Oxford Cambridge and RSA

Friday 9 June 2023 – 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 can use:
- a scientific or graphical calculator
- an HB pencil

H

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

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

Write your answers to each question in the box provided.

1 Which group will have the **most** organisms in any ecosystem?

A Community

B Population

C Species

D Trophic level

Your answer ☐ **[1]**

2 Biomass is lost as it passes through a food chain.

Which processes are responsible for this loss in biomass?

A Egestion, excretion and respiration

B Egestion, transpiration and respiration

C Excretion, transpiration and respiration

D Photosynthesis, egestion and excretion

Your answer ☐ **[1]**

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3 Lichens grow on trees and can indicate air pollution levels.

A student wants to find out the level of pollution in an area by measuring the abundance of a particular species of lichen.

Which two tools should the student use to find out the abundance of the lichen in the area?

A Key and net

B Key and quadrat

C Line transect and key

D Pooter and quadrat

Your answer ☐ **[1]**

4 What is the definition of the **genome**?

A All the alleles that are expressed in the phenotype of an individual.

B All the coding DNA that is present in an individual.

C All the genetic material that is present in an individual.

D All the non-coding DNA that is present in an individual.

Your answer ☐ **[1]**

5 Which sentence describes Gregor Mendel's discovery that helped develop our understanding of genetics?

A Characteristics are controlled by DNA found in the nucleus of each cell.

B Characteristics are controlled by factors and these factors can be dominant or recessive.

C Chromosomes are found in pairs and one from each pair is found in the gamete.

D Genes are found on chromosomes and each chromosome is made of DNA.

Your answer ☐ **[1]**

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6 A rare species of animal is found in a less economically developed country.

The government of the country want to set up a conservation area.

Which of these is **unlikely** to be a problem for the government?

A Making agreements with all the people that own the land.

B Persuading conservation organisations that preserving the ecosystem is important.

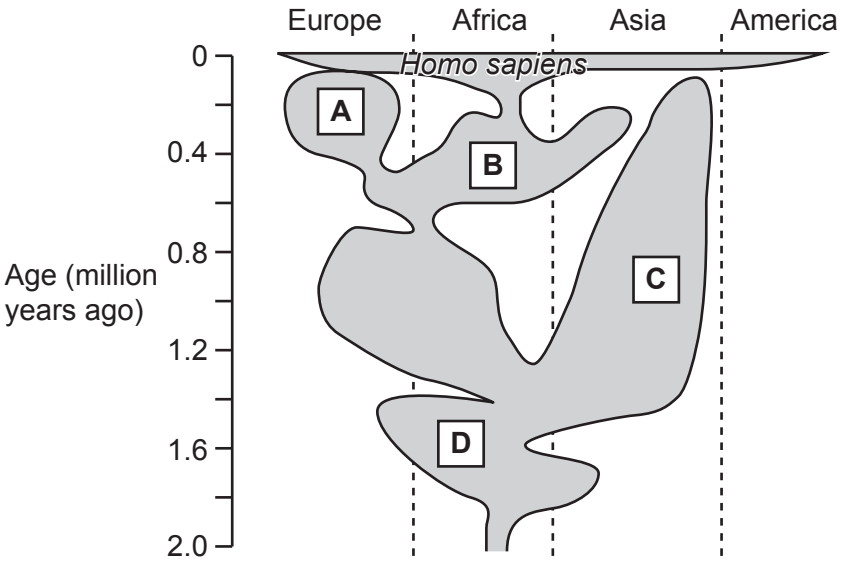
C The cost of the conservation scheme.

D The need to allow ecotourism without causing damage.

Your answer ☐ **[1]**

7 Studying fossils has provided evidence for the evolution of modern humans (*Homo sapiens*).

The diagram shows details of four species **A**–**D** who were modern humans' close relatives.
It shows where fossils were found and dates of when the organisms were alive.



Based on this fossil record, which species would have the most similar DNA to modern humans?

Your answer ☐ **[1]**

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8 Which statement about genes and alleles is correct?

A Mutations can produce new genes but not new alleles.

B Only genes but not alleles can be dominant or recessive.

C The alleles of a gene are always found on the same pair of chromosomes.

D There can only be two different alleles of each gene in a population.

Your answer ☐ **[1]**

9 Different cells are used in the production of monoclonal antibodies.

Which cells produce the monoclonal antibodies?

