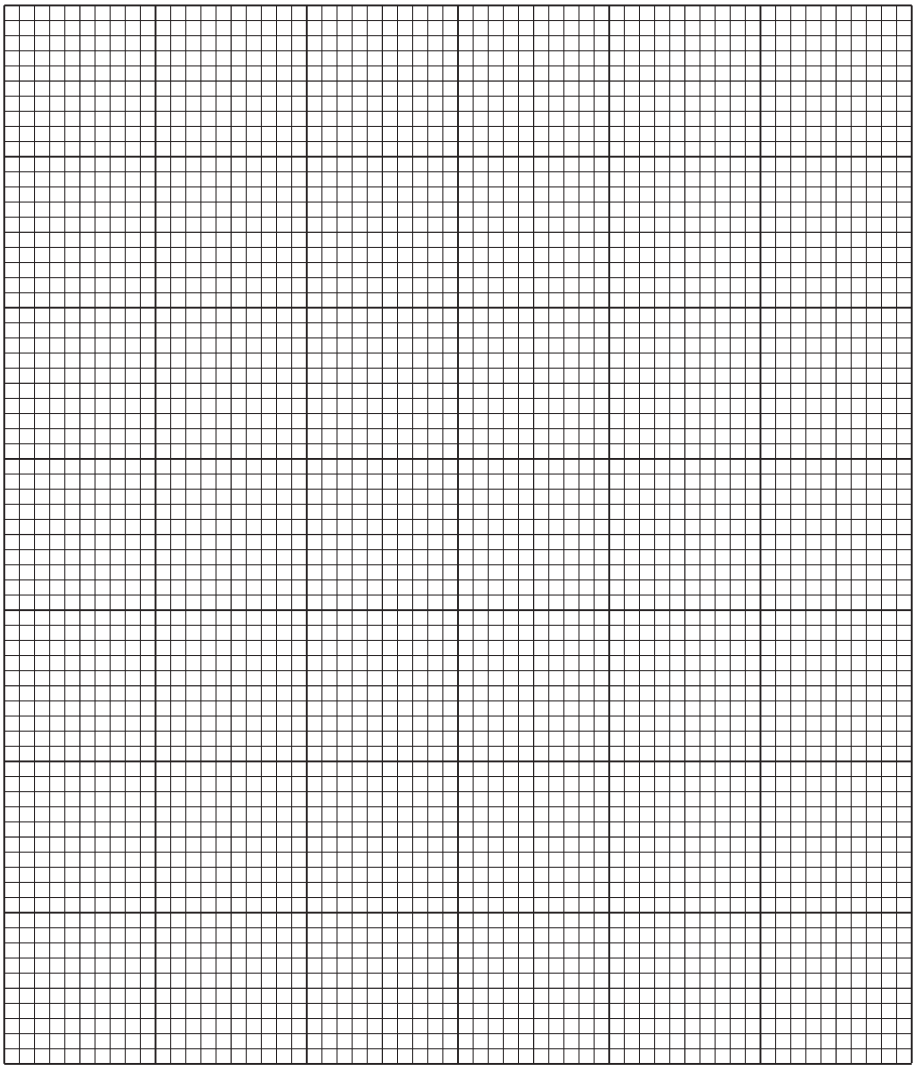
(d) **Table 18.1** shows the scientists' temperature readings.

	Temperature of the compost (°C)	
Time (days)	normal compost	bokashi compost
0	26	26
10	70	27
20	53	29
30	42	31
40	28	28

Table 18.1

(i) Plot the scientists' results on the grid for normal and bokashi compost, and draw **two** curves of best fit.



[5]

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(ii) Explain why the temperature of the compost in the **normal** bin changed as shown in the graph.

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..... **[2]**

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

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..... **[2]**

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(e) **Table 18.2** shows the scientists' results for the mass of the compost.

	Normal compost	**Bokashi compost**
Mass at start (kg)	1500	1500
Mass after 40 days (kg)	750	1100

Table 18.2

A gas is given off in the formation of the compost. This causes most of the decrease in mass.

(i) The percentage decrease in the mass of the normal compost is 50%.

Calculate the percentage decrease in the mass of the bokashi compost.

Give your answer to **2** significant figures.

Percentage decrease = ... % **[3]**

(ii) The scientists concluded that the bokashi method of composting might be better for the environment.

Use your answer from part **(e)(i)** to justify the scientists' conclusion.

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..... **[2]**

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19 Fanconi anaemia is a genetic disorder. It results in the bone marrow being destroyed. This causes a decrease in the numbers of red blood cells, white blood cells and platelets.

(a) Explain **two** possible symptoms of Fanconi anaemia.

1 .....

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2 .....

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[2]

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(b) **Table 19.1** shows normal ranges for blood components in people **without** Fanconi anaemia.

Blood component	Number per mm^3
red blood cell	$4.5 – 6.5 \times 10^6$
white blood cell	$6.0 – 16.0 \times 10^3$
platelet	$1.5 – 4.0 \times 10^5$

Table 19.1

(i) Suggest why there is such a wide range of white blood cell numbers.

