OCR
Oxford Cambridge and RSA

Friday 10 May 2024 – Morning

GCSE (9–1) Biology B (Twenty First Century Science)

J257/03 Breadth in biology (Higher Tier)

Time allowed: 1 hour 45 minutes

H

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

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

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 page 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 **[ ]**.
- This document has **28** pages.

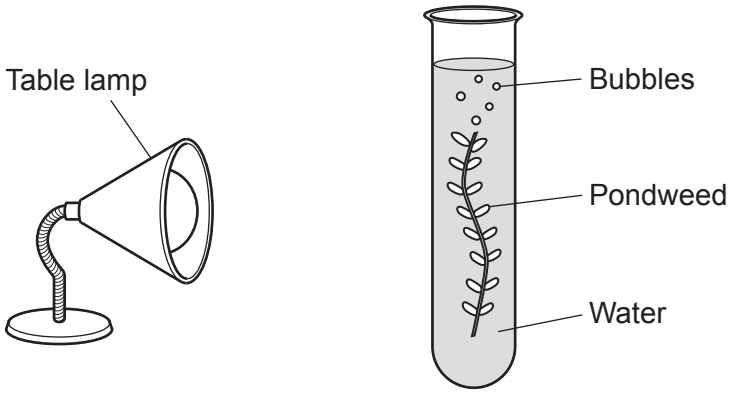
ADVICE
- Read each question carefully before you start your answer.

1 A student is investigating how light intensity affects the rate of photosynthesis.

(a)

(i) **Fig. 1.1** shows the equipment the student sets up.

Fig. 1.1



Describe the method the student will use with the equipment in **Fig. 1.1** to find how light intensity affects the rate of photosynthesis.

Include in your answer:
- what they will change
- what they will keep the same
- what data they will record.

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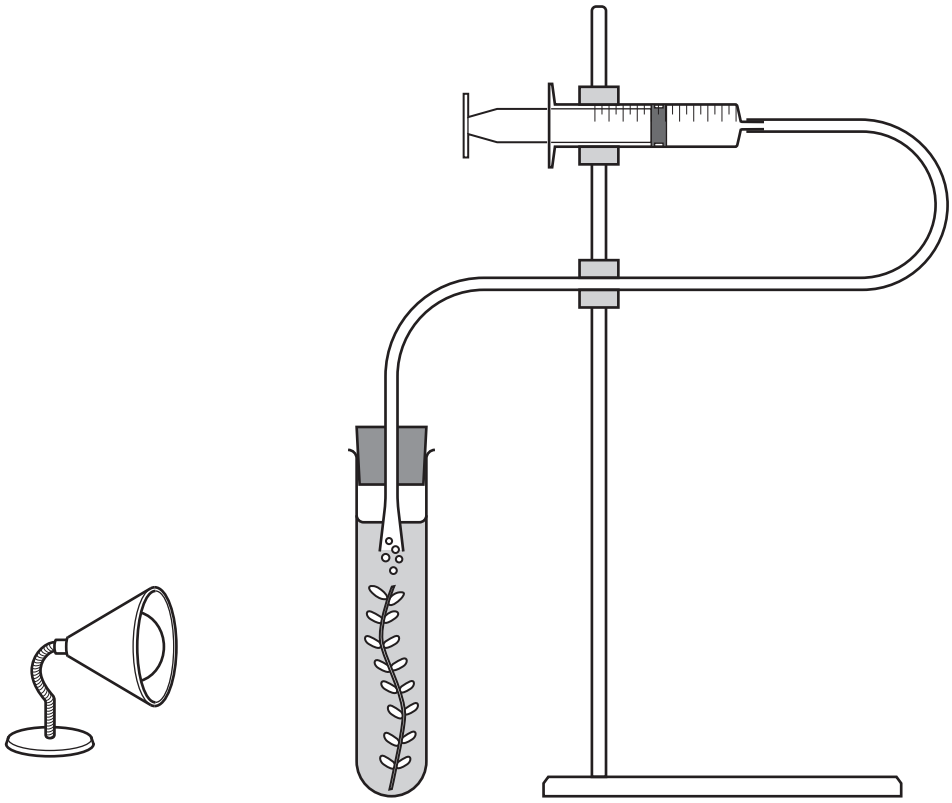
..... **[3]**

(ii) **Fig. 1.2** shows a different set of equipment that can be used.

