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H

Friday 7 June 2019 – Afternoon

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 may 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 may use an HB pencil for graphs and diagrams.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of the booklet. The question number(s) must be clearly shown.

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 consists of **28** pages.

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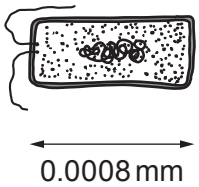
SECTION A

Answer **all** the questions.

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

Write your answer to each question in the box provided.

1 Look at the bacterial cell that causes disease in humans.



The human eye can see objects 0.1 mm in size.

What **minimum** magnification will be needed before the eye can see this bacterial cell?

A 12.5×

B 125×

C 1250×

D 12500×

Your answer ☐ **[1]**

2 A student estimates the number of snails in a pond.

Part of his method involves collecting snails and marking them.

What is the name of the method that he is using?

A Aseptic technique

B Capture-recapture

C Percentage increase

D Scaling-up

Your answer ☐ **[1]**

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3 What was Mendel's contribution to modern genetics?

A He developed the theory of natural selection.

B He discovered that most characteristics are controlled by multiple genes.

C He worked out how sex determination occurs in mice.

D He found a pattern that shows how characteristics are passed on.

Your answer ☐ **[1]**

4 Many human diseases are caused by risk factors.

Food and drink can be major risk factors.

Which disease does **not** have food or drink as a major risk factor?

A Type 1 diabetes

B Cirrhosis of the liver

C Type 2 diabetes

D Cardiovascular disease

Your answer ☐ **[1]**

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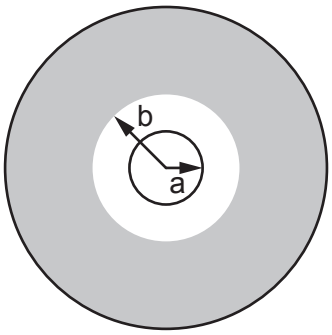
5 A student places an antibiotic disc onto the surface of agar that is covered in bacteria.

She calculates the area around the disc that is free from bacteria.



Which formula should she use?

A $2\pi b^2 - 2\pi a^2$

B $\pi b^2 + \pi a^2$

C $\pi b^2 - \pi a^2$

D $\pi(b - a)^2$

Your answer ☐ **[1]**

6 Which row on the table is correct for HIV?

	Destroyed by antibiotics	**Causes cervical cancer**	**Sexually transmitted**
A	✓	X	X
B	X	X	✓
C	X	✓	✓
D	✓	✓	✓

Your answer ☐ **[1]**

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7 Which of these is an example of ecotourism?

A Setting up monkey parks in the UK.

B Allowing people to sponsor endangered animals.

C Encouraging people to view animals in their natural environment.

D Educating children about the benefits of conservation.

Your answer ☐ **[1]**

8 In food chains, biomass is lost between different trophic levels.

One reason for this is the release of undigested food from the body.

Which term is used to describe this release?

A Decomposition

B Egestion

C Excretion

D Peristalsis

Your answer ☐ **[1]**

9 Which is a definition of cancer?

A An infection of foreign cells which divide uncontrollably.

B Body cells that divide uncontrollably many times.

C Body cells that lose the ability to divide and make stem cells.

D Pathogens that grow and divide unchecked.

Your answer ☐ **[1]**

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10 What does a vaccine contain that protects a person from infection?

A Antibiotics that will attach to antigens.

B Antigens that will stimulate antibody production.

C Antibiotics that kill pathogens.

D Antivirals that destroy viruses.

Your answer ☐ **[1]**

11 Which of these is a feature of an **artificial** classification system?

A It shows evolutionary links between organisms.

B It can be based on similarities in DNA.

C It may compare the amino acids in proteins.

D It uses a single difference or similarity between organisms.

Your answer ☐ **[1]**

12 New drugs are tested using preclinical trials.

Which statement describes a preclinical trial?

A One group of volunteers are given a placebo, another group the drug.

B The drug is tested on human cells.

C Volunteers are given a placebo only.

D Volunteers are given the new drug.