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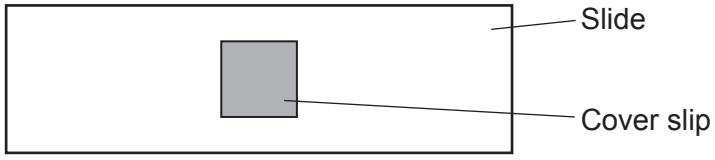
..... **[2]**

(ii) The diagram shows a microscope slide containing blood from a patient.



The square cover slip is 10 mm wide and the thickness of the blood underneath is 0.001 mm.

Calculate the volume of blood under the cover slip.

Volume of blood = ... mm^3 **[1]**

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(iii) Under the cover slip are 1000 white blood cells.

Does the blood sample provide evidence that the patient has Fanconi anaemia?

Use **Table 19.1** and your answer to part **(b)(ii)** to justify your answer.

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..... **[3]**

(c) There are many different genetic disorders that can affect blood cells. Details of three of these are found in **Table 19.2**.

Name of disorder	Cause of disorder	Symptom
D-B anaemia	dominant allele	low red blood cell numbers
S-D syndrome	recessive allele	low white blood cell numbers
Fanconi anaemia	recessive allele	small numbers of all blood cells

Table 19.2

A blood smear from another patient shows that he has 3×10^6 red blood cells per mm^3 of blood. Neither of his parents have a blood disorder.

Use **Table 19.1** and **Table 19.2** to explain which blood disorder the patient could have.

Name of disorder .....

Explanation .....

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..... **[3]**

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20 **Fig. 20.1** is a diagram of an antibody molecule. Antibodies are protein molecules. The ends of the antibody molecule bind with a particular antigen molecule.

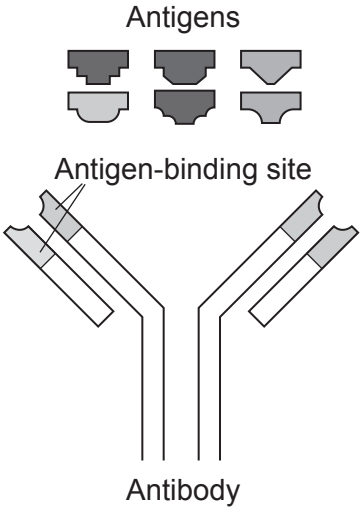

Fig. 20.1

(a) Explain why a different antibody molecule is needed for each antigen.

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(b) Large quantities of one type of antibody can be made by the process shown in **Fig. 20.2**.

These antibodies are called monoclonal antibodies.

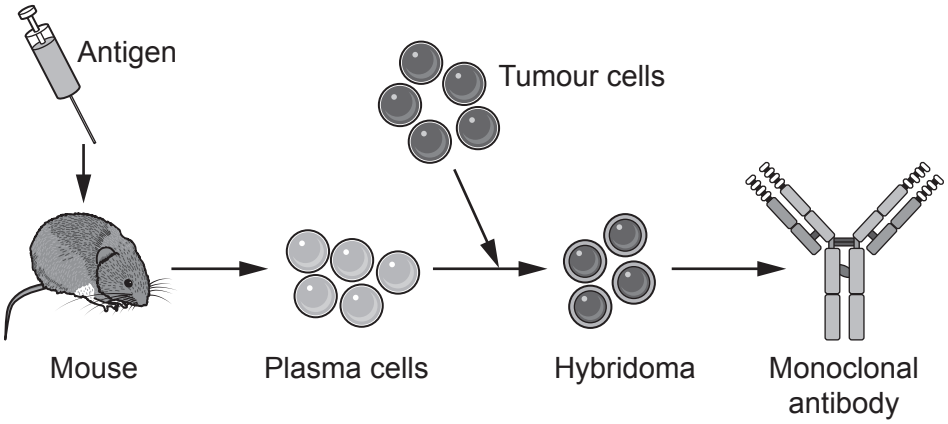

Fig. 20.2

(i) Give **two** uses of monoclonal antibodies.

1 .....

2 .....

[2]

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(ii) Why are tumour cells used in this process?

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

(c) Two scientists discovered a different method of making monoclonal antibodies.

They put genes that code for many different antibodies into viruses. The viruses then make the antibodies on their surfaces.

If an antigen attaches to an antibody, the scientists use the gene for this antibody to genetically engineer bacteria. The bacteria are then used to make large quantities of the antibody.

(i) Describe how scientists could use the antibody gene to genetically engineer bacteria to make many copies of the antibody.

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(ii) Many people would prefer to use antibodies made using bacteria and viruses, rather than the method shown in **Fig. 20.2**.

Suggest an explanation for this.

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(iii) In 2018, the scientists were awarded the Nobel Prize for their work.

Explain why their work had to be peer reviewed before they were awarded the prize.

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..... **[2]**

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21 Hypercholesterolemia (HC) is the result of a mutation in the genome. It is caused by a dominant allele on chromosome 19. The mutation involved causes a change in the DNA nucleotides.

