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Oxford Cambridge and RSA

H

Friday 26 November 2021 – 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 your 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

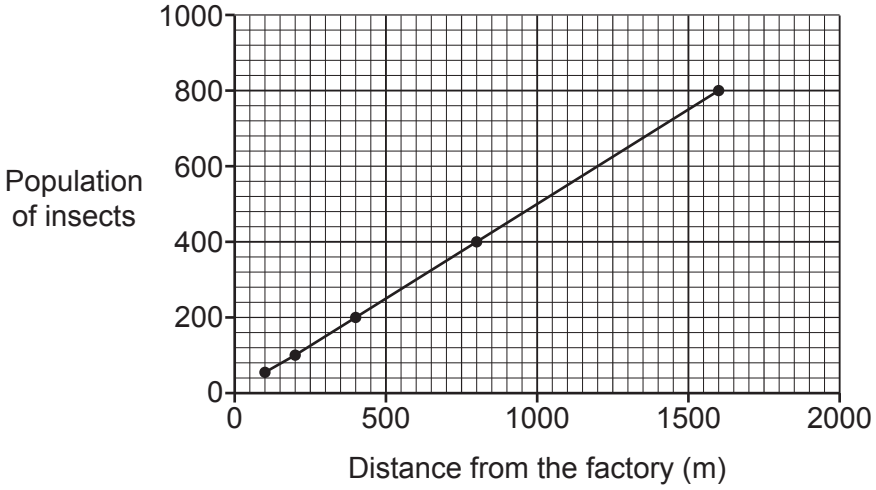
Answer **all** the questions.

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

Write your answer to each question in the box provided.

1 A student estimated the population of insects at different distances from a factory using capture-recapture.

They plotted their results on a graph.



Which of these statements describes the student's results?

A Population size = distance from the factory

B Population size ∝ distance from the factory

C Population size > distance from the factory

D Population size ~ distance from the factory

Your answer ☐ **[1]**

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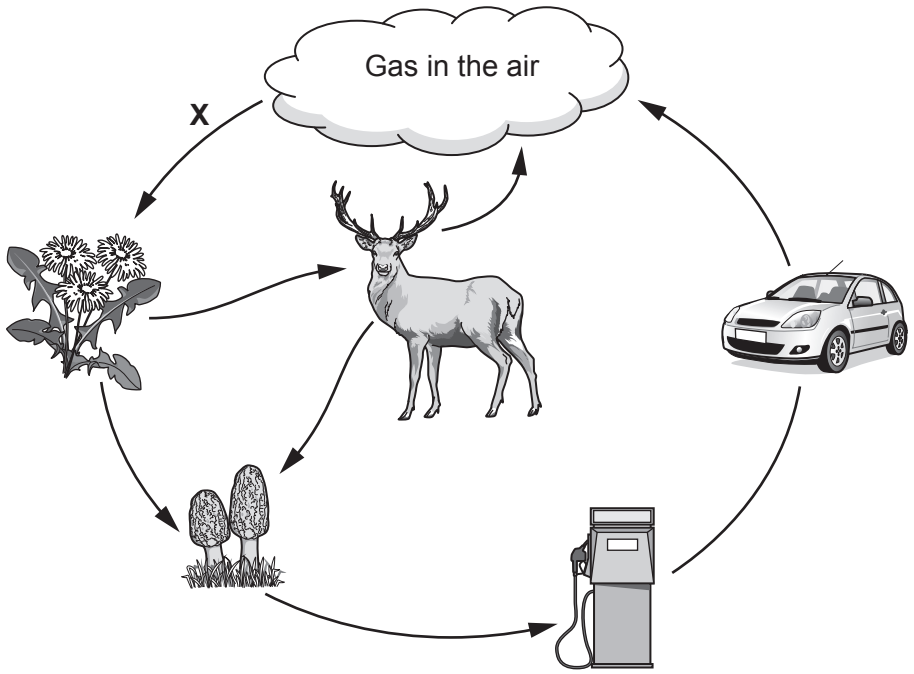
2 Which row in the table gives the optimum conditions for decomposition?

	Oxygen	Temperature (°C)	Decomposers
A	Present	40	Present
B	Absent	10	Absent
C	Present	80	Present
D	Absent	40	Present

Your answer ☐ **[1]**

3 The diagram shows the carbon cycle.



What is the importance of process **X** to living organisms?

A It produces food containing carbon molecules.

B It produces fossil fuels for combustion.

C It provides minerals to plants.