A Hybridoma cells

B Plasma cells

C Tumour cells

D White blood cells

Your answer ☐ **[1]**

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10 The table shows some different treatments for cardiovascular disease.

Which treatments for cardiovascular disease work by directly reducing blood pressure?

Treatment	Main method of action
antiplatelets	reduce the action of platelets
beta blockers	block the effects of adrenaline
nitrates	widen blood vessels
statins	reduce cholesterol levels in the blood

A Antiplatelets and beta blockers

B Beta blockers and nitrates

C Nitrates and antiplatelets

D Statins and nitrates

Your answer ☐ **[1]**

11 In 2022, there were 66 900 000 people living in the UK.

Estimate how many of these people have a Y chromosome in their cells.

Individuals of each sex in the UK (%)	
males	females
49.2	50.8

A 32 914 800

B 33 985 200

C 50 442 600

D 66 900 000

Your answer ☐ **[1]**

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12 Which of these treatments is **not** an example of genomic medicine?

A Advising people who have certain alleles to make changes in their lifestyle

B Designing drugs that are specific to a person's alleles

C Removing a female's ovaries if she has alleles that make her more likely to develop ovarian cancer

D Using genetic engineering to produce new medicines

Your answer ☐ **[1]**

13 Scientists are using stem cells to try and cure cystic fibrosis.

They are trying two methods:
1) using stem cells from cloned embryos
2) converting skin cells from a donor into adult stem cells.

What is the advantage of the **second** method?

A Adult stem cells are less likely to be infected by viruses.

B Adult stem cells can form a wider range of tissues.

C Embryos will not need to be destroyed.

D Stem cells produced from donor skin cells are less likely to be rejected.

Your answer ☐ **[1]**

14 Why are antibiotic markers used in the process of genetic engineering?

A To act as a vector allowing the DNA into the cell.

B To identify which cells have taken up the genetic material.

C To make the engineered cells resistant to bacterial infections.

D To prevent the spread of antibiotic resistant bacteria.

Your answer ☐ **[1]**

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15 Human fetuses have a different form of haemoglobin to adults.
When a baby is born, a gene called BCL11A produces a protein that switches off the production of fetal haemoglobin.

Sickle cell disease affects adult haemoglobin but **not** fetal haemoglobin.
Scientists are trying to treat sickle cell disease by targeting the BCL11A gene.

How could this new treatment for sickle cell disease work?

A Disabling all the ribosomes in the cells to prevent protein synthesis

B Genetically engineering cells by inserting extra copies of the BCL11A gene

C Making sure that the translation of the BCL11A gene continues after birth

D Preventing the BCL11A gene from being expressed, so that transcription of the fetal haemoglobin gene continues

Your answer ☐ **[1]**

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Section B

16 (a) Complete each sentence about decomposition.

Decomposition is caused by microorganisms such as ..... .

The microorganisms use the process of ..... to release the energy in dead organisms.