Fig. 1.2



A second student suggests that the equipment shown in **Fig. 1.2** will improve the investigation.

Explain why.

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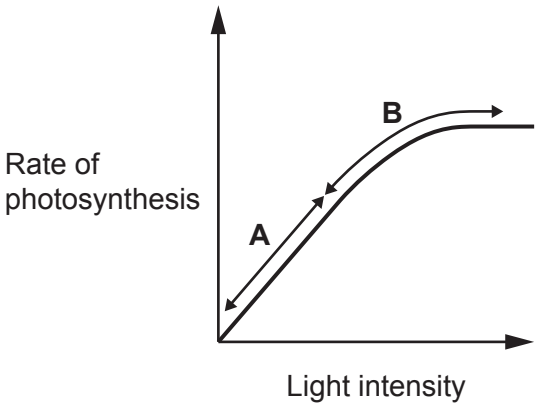
..... **[2]**

(b) **Fig. 1.3** shows the effect of changing the light intensity on the rate of photosynthesis.

Fig. 1.3



Which section or sections of the graph in **Fig. 1.3** show the relationship $y = mx + c$?

Tick (✓) **one** box.

Section **A** ☐

Section **B** ☐

Sections **A** and **B** ☐

[1]

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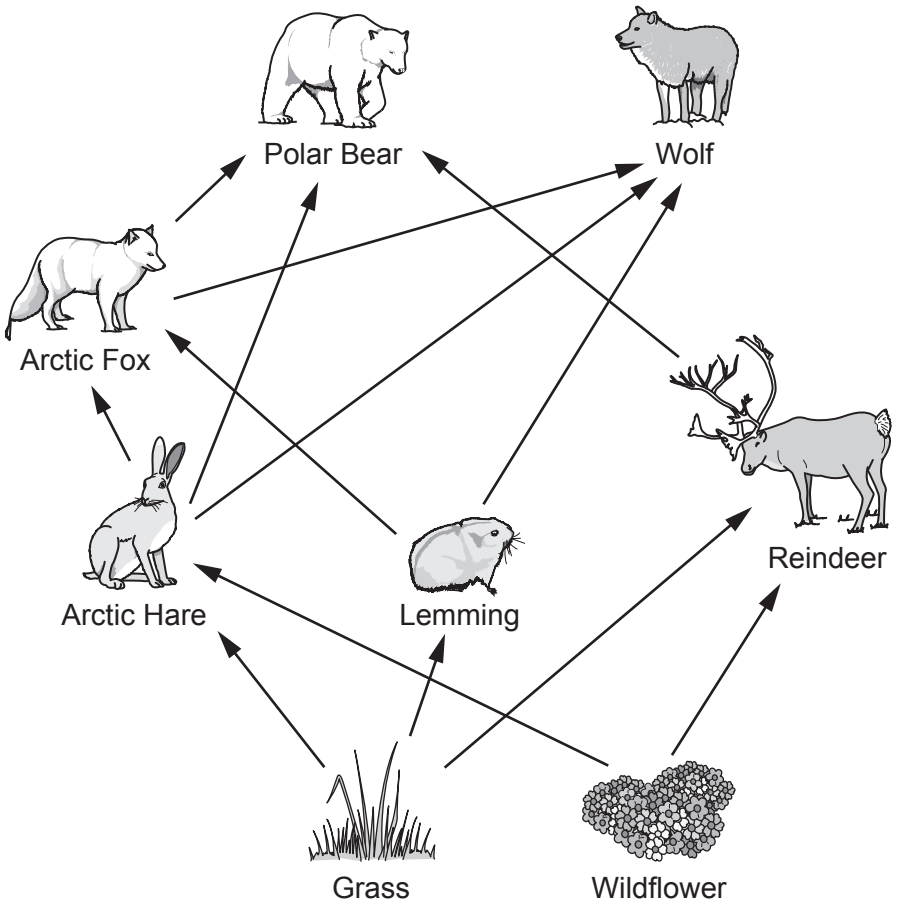
Turn over for the next question

2 The diagram shows the feeding relationships of some of the organisms that live in an Arctic ecosystem.



(a) What does each picture in the food web represent?