D It releases energy and carbon dioxide.

Your answer ☐ **[1]**

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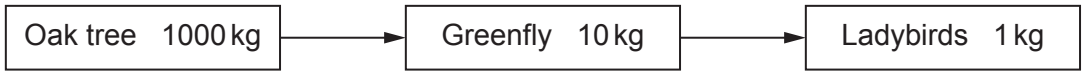
4 The diagram shows the biomass in different trophic levels of a food chain.



Which processes account for the decrease of biomass along the food chain?

A Egestion, growth and respiration

B Egestion, respiration and excretion

C Photosynthesis, respiration and excretion

D Respiration, growth and excretion

Your answer ☐ **[1]**

5 Which pair of genetic terms have the same meaning?

A Base and nucleotide

B Gene and allele

C Gene and genome

D Variant and allele

Your answer ☐ **[1]**

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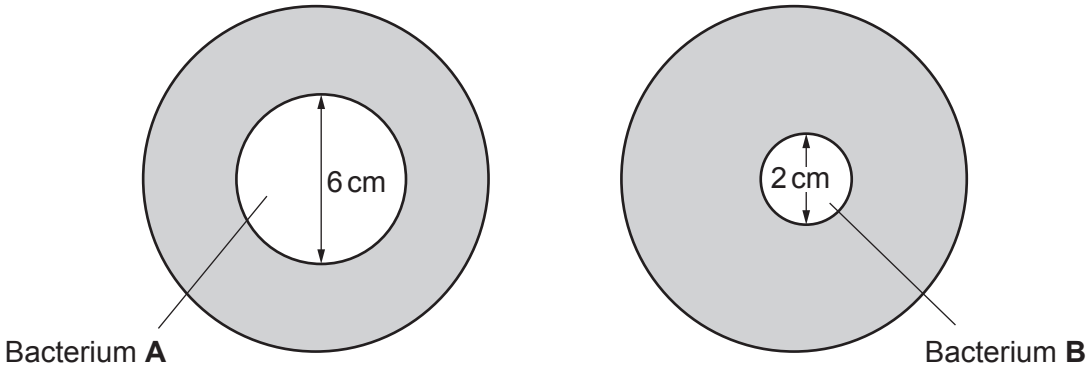
6 The diagram shows colonies of bacteria growing on two agar plates.



What is the ratio of the area covered by bacterium **A** compared to the area covered by bacterium **B**? (The area of a circle = πr^2)

A 1 : 3

B 1 : 9

C 3 : 1

D 9 : 1

Your answer ☐ **[1]**

7 Before surgery, a doctor will wipe the skin of the patient with a chemical to kill bacteria.

Which type of chemical is the doctor likely to use?

A Antibiotic

B Antigen

C Antiseptic

D Antiviral

Your answer ☐ **[1]**

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8 Which of these is a step in the process used to make monoclonal antibodies?

A Fusing hybridoma cells with lymphocytes (plasma cells).

B Fusing tumour cells with lymphocytes (plasma cells).

C Injecting antibodies into an animal such as a mouse.

D Injecting tumour cells into an animal such as a mouse.

Your answer ☐ **[1]**

9 What is the purpose of a placebo in a clinical trial?

A To calculate the lowest effective dose of the medicine.

B To make sure the results of the trial are reproducible.

C To see if the effects of the medicine are due to the expectations of the patient.

D To see if the effects of the medicine last for a long period of time.

Your answer ☐ **[1]**

10 Genetic engineering involves the use of sticky ends to form plasmids.

What is a sticky end?

A A length of DNA which is single stranded.

B A length of DNA which is double stranded.

C A length of mRNA which is single stranded.

D A length of mRNA which is double stranded.

Your answer ☐ **[1]**

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11 The diploid number of chromosomes in sheep is 54. Sex in sheep is determined in the same way as in humans.

Which is a possible chromosome combination in a **sperm cell** of a male sheep?