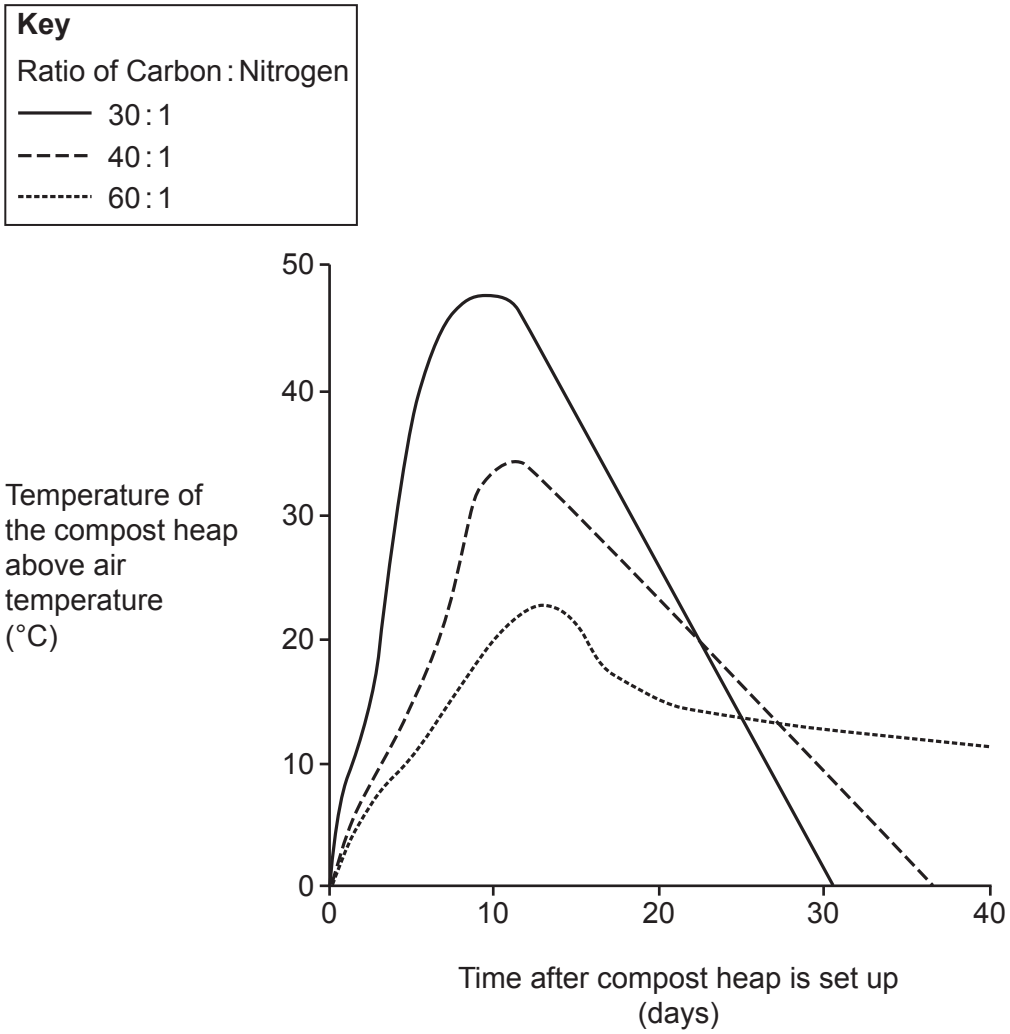
Decomposition also allows minerals to be ..... in nature for plants to use.

[3]

(b) Some students investigate plant decomposition.
They put three different plant wastes into compost heaps.
Each type of plant waste contains different ratios of carbon to nitrogen.

They measure the rate of decomposition by measuring the temperature in the compost.

The graph shows their results.



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(i) The pupils used the temperature of the compost heap as a measure of the rate of decomposition.

Which statement explains why they could do this?

Tick (✓) **one** box.

- Carbon dioxide contains more energy than oxygen. ☐
- Decomposition involves an endothermic reaction. ☐
- Microorganisms give off heat when they decompose waste. ☐
- Mineral salts will increase the temperature of the compost. ☐

[1]

(ii) Which statement describes the results of the investigation?

Tick (✓) **one** box.

- High levels of carbon results in faster decomposition. ☐
- If the carbon : nitrogen ratio is higher, then decomposition is faster. ☐
- Low levels of nitrogen result in faster decomposition. ☐
- The higher the nitrogen content compared to carbon, the faster the rate of decomposition. ☐

[1]

(iii) Give **one** abiotic factor that the students should keep constant in their experiment.

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

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(c) The table shows the mass of carbon and nitrogen in different plant materials.

Plant material	**Mass of carbon per kg (g)**	**Mass of nitrogen per kg (g)**
Fruit waste	14	0.350
Horse manure	18	0.600
Straw	9	0.015

Which plant material would decompose the **fastest**?

Explain your answer using calculations and the graph in **(b)**.

Plant material .....

Reason .....

.....

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[3]

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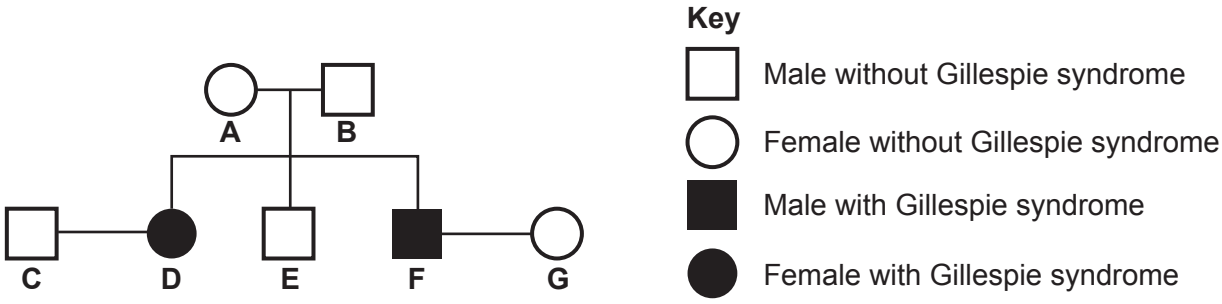
17 Gillespie syndrome is a rare genetic disorder.
People with Gillespie syndrome have eyes with no iris and damage to their cerebellum.