Tick (✓) **one** box.

A community ☐

A population ☐

An individual ☐

[1]

(b) Complete each sentence by writing in the correct number.

There are ..... producers in the food web.

There are ..... herbivores in the food web.

The arctic fox is in trophic level ..... .

[3]

(c) A lemming has a mass of 82 g.
An arctic fox eats the lemming, but only consumes 75 g of the lemming.

Calculate the percentage mass the arctic fox has consumed.

Give your answer to **3** significant figures.

Percentage mass consumed = ... % **[3]**

(d) When lemmings are in short supply, the arctic fox will eat eggs.

(i) Eggs contain protein.

Which reagent is used to test for protein?

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

(ii) The yolk of the egg contains lipids.

Put a (ring) around the **two** components that make up a lipid.

amino acids **fatty acids** **glucose** **glycerol**

[2]

(iii) A student calculates the surface area and volume of an egg.

Surface area of the egg = 67.5 cm^2

Volume of the egg = 50 cm^3

Show that the surface area to volume ratio of the egg is 1.35 : 1.

[2]

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Turn over for the next question

3

(a) Sam is visiting Norway where the average temperature in the winter is –6.8 °C.

Sam steps outside the hotel wearing only a jumper.

Complete the sentences to describe the processes that the body will use to regulate Sam's body temperature.

Use words from the list.

glands	**hypothalamus**	**muscles**	**pituitary**
receptors	**shivering**	**skin cells**	**sweating**

The external temperature is detected by ..... in the skin.

An electrical impulse is sent to the ..... which coordinates a response.

An electrical impulse is sent from the coordinator to the ..... .

The body will respond by ..... .

[4]

(b) Which method of cooling the human body would be the **least** effective in a **hot humid environment**?
Explain your answer.

Method .....

Explanation .....

.....

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[3]

(c) Explain the importance of maintaining a constant internal temperature.

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

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Turn over for the next question

4 A student is investigating the distribution of stomata on leaf surfaces.

The student removes 4 leaves from the same plant.

Leaf 1 – they cover the lower surface of the leaf in waterproof grease.

Leaf 2 – they cover the upper surface of the leaf in waterproof grease.

Leaf 3 – they cover both surfaces of the leaf in waterproof grease.

Leaf 4 – neither surface of the leaf is covered in waterproof grease.

The results of the experiment are shown in the diagram

Leaf 1	**Leaf 2**	**Leaf 3**	**Leaf 4**
Slight wilting	**Significant wilting**	**No sign of wilting**	**Dry and shrivelled**
			

(a) Explain why applying waterproof grease to both sides of the leaf prevented wilting.

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

(b) The student looks at the results and writes this conclusion:

> 'Stomata are located on both surfaces of the leaf, but there are more stomata on the lower surface of the leaf.'

Explain how the results of the investigation support the student's conclusion.

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

(c) Which structure brings water to the leaf from the roots?

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

5 Rats are considered a pest to many farmers as they eat their crops.

A chemical called warfarin can be used to kill rats.

Some rats developed a natural resistance to warfarin.

(a) What is the most likely cause of this resistance?

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

(b) Complete the sentences to explain how more rats developed resistance to warfarin.

Use words from the list.

allele	**die**	**genome**	**reproduce**
respire	**ribosome**	**survive**	

Rats that were resistant to the warfarin were more likely to ..... and

..... and therefore pass on the ..... for resistance to their offspring.

[3]

(c) State the names of the **two** scientists who developed the theory of evolution by natural selection.

..... and .....

[1]

(d) Explain why some people do **not** accept this modern theory of evolution.

.....