A 22 chromosomes + Y

B 26 chromosomes + X

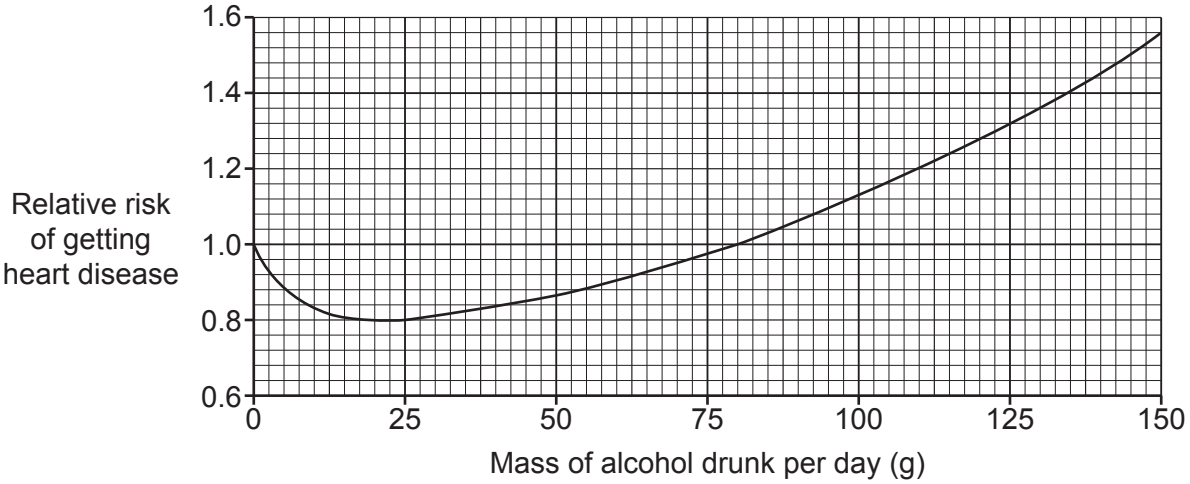
C 52 chromosomes + XY

D 54 chromosomes + XY

Your answer ☐ **[1]**

12 Scientists studied how the mass of alcohol drunk per day affects the relative risk of getting heart disease. The graph shows the results of their study.

$$\text{relative risk} = \frac{\text{the number of people getting heart disease who drink each mass of alcohol}}{\text{the number of people getting heart disease who drink no alcohol}}$$



Which conclusion can be made from this graph?

A Drinking 80 g of alcohol a day does not increase the risk of heart disease.

B Drinking above 80 g of alcohol per day reduces the risk of heart disease.

C Drinking alcohol has little effect on the risk of heart disease.

D Drinking any mass of alcohol increases the risk of heart disease.

Your answer ☐ **[1]**

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13 The pea plants studied by Mendel were either tall or dwarf.

Scientists think that he was lucky to have chosen this characteristic because many other characteristics produce a range of different phenotypes.

Which statement about the types of inheritance discussed by the scientists is correct?

A Height in pea plants is controlled by a single allele.

B Height in pea plants is controlled by two different genes.

C Many characteristics are controlled by multiple genes working together.

D Many characteristics are completely controlled by the environment.

Your answer ☐ **[1]**

14 Researchers studied over 200 DNA samples from giraffe cells. Some populations of giraffe, which were geographically isolated, were found to be genetically very similar.

Which technique would the researchers have used to find that the giraffe populations were genetically similar?

A Cloning using stem cells

B DNA sequencing

C Genetic engineering

D Transcription

Your answer ☐ **[1]**

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15 Scientists have found that only about 1% of our DNA codes for proteins.

The other 99% of DNA used to be called ‘junk’ DNA.

Why is the term ‘junk’ DNA **not** used anymore?

A Enzymes may be present in the ‘junk’ DNA.

B The ‘junk’ DNA can code for the production of carbohydrates.

C The ‘junk’ DNA is non-coding DNA that can control transcription.

D Translation can occur on the ‘junk’ DNA.

Your answer ☐ **[1]**

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SECTION B

Answer **all** the questions.

16 Farmers' fields are usually surrounded by hedges. An example of this is shown in **Fig. 16.1**.

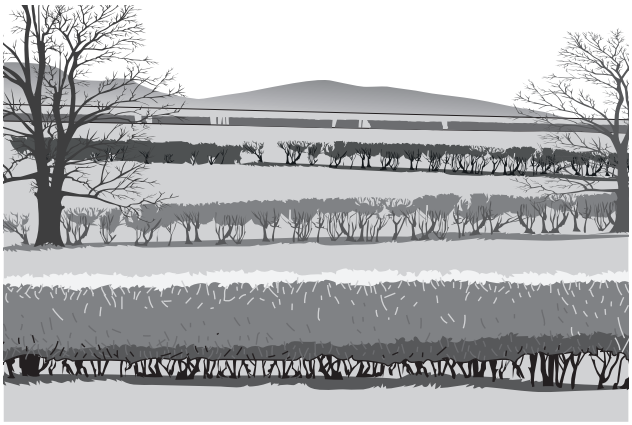

Fig. 16.1

Different plant species grow in the hedges. Scientists are studying hedges to find the number of different plant species.