Your answer ☐ **[1]**

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13 What is the role of antibiotic resistance markers in producing genetically engineered bacteria?

A To identify which genes to insert into the bacteria.

B To identify which bacteria have taken up the plasmid.

C To identify which plasmids contain the genes.

D To identify which proteins are produced by the bacteria.

Your answer ☐ **[1]**

14 How does the fossil record provide evidence for evolution?

A It provides information about **all** extinct organisms.

B It shows that all organisms have evolved at the same rate.

C It shows that many small changes can result in a large change in organisms over time.

D It shows that changes in phenotype occurring during life can be passed on in the genes.

Your answer ☐ **[1]**

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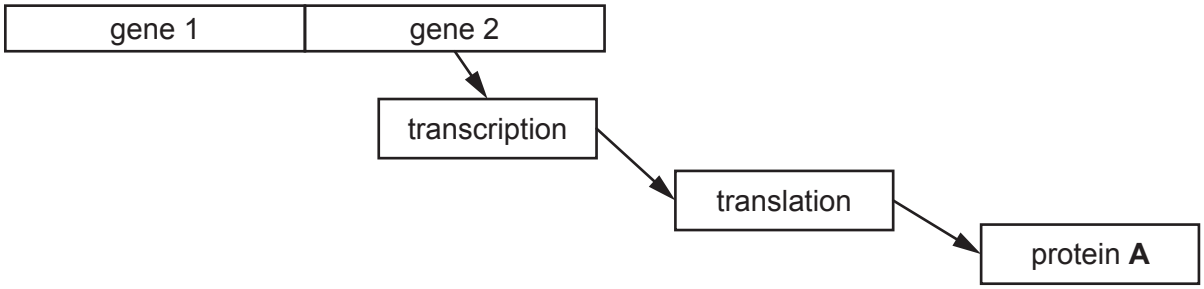
15 Gene **1** and gene **2** are both needed for the production of protein **A**.



What is the function of **gene 1** in this process?

A It codes for the amino acids in protein **A**.

B It codes for the mRNA needed to make protein **A**.

C It acts as the site for protein synthesis.

D It controls the expression of **gene 2**.

Your answer ☐ **[1]**

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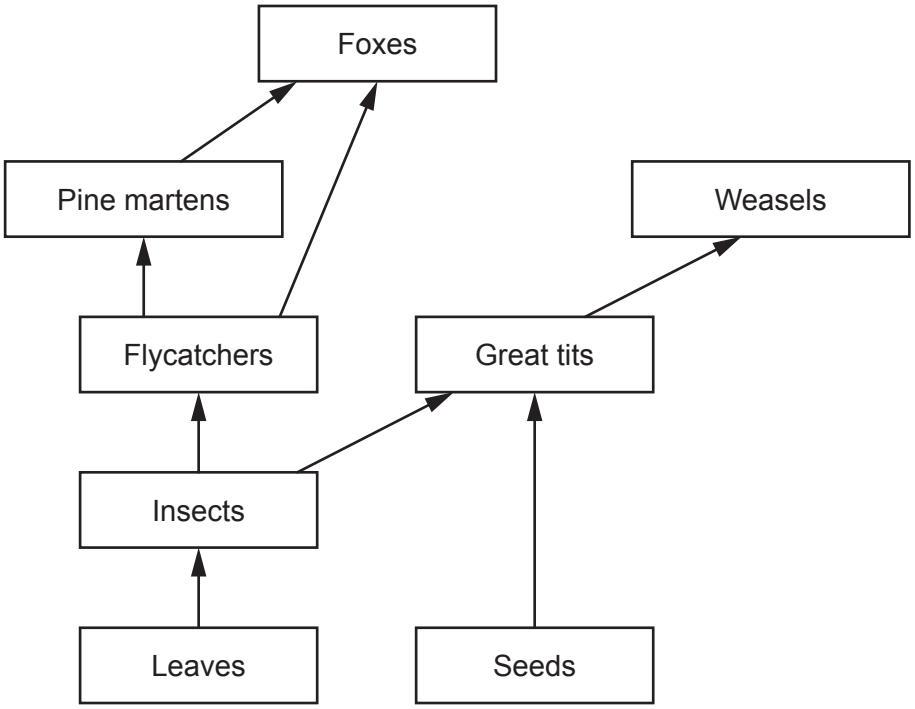
SECTION B

Answer **all** the questions.