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

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Turn over for the next question

6

(a) The human body has two communication systems:

- the hormonal system
- the nervous system.

State **two** ways that the response generated by the hormonal system is different to the response generated by the nervous system.

1 .....

2 .....

[2]

(b) ADH is a hormone that controls the water balance in the body.

Draw lines to connect each question with the correct answer.

Which structure releases ADH?	Cerebellum
	Kidney tubules
Where does ADH have its effect?	Pancreas
	Pituitary gland

[2]

(c) What effect will body fluids that contain too much water have on cells?

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

7 Some babies are born with cataracts.

(a) Cataracts affect the lens.

What role does the lens have in the functioning of the eye?

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

(b) Surgical removal of cataracts in babies can be done, but there may be problems after surgery.

In a trial, scientists removed the lens from 12 babies with cataracts but left behind the stem cells.

All the babies grew a new lens within 3 months.

(i) Explain how the new lens grew from the stem cells.

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

(ii) Suggest why some parents may be concerned about this trial procedure being used on their babies.

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

8 *Salmonella* is a communicable disease caused by bacteria.

Salmonella bacteria can enter the body in contaminated food.

A doctor sees a patient with symptoms that suggest they have food poisoning caused by *Salmonella* bacteria.

The doctor decides to take a sample from the patient to send to a laboratory for further testing.

(a) Suggest a suitable sample that could be taken from the patient that can be tested for *Salmonella* bacteria.

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

(b) When the sample arrives at the laboratory the scientists first make a culture of the bacteria.

Explain why the scientists make a culture.

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

(c) The scientists take a sample from the culture.

They prepare a slide so they can view the bacteria.

They use a stain that turns *Salmonella* bacteria pink.

Describe how the scientist can use a light microscope to determine if the patient's symptoms are caused by *Salmonella*.

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

(d) Explain why it is important that aseptic techniques are used at all stages of the procedure.

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

(e) Bacteria reproduce asexually.

(i) State **one** advantage of asexual reproduction.

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

(ii) State **one** disadvantage of asexual reproduction.

.....

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

9

(a) Monoclonal antibodies can be produced in the laboratory and used to treat disease.

Put statements **A** to **E** in the correct order to describe how monoclonal antibodies are made.

A Antibody producing cells are removed from the animal.

B Antigens are injected into an animal.

C Cells are cultured to produce clones.

D Cells producing the correct antibody are selected.

E White blood cells which produce the antibodies are made by the animal.

Write **one** letter in each box.

One has been done for you.

B				

[3]

(b) Draw a line to connect each **disease** to the type of **pathogen** that causes the disease.

Disease	**Pathogen**
Athletes foot	Bacteria
HIV	Fungus
Influenza	Protist
Malaria	Virus

[3]

(c) The United Nations collects data on global diseases.

The table shows regional data about the number of new HIV infections in 2022.

Region	Estimated number of new HIV infections
Asia and the Pacific	3.0×10^5
Caribbean	1.6×10^4
Eastern and Southern Africa	5.0×10^5
Eastern Europe and central Asia	1.6×10^5
Latin America	1.1×10^5
Middle East and North Africa	1.7×10^4
Western and central Africa	1.6×10^5
Western and central Europe and North America	5.8×10^4

(i) Which region had the highest estimated number of new HIV infections in 2022?

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

(ii) Suggest **two** reasons why the number of HIV infections was greater in this region than in other regions.

1 .....

2 .....

[2]

(iii) The data provided by the United Nations is an estimation and is not the actual number of new HIV infections.

Explain why the data is only an estimation.

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

(iv) HIV destroys an important type of white blood cell called CD4.
The 'normal' range for CD4 white blood cells is 800–1200 cells per mm^3 of blood.

One particular person living with HIV has <200 CD4 cells per mm^3.

Describe the likely impact of this on the person's health.

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

10 **Fig. 10.1** and **Fig. 10.2** show the United Nations population projections for the year 2100.

Fig. 10.1 shows the projections made in 1975.

Fig. 10.2 shows the projections made in 2020.