(a) Write down why they would use a quadrat and a biological key in this process.

Quadrat .....

.....

.....

Key .....

.....

[3]

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(b) The scientists want to see if there is a link between the area of a field and the number of plant species growing in the hedge.

They sample hedges in five different sizes of fields, **A**, **B**, **C**, **D** and **E**.

The table shows the scientists' results.

Field	Area of field (m^2)	Mean number of plant species (per m of hedge)
A	3000	2.0
B	4000	1.7
C	7500	1.3
D	1500	2.1
E	10 000	1.2

(i) Plot the data for the five fields on the grid in **Fig. 16.2**.

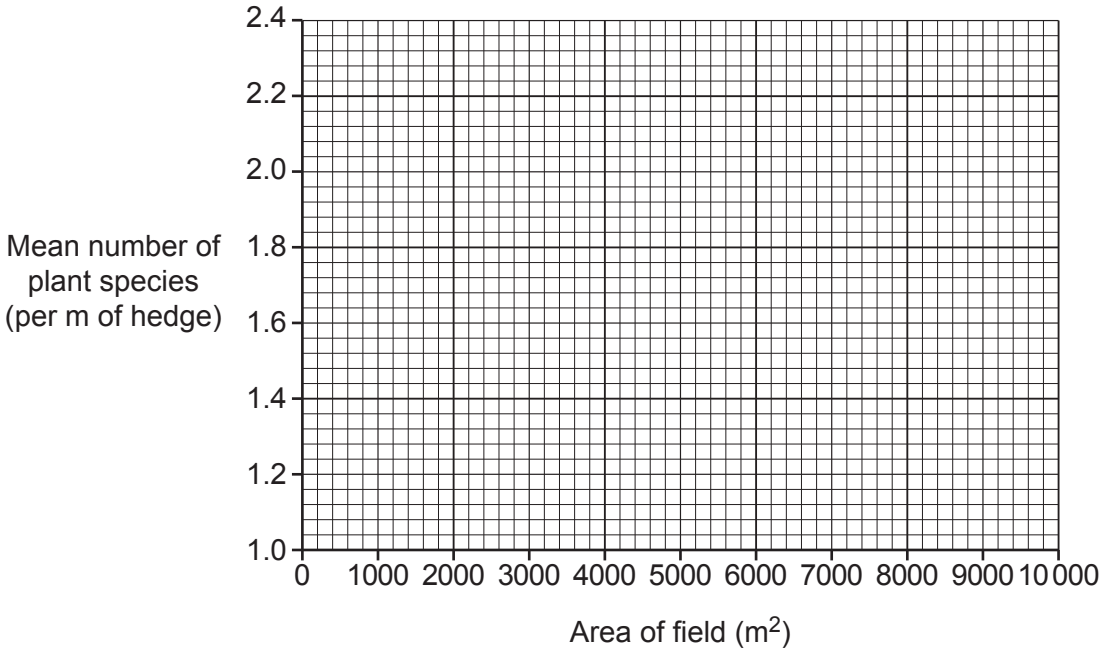

Fig. 16.2

[2]

(ii) Draw a line of best fit on the graph in **Fig. 16.2**. **[1]**

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(iii) There is a formula that can be used to estimate the age of a hedge.

$$\text{age in years} = \left(\begin{array}{c}\text{mean number of}\\ \text{plant species}\\ \text{per m of hedge}\end{array}\right) \times 110 + 30$$

The hedges in field **E** are 162 years old.

Calculate the age of the hedges in field **D**.

Age = ... years **[2]**

(iv) To try to grow more crops, farmers now use larger machines.

Modern farms have larger fields to make it easier to use these machines.

Does the scientists' data support the idea that older fields are smaller?

Explain your answer.

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

(c) Birds such as blackbirds make nests in hedges.

Fig. 16.3 shows a food web that occurs in a hedge next to a field of wheat.

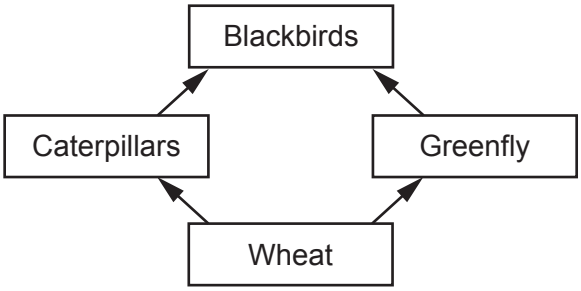

Fig. 16.3

Farmers are replanting hedges in their fields.