16 The diagram shows part of a food web from a woodland.



(a) **(i)** Great tits are described as both primary consumers and secondary consumers.

Explain why.

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

(ii) Foxes are described as both predators and competitors of pine martens.

Explain why.

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

(iii) Which organism in the food web occupies the second trophic level?

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

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(b) Great tits and flycatchers are both birds.

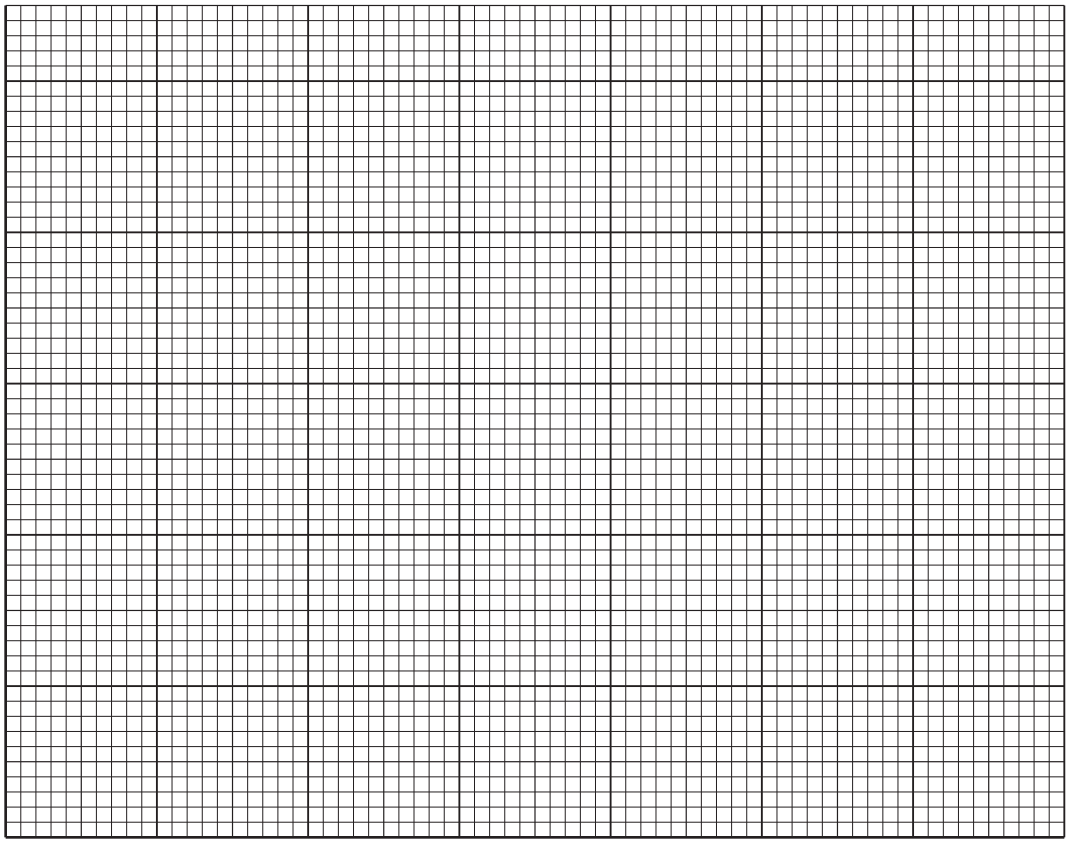
In a conservation project, scientists have built boxes for the birds to nest in. The scientists fixed the boxes on trees at different heights.

The table shows how many birds of each type used the boxes for nesting.

	Number of bird boxes used	
Height of bird box above the ground (m)	**By great tits**	**By flycatchers**
1	1	6
2	7	5
4	10	6

(i) Draw a **bar chart** on the graph paper to show the scientists' results.

The results for great tits and flycatchers should be on the same axis.