Fig. 10.1

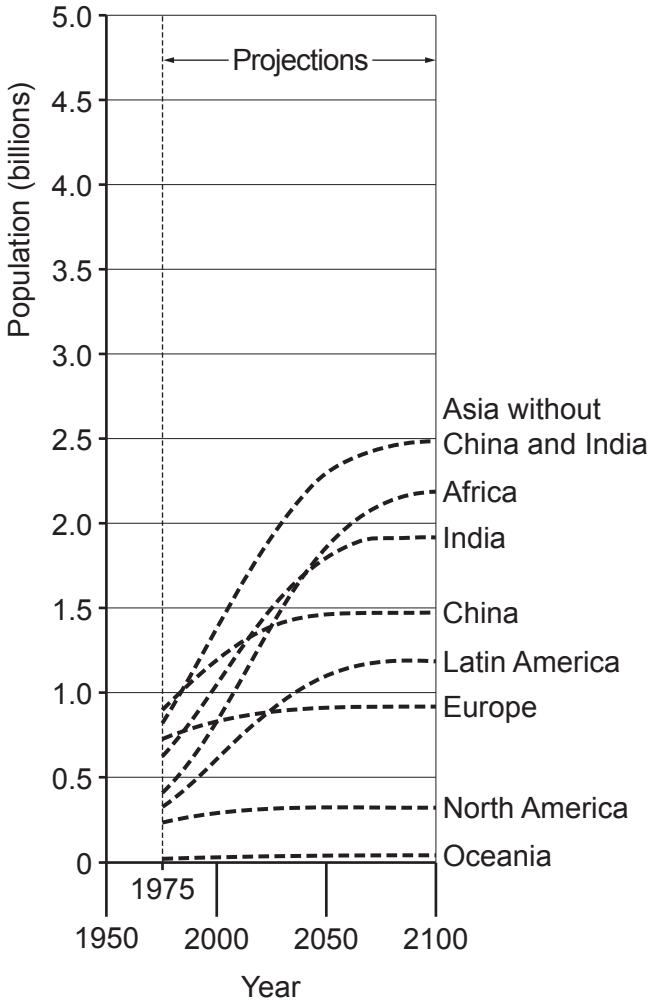
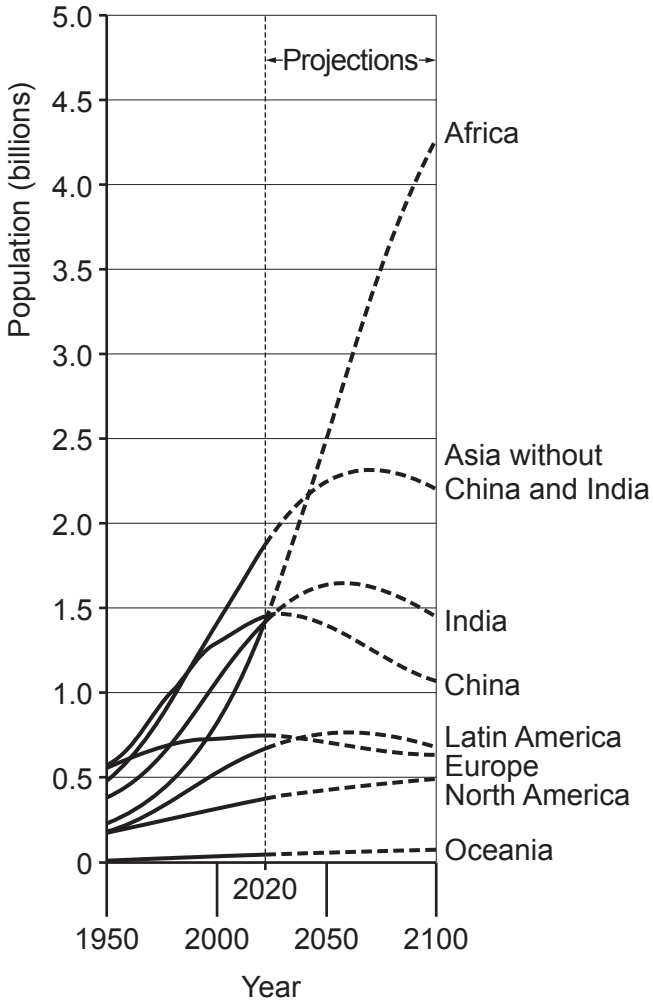


Fig. 10.2



(a) State **two** differences between the projections made in 1975 and those made in 2020.