Use information from the food web in **Fig. 16.3** to explain how this could increase the yield of wheat.

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

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17 Sulfur dioxide is a gas released when coal and oil are burned. Sulfur dioxide dissolves in water to make an acid. Scientists think that this might harm plants by affecting photosynthesis.

(a) Photosynthesis is controlled by enzymes.

Which **two** statements explain how an acid could affect photosynthesis?

Tick (✓) **two** boxes.

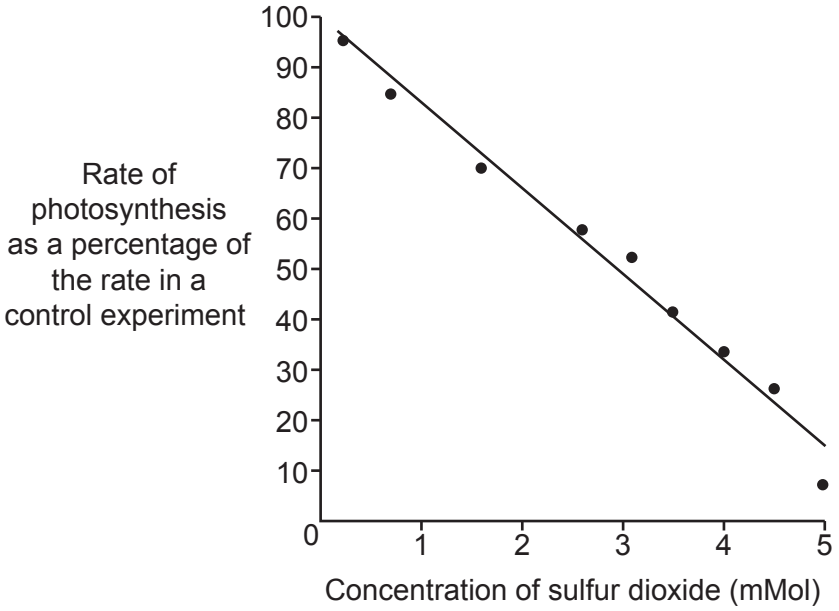
- Acid will decrease the pH and cause the enzyme to change shape. ☐
- Acid will increase the pH and cause the enzyme to change shape. ☐
- Acid will increase the pH and cause the substrate to change shape. ☐
- The enzyme will not fit into the active site of the substrate. ☐
- The substrate will denature. ☐
- The substrate will not fit into the active site of the enzyme. ☐

[2]

(b) Students take some spinach leaves and spray them with water containing different concentrations of sulfur dioxide.

They then measure the rate of photosynthesis of the leaves.

The graph shows their results.



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(i) The students plotted the rate of photosynthesis as a percentage of the rate in a control experiment. The control experiment involved spraying the leaves with a different substance.

Suggest what substance the students used to spray the leaves as a control.

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

(ii) One of the students makes this conclusion:

'The results of our experiment show that sulfur dioxide is affecting the plant and it is doing this because it forms an acid.'

Discuss whether this is a reasonable conclusion to make from the students' results.

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

(iii) Suggest how the students could modify their experiment to prove that sulfur dioxide is affecting the plant because it forms an acid.

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

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18 This question is about plant diseases.

(a) Plant diseases can be caused by bacteria, fungi or viruses.

Complete the table by choosing words from this list to identify the **cause** of each of the diseases.

You can use each word once, more than once, or not at all.

bacterium **fungus** **virus**

Name of disease	**Cause**
Barley mildew	.....
Crown gall disease	.....
Tobacco mosaic disease	.....

[3]

(b) Tomatoes are an important food crop. They can be infected by a number of different pathogens.

It is important that farmers can identify which pathogen is infecting their tomatoes as soon as possible.

Give **two** reasons to explain why.

1 .....

.....

2 .....

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[2]

(c) Tomatoes can be infected by two types of disease called early blight and late blight.

The type of disease can currently be identified by taking sections of leaves and examining them using a microscope.

Scientists are developing a new method of identifying these two diseases. They scan a leaf with light for 10 seconds and measure the wavelengths of light that are reflected.

(i) Give **one** reason why the new method may be an improvement on the current method.