[4]

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(ii) The food web shows:

- Weasels feed on great tits
- Pine martens feed on flycatchers.

Weasels live on the ground but pine martens live in trees.

How can this be used to explain the results of the scientists' investigation?

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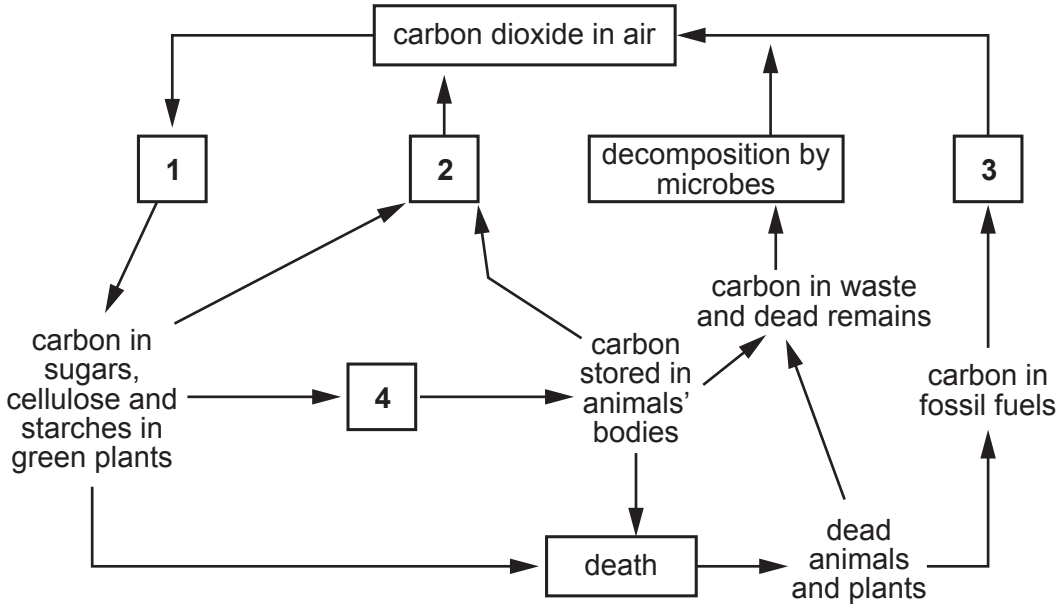
17 **(a)** The diagram shows the carbon cycle.



Boxes **1–4** represent different processes in the carbon cycle.

Draw lines to link boxes 1–4 to the correct name for the process in the carbon cycle.

1	**Combustion**
2	**Eating**
3	**Photosynthesis**
4	**Respiration**

[2]

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(b) Scientists investigated if crops could be grown on the planet Mars.

They used a soil that was similar to the soil found on Mars. The soil contained some minerals but no living organisms.

(i) The scientists managed to grow crops in the soil. However on Mars, the minerals in the soil would soon run out.

Explain why.

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(ii) Living organisms could be added to the soil but there is no air on Mars. The plants would need to be grown in an enclosed structure.

At first, air would need to be added, but after a while the organisms in the soil and the plants would supply each other with the gases they need.

Explain how this would happen.

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18 Two farmers grow barley in their fields.

They both have a problem with barley powdery mildew infecting their crops.

(a) Powdery mildew is caused by a fungus.

Describe how fungal infections can spread and how they enter plant leaves.

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(b) The farmers want to prevent their crops from getting powdery mildew.

(i) Explain how burning plants after the barley has been harvested can protect the crops.

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(ii) Explain how growing barley in the fields one year, then wheat the next year can protect the crops.

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(c) The farmers test two different fungicides.

They each grow barley in one of their fields. Each farmer sprays a different fungicide on their field. They then compare the crop yield in the two different fields.

How could you improve the farmers' experiment?

Explain your answer.