1 .....

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2 .....

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[2]

(b) Suggest why the United Nations revises their projections regularly.

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

(c) Scientists are concerned about food security for future generations.

Describe **two** biological factors that affect food security.

1 .....

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2 .....

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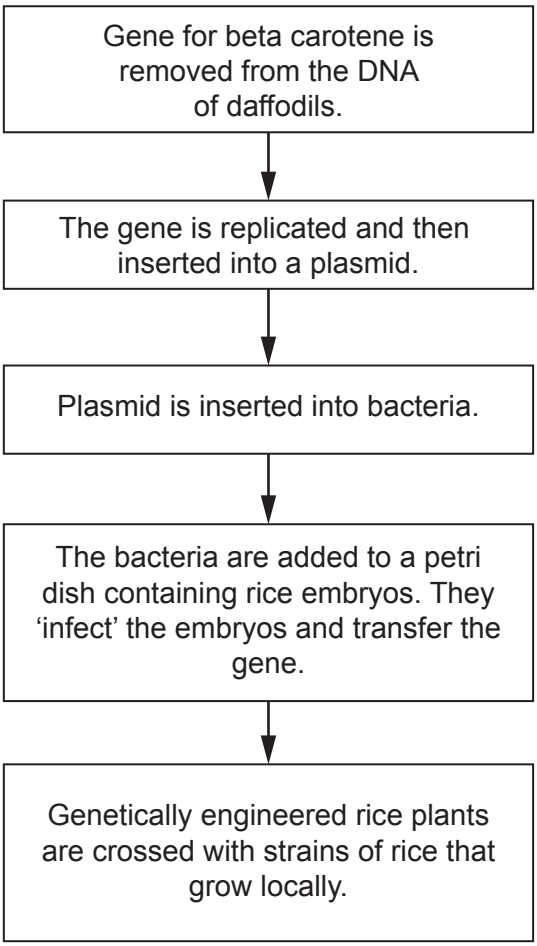
[2]

(d) Scientists think genetic engineering may be one solution for the food security problem.

Scientists have genetically engineered rice to contain beta carotene, which the body can use to make vitamin A.

The diagram shows stages involved in this process.



(i) Explain why it is important that only the gene that is required from the daffodil is removed from the daffodil DNA.

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

(ii) Explain why the scientists replicate the genes that have been isolated before inserting them into the plasmids.

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

(iii) What vector is used to genetically engineer rice?

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

(iv) Suggest why the genetically engineered rice plants are crossed with strains of rice that already grow locally.

.....

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

11 PKD (Polycystic Kidney Disease) is a genetic condition found in cats.
It is caused by a dominant allele of a single gene.

(a) Explain why cat breeders will be more concerned about a genetic condition that is caused by a dominant allele than a recessive allele.

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

(b) A male cat which is homozygous recessive mates with a female cat that is heterozygous for PKD.

(i) Show how these cats could produce kittens that have PKD.

Use a Punnett square.

Use **D** to represent the dominant allele and **d** to represent the recessive allele.

[4]

(ii) When the male homozygous recessive cat mates with the female heterozygous cat, they have 2 kittens.

Calculate the probability that both kittens have PKD.

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

(c) The cat breeder could use genome sequencing to determine which of the kittens has PKD. Genome sequencing costs a lot of money.

Suggest why the cat breeder decides to spend this money.

.....

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

(d) Cats have 38 chromosomes in a body cell.

How many chromosomes will a cat have in a sperm cell?

Tick (✓) **one** box

19 ☐

38 ☐

57 ☐

76 ☐

[1]

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use this lined page. You must write the question numbers clearly in the margin.