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

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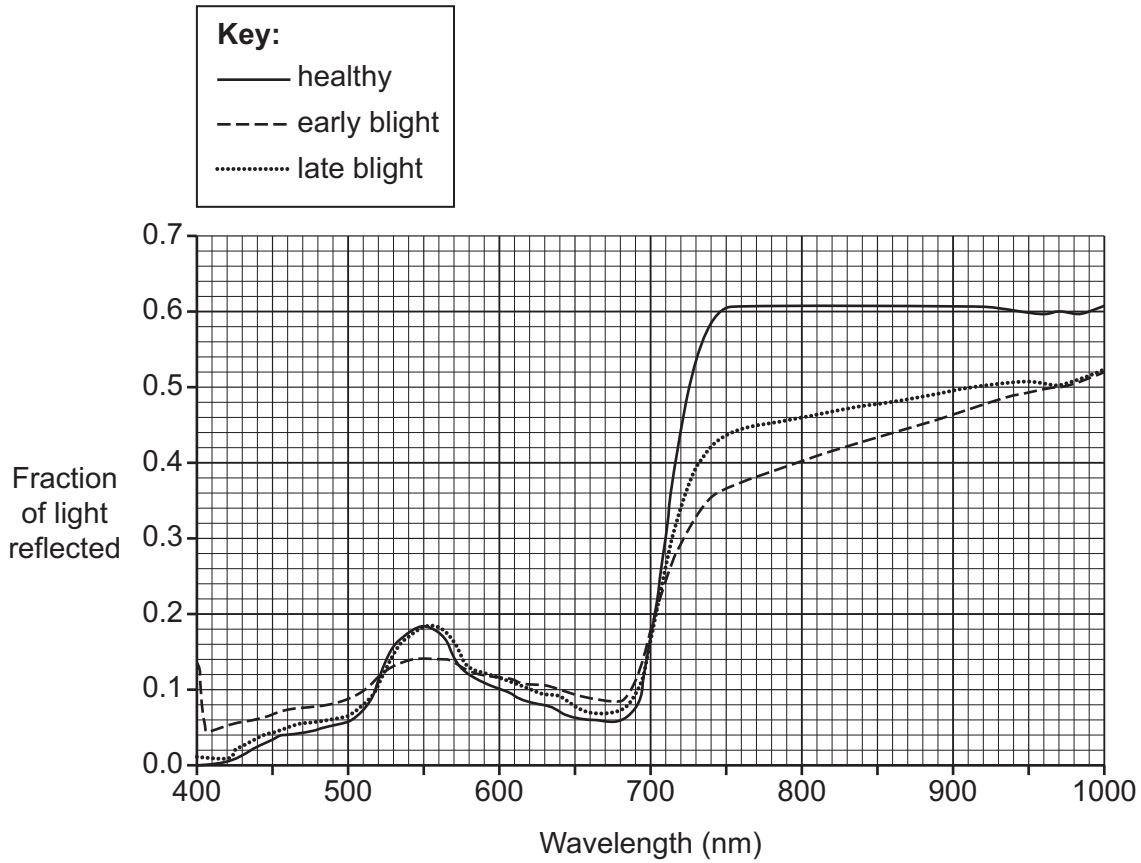
(ii) The diagram shows the results of scanning three different tomato leaves.

One leaf has early blight, one has late blight and the other is healthy.



The scientists think that they only need to shine light of one wavelength at the leaf to decide if it is healthy or which disease it has.

Suggest a wavelength that the scientists could use.

Explain your answer.

Wavelength .....

Explanation .....

.....

.....

[2]

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19 Cancer is caused by changes in cells.

(a) Describe the effects that cancer has on cells.

.....

.....

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

(b) Cells usually become cancerous due to damage to their DNA.

Scientists have found a gene called *BRCA*. This gene usually produces a protein that repairs damage in DNA.

(i) There are 3×10^7 females in the UK and 1 in 400 of them has a mutation in their *BRCA* gene.

60% of women with this mutation are likely to develop breast cancer.

Calculate how many females in the UK could develop breast cancer due to a mutation in the *BRCA* gene.

Give your answer in **standard form**.

Number of females = ... **[3]**

(ii) Cancer can occur in the cells of the breast.

This type of cancer is often caused by breast cells being stimulated by the hormone oestrogen.

Use this information to suggest **two** possible treatments for breast cancer.

1 .....

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2 .....