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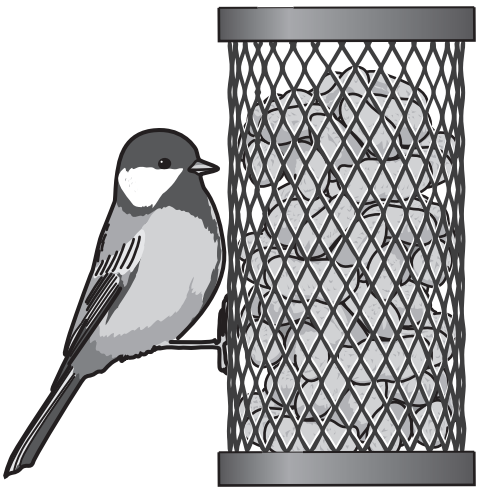
19 Blue tits are small birds seen in gardens.

(a) Many people in the UK feed birds nuts using a bird feeder, as shown in the diagram below.



Scientists measured the mean lengths of blue tits' beaks in the UK.

They found that blue tit beaks in the UK are slightly longer than blue tit beaks in the rest of Europe.

Very few people in the rest of Europe put bird feeders out for their birds.

Use Charles Darwin's theory of natural selection to explain why the blue tits in the UK have slightly longer beaks than those in the rest of Europe.

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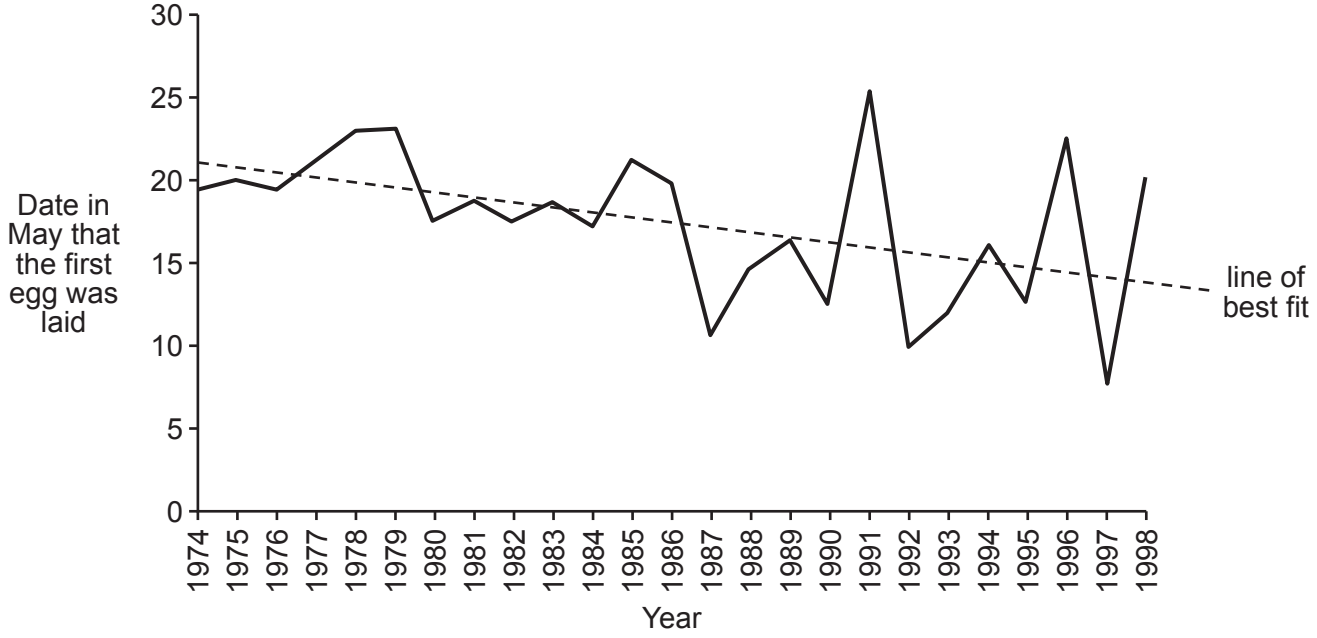
(b) Blue tits usually lay their eggs in the month of May.

For many years, the scientists have recorded the first day that an egg was laid.

This data is shown in the graph.



The scientists made this explanation for the results:

The results are due to climate change.

Suggest arguments **for** and **against** this possible explanation.