Fig. 17.1 shows the inheritance of Gillespie syndrome in a family.

Fig. 17.1



(a) A doctor makes this statement:
The allele causing Gillespie syndrome in this family is recessive.

Explain why this statement is correct. Use evidence from **Fig. 17.1**.

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

(b) Person **A** and person **B** are expecting another baby.

Complete **Fig. 17.2** to find the probability that it will have Gillespie syndrome.

(Use G for the dominant allele and g for the recessive allele.)

Fig. 17.2

		Person **B**	
Person **A**			

Probability = ...
[3]

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(c) Person **D** is very sensitive to bright light and has difficulty controlling their balance.

Explain why this is.

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

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18 Multiple sclerosis is an auto-immune disease that destroys nerve cells.

The body's immune system usually only destroys invading cells but in auto-immune diseases the body starts to destroy its own cells.

(a) Describe **two** ways that the body's immune system destroys invading cells.

1 .....

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2 .....

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[2]

(b) Suggest **two** reasons why multiple sclerosis is so difficult to treat.

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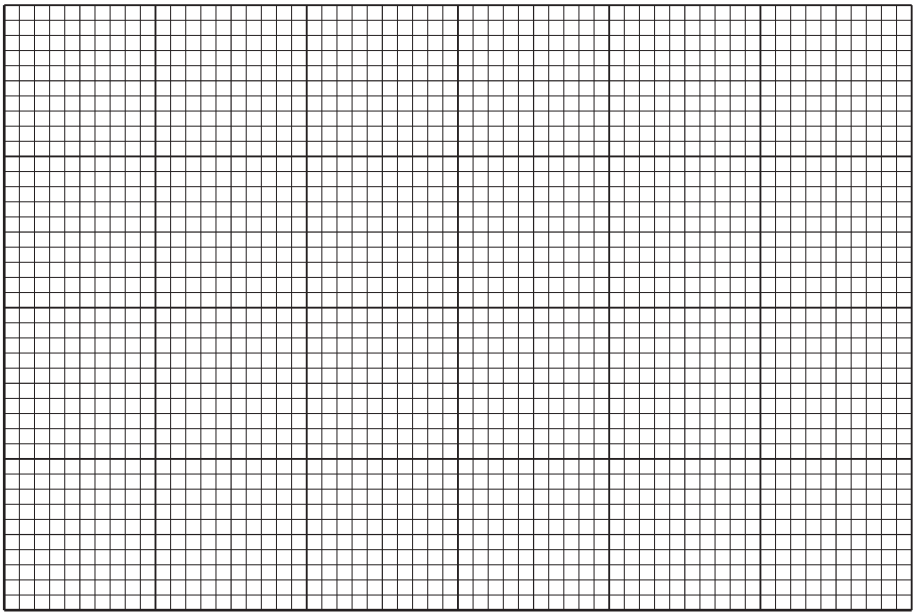
19 The table shows the mean mass of four types of rodent and the mean number of years they live.

Type of rodent	**Mean mass (g)**	**Mean number of years they live**
Gerbil	40	1.5
Guinea pig	1000	4.0
Rat	200	2.0
Squirrel	600	3.0

(a) **(i)** Choose suitable scales and plot the data from the table onto the graph. **[3]**

(ii) Draw a line of best fit through the points. **[1]**

Mean number of years they live



Mean mass (g)

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(b) Mole rats are rodents that live in Africa.

The mean mass of a mole rat is 60 g and they live for about 18 years.

Use the graph you drew in **(a)** to explain what is unusual about the mole rat data compared to other rodents.

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

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(c)* Mole rats spend most of their life burrowing underground in tunnels.
Some tunnels have only 5% oxygen in the air compared with 21% above ground.

Scientists have found that the mole rats have several unusual features compared to other rodents.

The mole rats have:

- a very low respiration rate
- haemoglobin that binds to oxygen more easily
- very few pain receptors that respond to acid build up in their body.

Explain how these features would help the mole rats survive in the tunnels.