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[2]

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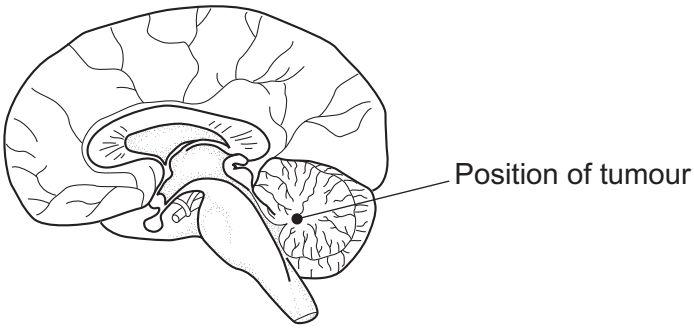
(c) Cancer can also occur in the brain.

The diagram shows the position of a tumour in the brain.



Explain why operating to remove this tumour could produce side effects.

Include in your answer **one** of the possible side effects.

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

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20 **Fig. 20.1** shows two types of insect called the Blandford fly and the mayfly.

Blandford fly **Mayfly**

Fig. 20.1

(a) The young of Blandford flies live in rivers. They compete with mayflies for algae.

Large fish called trout are predators of mayflies and Blandford flies.

Complete the pyramid of biomass in **Fig. 20.2** for these feeding relationships.

algae

Fig. 20.2

[2]

(b) Adult Blandford flies feed on sugary liquid from flowers.

However, when eggs start to develop inside female flies, they will start to suck animal blood.

(i) Suggest why the females show different feeding behaviour when they develop eggs.

.....

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

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(ii) The female flies often bite people and feed by sucking up blood.

Before they start feeding, they inject proteins into the skin. These proteins block sensory receptors in the skin.

Suggest how blocking sensory receptors using these proteins might help the fly.

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

(c) After the fly has finished eating, the person has an immune response against the proteins. Antibodies are produced.

Describe how antibodies would help the body destroy the proteins.

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

(d) Scientists are trying to reduce fly numbers.

They found bacteria living in the guts of the flies that digest the algae that the flies eat.

They also found that the gut of Blandford flies is much more acidic than the gut of other flies. The Blandford flies get nutrients from the digested algae in return for providing an acidic habitat for the bacteria to live in.

(i) What name is given to the type of relationship shown by the fly and bacteria?

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

(ii) The scientists have developed a poison that becomes active in low pH.

Explain why this poison could kill the Blandford fly but not harm other types of fly.

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

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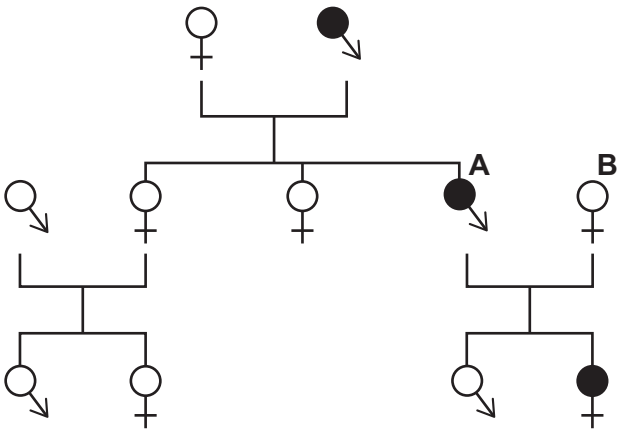
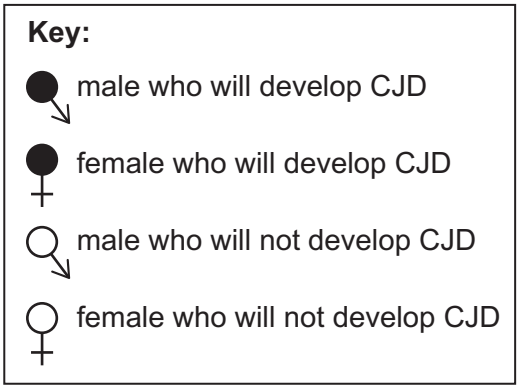
21 CJD is a group of diseases that occurs in the brain.
One type of CJD is caused by a **dominant allele**.

(a) The family tree shows the occurrence of this type of CJD in a family.





(i) Complete this table about the family tree.

Number of people who will develop CJD	**3**
Number of people that are homozygous recessive for this gene	.....
Number of people who are heterozygous for this gene	.....

[2]

(ii) Person **A** and person **B** are expecting another child.

Complete the genetic diagram to calculate the probability that the child will develop CJD.
(Use **D** to represent the dominant allele and **d** for the recessive allele.)

Person **B**

		.....	.....
Person **A**	.....	.....	.....
	.....	.....	.....