Use information from the graph in your answer.

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20 Some people get very painful headaches called migraines.

Scientists think that this is caused by a protein in the brain called CGRP.

Levels of the CGRP protein are higher in the brains of people who get migraines.

Doctors are trying to find a treatment to prevent migraines.

They have produced an antibody against the CGRP protein.

(a) Describe how antibodies are usually made in the human body.

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(b) The doctors test the antibody treatment on migraine patients.

The patients are divided into two groups:

- One group is given an injection of the antibody
- The second group receives an injection of a placebo.

They record the mean number of days each patient had migraines before and after treatment.

The table shows their results.

Treatment	Mean number of migraine days per patient **before** treatment	Mean number of migraine days per patient **after** treatment	Percentage decrease in migraine days per patient
antibody injection	9.1	4.4	
placebo	9.1	6.4	29.7

(i) Explain why a placebo group is used in drug testing.

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(ii) Calculate the percentage decrease in migraine days in the patients that had the antibody injection.

Give your answer to **1** decimal place.

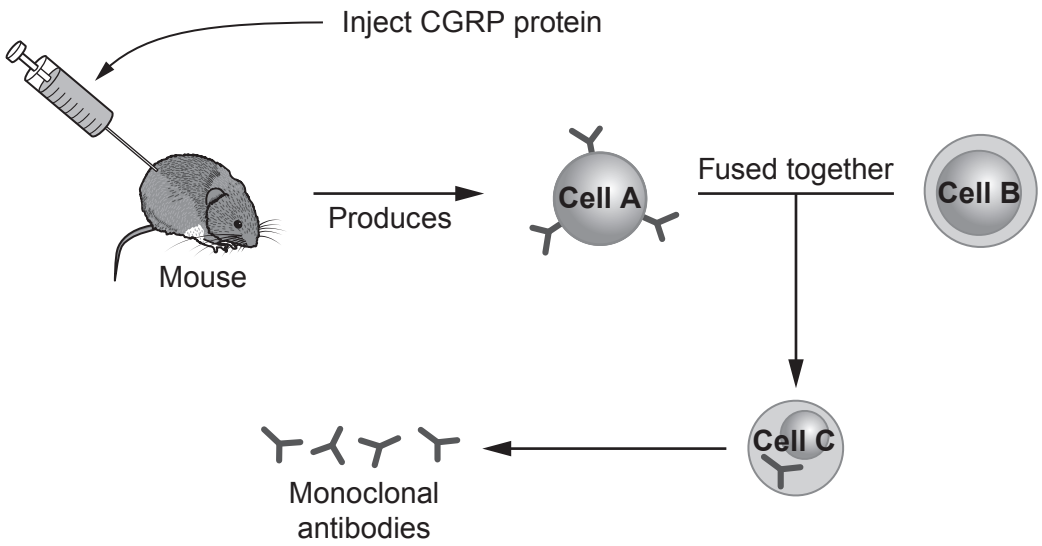
Percentage decrease = ... %

[3]

(c) The antibodies used in the investigation were monoclonal antibodies.

They can be made by injecting CGRP protein into a mouse.

The diagram shows this process.



Draw lines to identify each type of cell shown in the diagram.

Cell A	**Cancer cell**
Cell B	**Lymphocyte**
Cell C	**Hybridoma**

[2]

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21 Huntington's disease is a genetic condition. It is caused by a **dominant allele**.

(a) Explain what is meant by the term dominant allele.

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

(b)* The symptoms of Huntington's disease usually appear after the age of 40.

There is no cure and people with the disease usually die after 10–15 years.