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

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(d) Mole rats rarely develop cancer.
One theory to explain this involves two ‘over-crowding’ genes.
These genes slow down the cell cycle when cells come into contact with each other.

Explain how slowing down the cell cycle can protect mole rats from developing cancer.

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

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20

Buddleia, a butterfly's friend?

Buddleia flowers attract butterflies that feed on nectar.

Buddleia bushes produce large numbers of very small seeds. This means that buddleia bushes quickly colonise new habitats.

This has resulted in the populations of other plants decreasing. Scientists have noticed there are large communities of butterflies in these areas but the biodiversity of butterflies is low.

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(a) Suggest why the colonisation of land by buddleia bushes has caused a decrease in the populations of other plants.

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(b) Describe a sampling technique that could be used to estimate the number of one species of butterfly in a habitat.

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

(c) Explain how there can be a large community of butterflies but a low biodiversity of butterflies in an area.

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

(d) Scientists have suggested two possible methods of reducing the damage caused to habitats by too many buddleia bushes.

Explain how each of these methods would reduce the damage to habitats.

(i) genetically engineering buddleia bushes that produce larger seeds

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

(ii) producing hybrid buddleia bushes that have uneven numbers of chromosomes, which prevent meiosis occurring

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

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21 Sorghum is a crop plant grown in Africa for its seeds.

(a) Sorghum produces a bitter chemical in its seeds.

Birds do not like the taste of this chemical. Some people also find the taste unpleasant.

Explain how sorghum could have evolved to produce the bitter chemical.

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

(b) In some areas in Africa, farmers have been growing varieties of sorghum that have lower levels of the bitter chemical.
These varieties have been produced by artificial selection.

Describe how the process of artificial selection is carried out.

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

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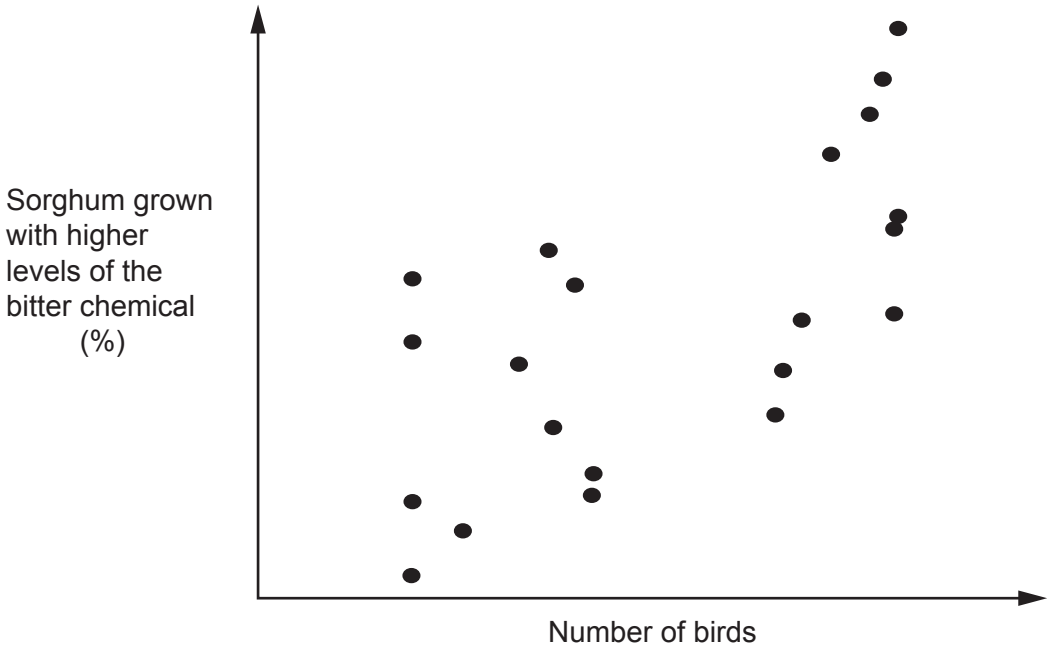
(c) Scientists recorded the types of sorghum grown in different areas of Africa that have higher levels of the bitter chemical.
They also recorded the number of birds that eat sorghum living in the same areas.

The graph shows their results.



Suggest an explanation for the pattern of results shown in the graph.