(a) Write the words **allele**, **chromosome**, **genome** and **nucleotide** in the boxes to show their size from smallest feature to largest feature.

Smallest feature	
Largest feature	

[1]

(b) One in 500 people are heterozygous for HC.

There are 66 000 000 people in the UK.

Calculate how many people in the UK are heterozygous for HC.

Number of people = ... **[1]**

(c) A woman who does not have HC and a man who is heterozygous are expecting a baby.

What is the probability of the baby having HC?

Complete the genetic diagram to explain your answer.

Use **D** for the dominant HC allele and **d** for the recessive allele.

		Man	
Woman			

Probability = ... **[2]**

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(d) The allele that is affected by HC codes for a protein called LDL receptor protein.
The faulty allele often has four extra nucleotides, making a total of 2521 nucleotides.

Calculate the number of **amino acids** found in the healthy, **unaffected** protein.

Number of amino acids = ... **[2]**

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(e)* People with HC are more likely to develop heart disease. **Fig. 21.1** shows the heart of a person who has heart disease.

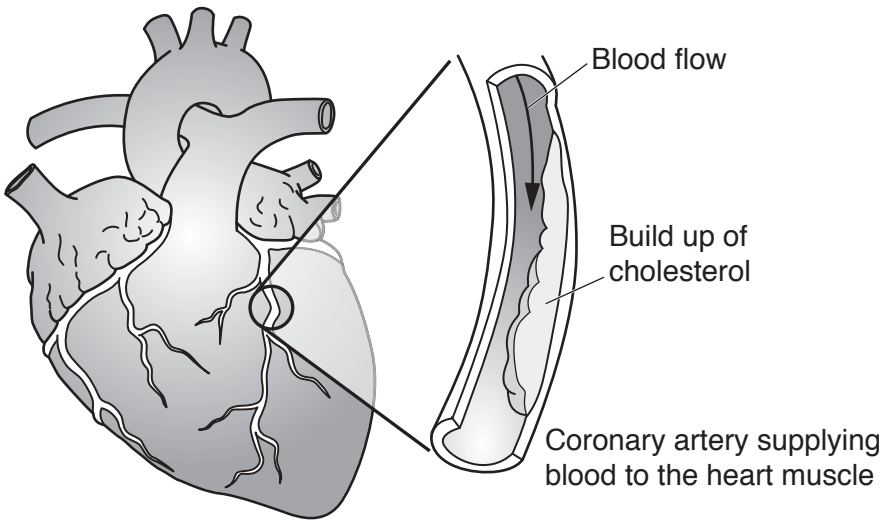

Fig. 21.1

The LDL receptor protein is found on the cell membrane of liver cells. The receptor picks up cholesterol from the blood and transports it into the liver cell. Inside the liver cell the cholesterol is broken down or used.

Explain why people who have the mutation in the allele for the LDL receptor are much more likely to develop heart disease.

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..... **[6]**

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(f) A drug is being developed that might help protect people from heart disease.
To test the drug patients were divided into three groups.
Each group was given a different treatment and their blood cholesterol measured.

The results are shown in **Fig. 21.2**.

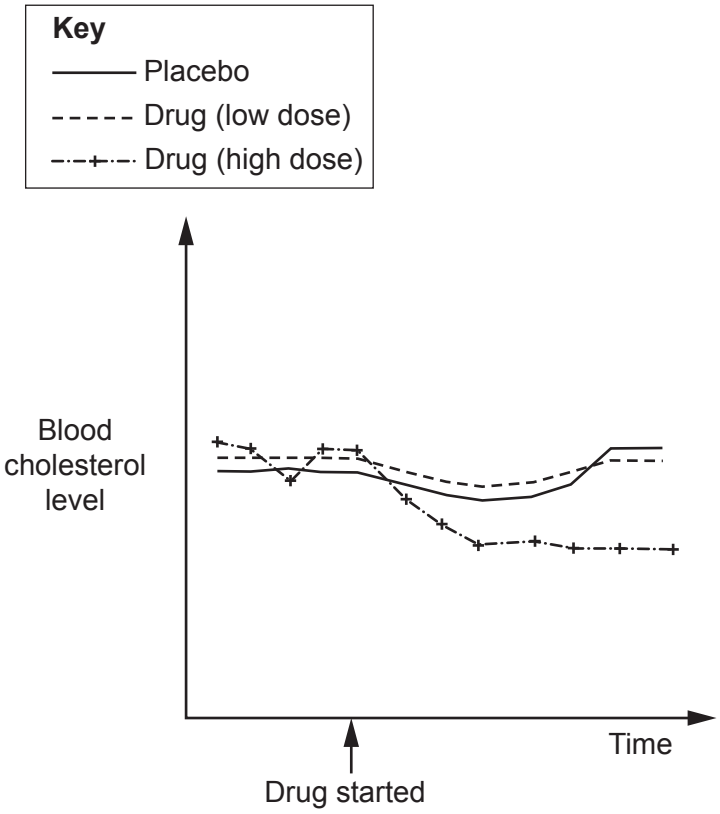

Fig. 21.2

Evaluate the results of the test.

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END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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