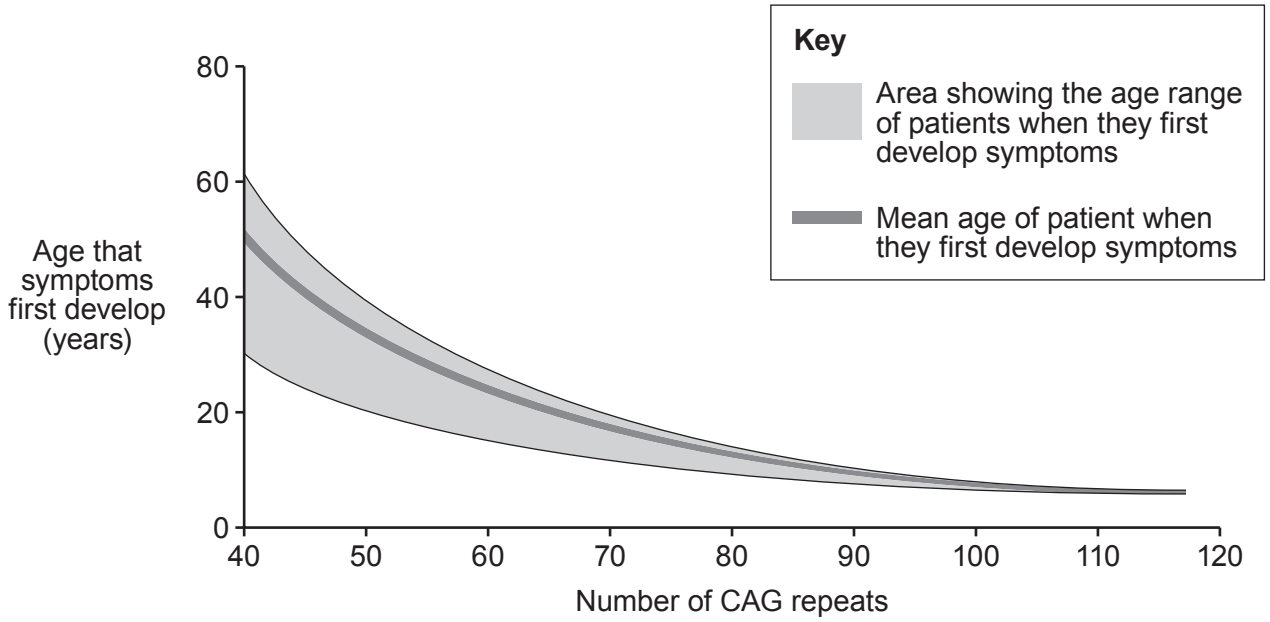
Scientists now know that there are a number of different forms of the allele that causes Huntington's disease. The allele has a sequence of three bases, CAG, that repeats many times. The number of repeats varies between patients.

Patients can be tested to see if they have the allele and how many repeats it has.

Doctors have studied many patients to see:

- The number of CAG repeats a patient has
- The age that the patient starts to show symptoms of the disease.

The results are shown on the graph.



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Discuss how useful the gene test and the graph are for people who have a history of Huntington's disease in their family.

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(c) A new study is giving hope for a treatment for Huntington's disease.

Doctors gave patients an injection of a drug that blocks the action of mRNA that is produced by the Huntington allele.

Explain how this drug could prevent the symptoms of Huntington's disease.

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

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22 A salt marsh is a large muddy area of land where a river joins the sea. This is a rare habitat and some plants grow on salt marshes but nowhere else.

(a) When the tide comes in the salt marsh gets covered with seawater.

Explain the effects of salt water on plant cells.