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

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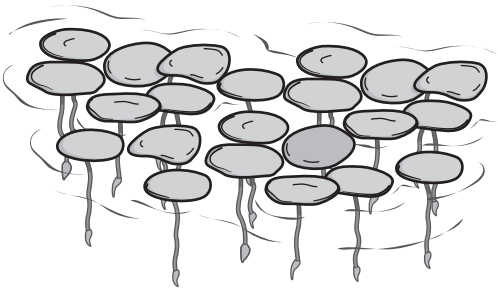
22 Some students investigate the effect of run-off water from a farm on the growth of plants. The run-off water is washed off the fields in the farm when it rains.

They use a pond plant called duckweed, shown in the diagram. A duckweed plant has a single leaf that floats on the surface of the water.
They chose duckweed because it is easy to count the plants.



This is the method they follow:

- Put different volumes of clean pond water and run-off water into 4 beakers.
- Add 3 duckweed plants into each beaker.
- Leave the beakers for ten days at the same temperature.

The table shows the results.

Beaker number	Contents	Number of duckweed plants after ten days
1	250 cm^3 of pond water	6
2	230 cm^3 of pond water + 20 cm^3 of run-off	12
3	210 cm^3 of pond water + 40 cm^3 of run-off	24
4	190 cm^3 of pond water + 60 cm^3 of run-off	48

(a) **(i)** Explain why the students put different volumes of clean pond water into each beaker.

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

(ii) To improve their experiment, the students should make sure that the carbon dioxide levels are the same in each beaker.

Describe how they could achieve this.

.....

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

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(b) Duckweed plants reproduce by dividing into two.

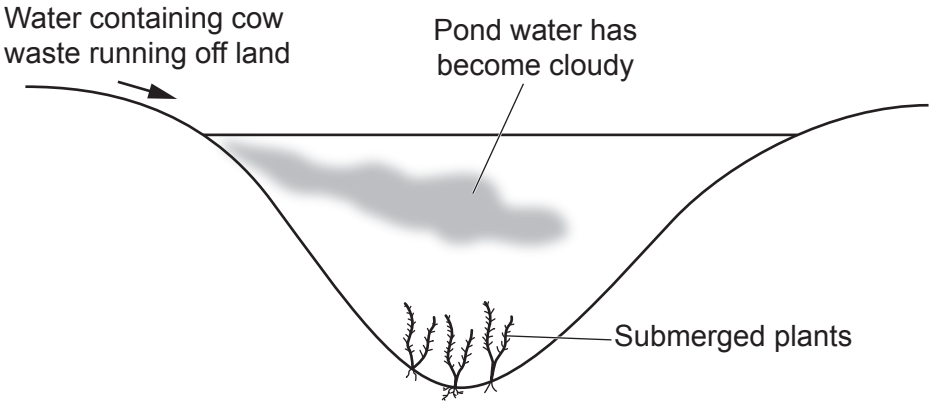
(i) What is the name given to this type of reproduction?

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

(ii) In beaker **4**, how many generations of duckweed plants are present after 10 days?

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

(c) An article said that the run-off water contains waste from cows and this makes the pond water cloudy. The run-off water is reducing the growth of submerged plants that grow in the pond.
The diagram shows this process.



Explain the results of the students' experiment and why using duckweed produces results that do **not** agree with the effect of run-off water described in the article.

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

(d) The students change their method to use a submerged plant rather than using duckweed.

Describe how the students could change their method to measure the growth of the submerged plant.

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

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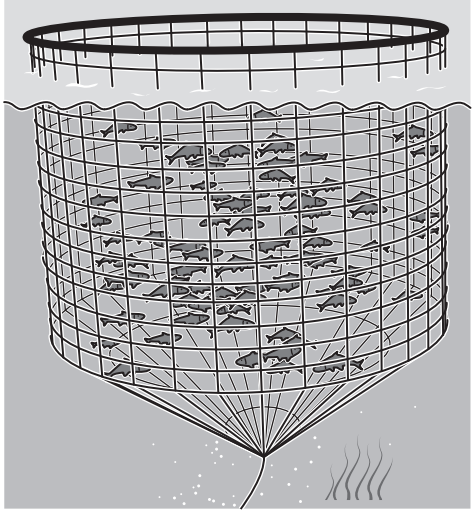
23 The demand for food in the world is growing. One possible solution to this is the use of aquaculture.

This involves farming fish, such as salmon, in large cages in lakes or the sea as shown in the diagram.
However, growing salmon in cages allows parasites on their body to spread easily from fish to fish.