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

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(b) This type of CJD, caused by a dominant allele, is called genetic CJD.

There is another type of CJD called sporadic CJD.

Scientists think that sporadic CJD can just suddenly occur in the brain without a genetic cause.

Give **one** reason why both these types of CJD are called non-communicable diseases.

.....

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

(c) CJD occurs when a protein made in the brain changes shape. This protein then attaches to other proteins, stopping them from working.

Scientists are working on a treatment for CJD. They have made an artificial antibody which they will inject into people with CJD.

(i) Explain why the body will not make its **own** antibodies against the CJD protein.

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

(ii) The artificial antibodies have been tested on mice.

Suggest **two** reasons why some people argue against the testing of medicines on animals.

1 .....

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2 .....

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[2]

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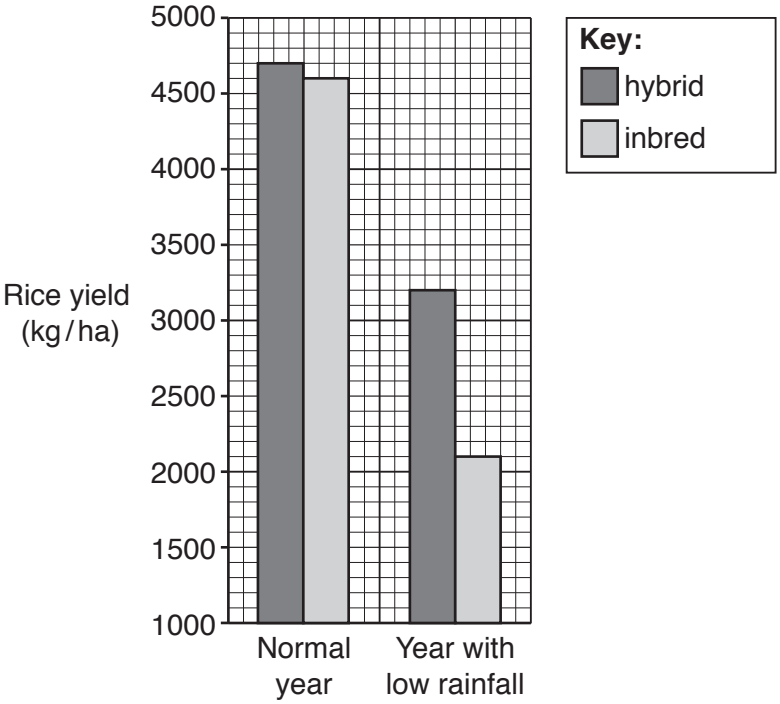
22 In China, many people rely on rice for their main food supply.

For many years people have grown the same varieties of rice (inbred rice).

New varieties of rice are now available. They are called hybrid rice.

The graph shows the yield of inbred rice and hybrid rice in a normal year and in a year with low rainfall.



(a) When there was low rainfall, the yield of the inbred rice dropped from 4600 kg / ha to 2100 kg / ha. That is a 54% decrease.

Calculate the **percentage decrease** of the hybrid rice when there is low rainfall.

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

Percentage decrease = ... **[2]**

(b) Explain why hybrid rice may be important if global warming causes changes in the climate in China.

.....

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

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(c) Hybrid rice is produced by breeding inbred rice with other types of rice found growing in the wild.

Explain why seedbanks might be useful if the climate changes in the future.

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

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23 This question is about the evolution of plants and animals on Earth.

(a) What is meant by the term evolution?

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

(b) Describe the work of Charles Darwin which led him to develop a theory of how evolution could occur.

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..... **[4]**

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(c)* For many millions of years the most complex organisms on Earth were bacteria.

- They lived in an environment that contained little oxygen.
- They made glucose by photosynthesis using hydrogen sulfide (H_2S).
- Sulfur was made as a waste product.

hydrogen sulfide + carbon dioxide $\longrightarrow$ glucose + sulfur

About 2.3 billion years ago, plants evolved to use water rather than hydrogen sulfide.

- These plants produced a different waste product.
- This waste product allowed animals feeding on the plants to use aerobic respiration.
- These animals could therefore grow larger, allowing secondary consumers to exist.

Explain why the change from using hydrogen sulfide to water allowed larger primary consumers to live and why this meant that secondary consumers could also exist.

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

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(d) Scientists think that the presence of secondary consumers (predators) caused primary consumers (prey) to evolve much more quickly.

Explain why this statement may be true.

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

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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