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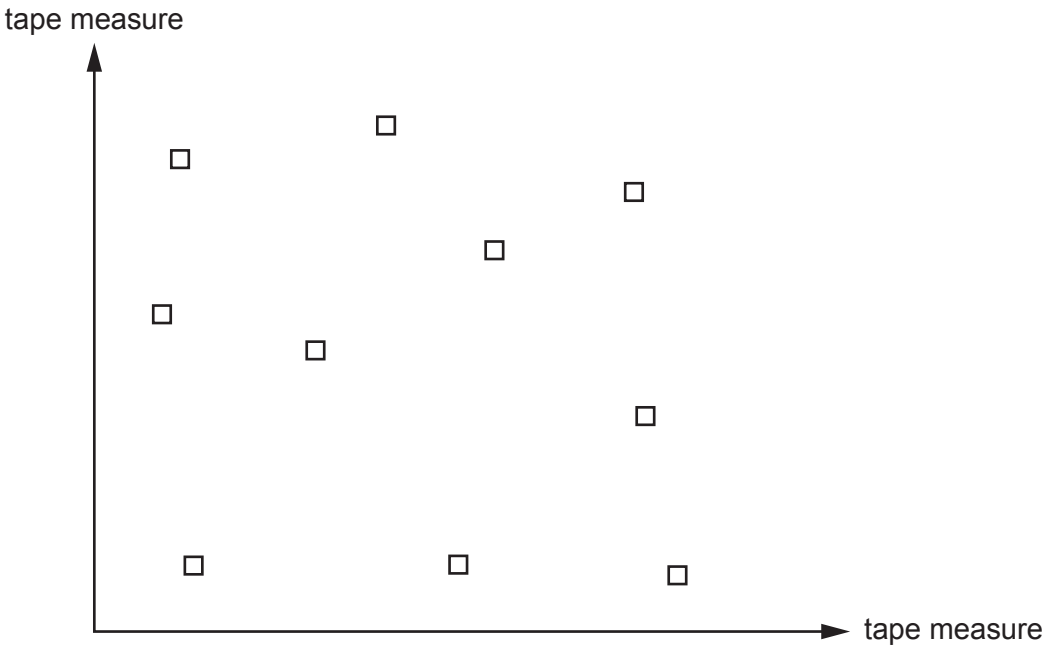
..... **[1]**

(b) A student investigates the plants growing on a salt marsh. He uses a quadrat to sample the plants.

He puts down two long tape measures at right angles to each other across the salt marsh. He then picks numbers at random and uses them to decide where to place a quadrat.

The diagram shows the position of all his quadrats across the salt marsh.



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(i) The salt marsh measured 50 m × 50 m.

Each quadrat measured 0.5 m × 0.5 m.

Calculate the percentage of the whole salt marsh that was sampled by the student.

Percentage = ... %
[3]

(ii) A second student sampled by placing five quadrats close together in the centre of the salt marsh.

Evaluate the sampling method of the second student compared to the method of the first student.

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

(iii) Suggest **one** factor that the students should consider in a risk assessment for their experiment.

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

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(c) In some salt marshes large sand banks have been built. This stops tides from entering the salt marsh.

The level of soil on the salt marsh builds up and the marsh turns into dry land.

This dry land shows a greater biodiversity of plants than a salt marsh.

Explain why some scientists want to limit the building of sand banks, even though they increase biodiversity.

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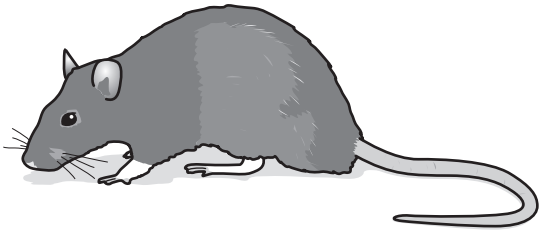
23 Rats are a major pest in many areas of the world. They can reduce food security and spread diseases.



(a) Warfarin is a chemical that is used as a rat poison. It stops the correct functioning of platelets in the blood.

Explain why warfarin can be used as a rat poison.

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(b) In 1958, some rats were found that were resistant to warfarin. They did not die, even when fed with large amounts of the poison. Scientists found that the resistance was due to dominant allele **R**.

Two resistant rats can mate and produce non-resistant rats.

Draw a genetic diagram below to show how these non-resistant rats can be produced.

[3]

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(c) When scientists studied the resistant rats they found that there were two different types.

Homozygous rats are resistant to warfarin but need to eat 20 times more vitamin K.

Heterozygous rats are resistant to warfarin but only need slightly increased amounts of vitamin K.

The scientists found that the non-resistant rats never died out completely.

Explain why.

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(d) Scientists now think that they might be able to reduce rat populations by using genetic engineering. They want to insert a gene into male rats that destroys all sperm that contain an X chromosome.

(i) Name the enzyme used to join two sections of DNA together in genetic engineering.

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

(ii) Explain how this method of genetic engineering would rapidly reduce the rat population.

You may use a diagram in your answer.

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

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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