(a) Small fish called wrasse are often kept in the cage with the salmon.
The wrasse act as a biological control mechanism. This results in an increased growth rate of the salmon.

Suggest how putting wrasse in the cage results in an increased growth rate of the salmon.

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

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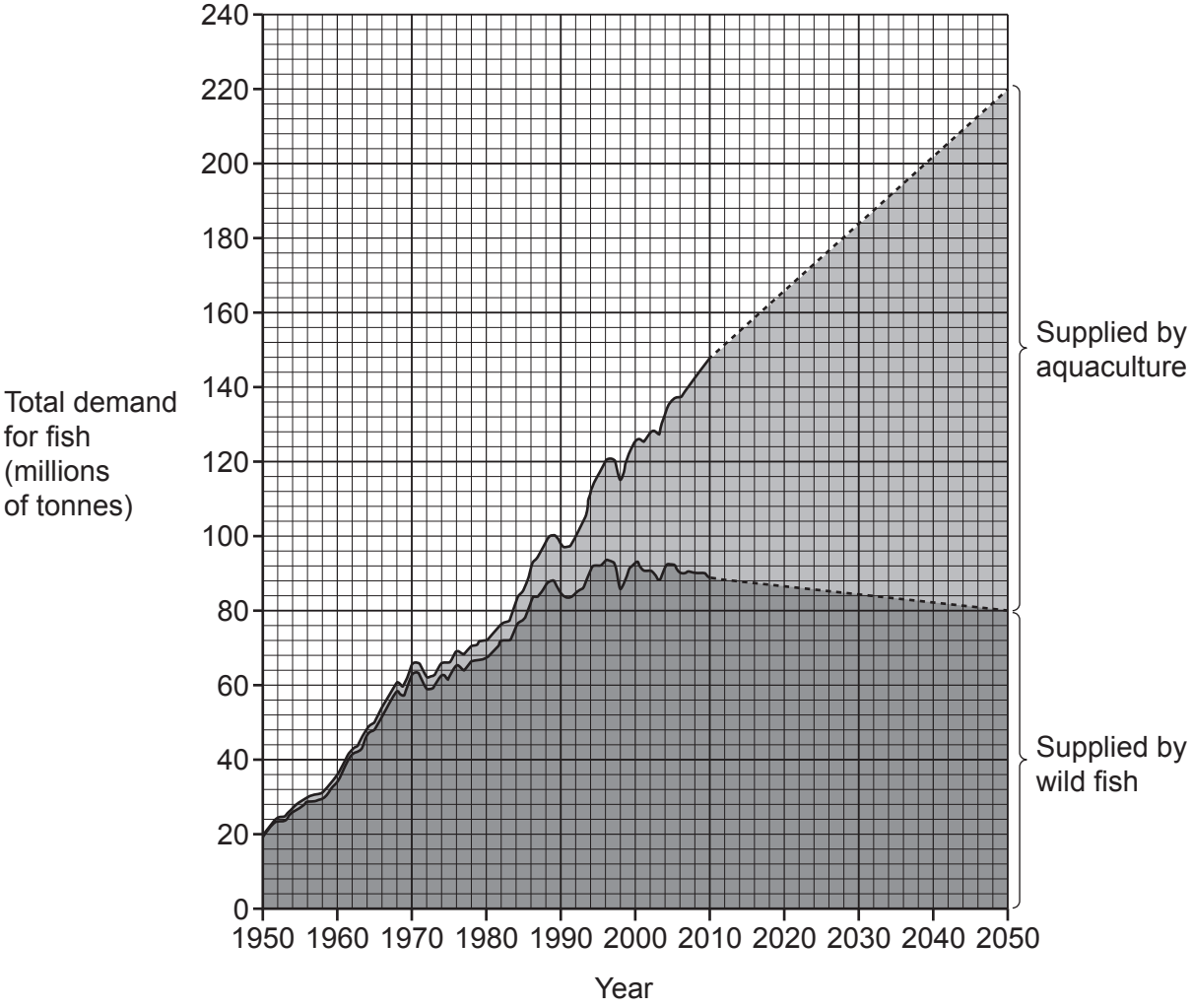
(b) Many people in the world eat fish as their main source of protein.
Fish eaten by people can be caught directly from the sea (wild fish) or grown using aquaculture.

The graph shows how the world's total demand for fish has changed since 1950 and how it is expected to change up to 2050. It also shows how the total demand is met by the supply of wild fish and fish from aquaculture.



Describe the patterns in past and predicted fish use shown by the graph.

Include data.

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

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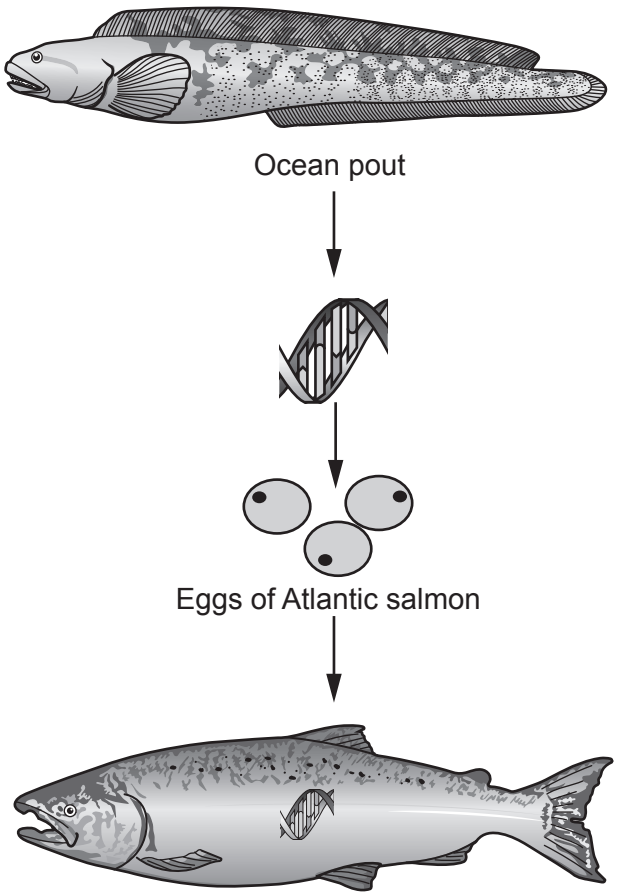
(c) Scientists are trying to increase the mass of Atlantic salmon produced by aquaculture using genetic engineering and a fish called ocean pout.

The growth of fish is controlled by growth hormone.
Atlantic salmon only grow for part of the year but ocean pout grow throughout the year.

The diagram shows how scientists are producing genetically engineered Atlantic salmon.



(i) What is the name of the enzyme used to cut out the gene from the DNA of the ocean pout?

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

(ii) What is the name of the enzyme used to join the gene from the ocean pout into the DNA of the Atlantic salmon?

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

(iii) Explain how the addition of the gene from ocean pout can cause the Atlantic salmon to grow faster.

.....

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

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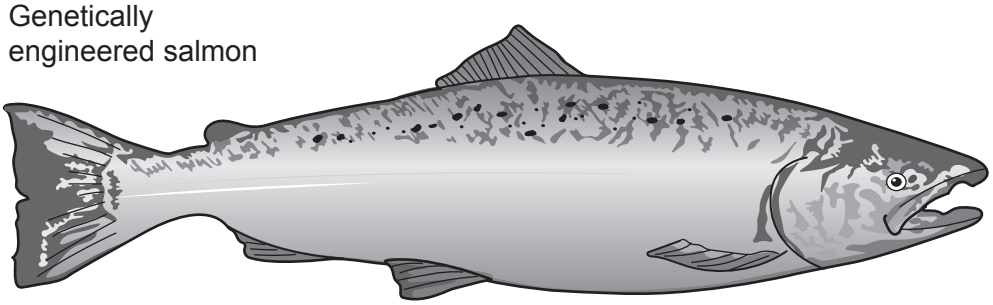
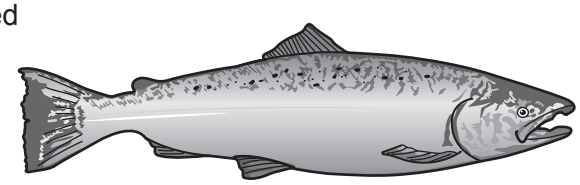
(iv) This diagram shows a genetically engineered salmon and a non-engineered salmon of the same age. The drawings are to the same scale.

Genetically engineered salmon



Non-engineered salmon



Use a ruler to measure the length of each salmon.

Calculate the percentage increase in length caused by genetic engineering using your measurements.

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

Percentage increase in length = ... % **[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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