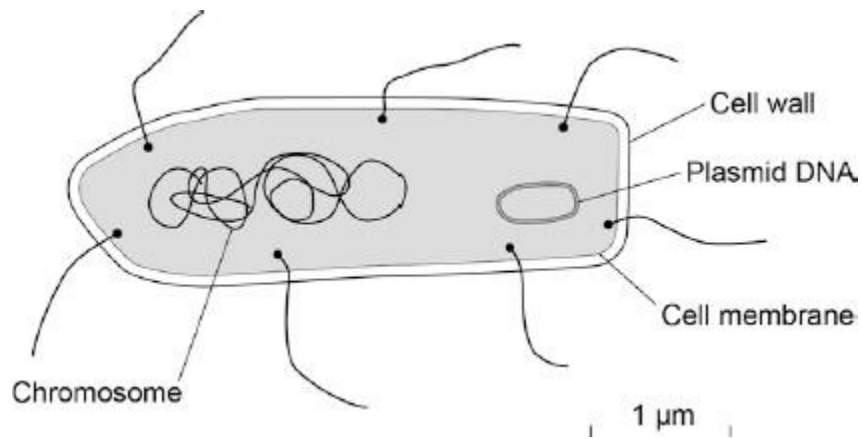**1** Bacteria can cause disease.

Figure 1 shows some features of a *Salmonella* bacterium.

Figure 1

(a)   Draw **one** line from each feature of the *Salmonella* bacterium to the function.

Feature   **Function**

| Controls the movement of substances into and out of the cell |

Cell membrane

| Carries genetic information |

Plasmid DNA

| Provides support and protection |

| The site of protein synthesis |

(2)

(b)   How is *Salmonella* spread between people?

Tick **one** box.

Animal bites ☐

Contaminated food ☐

Sneezing ☐

Sexual contact ☐

(1)

(c)   Give **two** ways you could stop *Salmonella* from spreading.

1. _____

_____

2. _____

_____

(2)

(d)   Harmful bacteria can also be useful.

Scientists are doing research to find out if *Salmonella* can be used in a vaccine to treat cancer.

The *Salmonella* vaccine can be injected into the blood or swallowed in a tablet.

One benefit of injecting the vaccine is that it gets to the cancer quickly in the blood.

What is another benefit?

Tick **one** box.

All cancers can be treated by the injection ☐

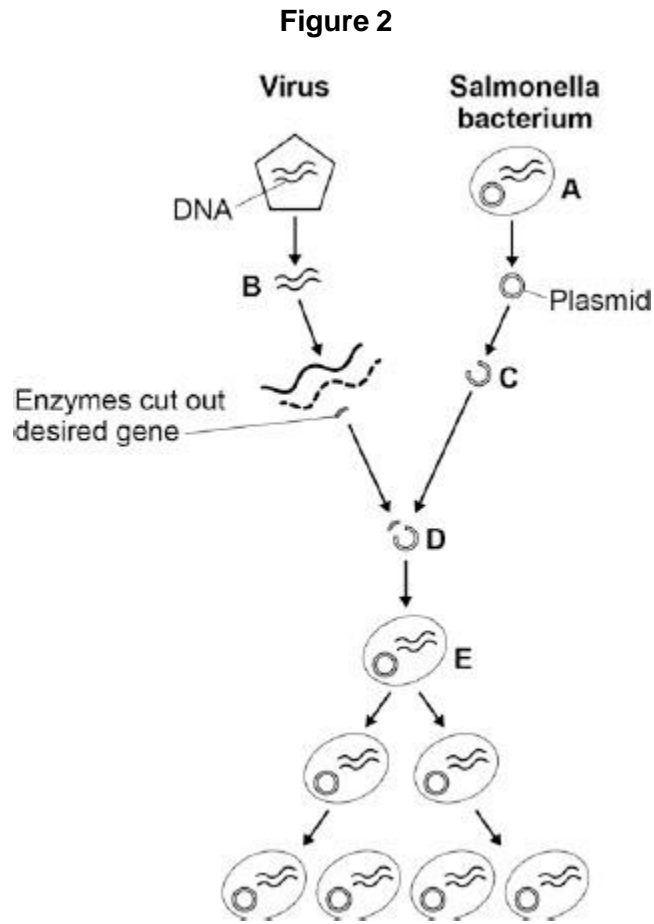It will not cause sickness and diarrhoea side effects ☐

The injection is not painful to the patient ☐

The injection introduces cancer cells into the body ☐

(1)

(e) The *Salmonella* bacterium used in the vaccine is genetically modified using part of a virus.

Look at **Figure 2**.

Figure 2

Complete the sentences.

Use the letters from **Figure 2**.

Bacteria reproduce quickly in part _____

DNA with the desired gene is removed from the virus in part _____

The chosen gene is inserted into the plasmid in part _____

(3)
(Total 9 marks)

2　(a)　Which of the following is the **best** definition of a species?

Tick (✓) **one** box.

Organisms with many features in common ☐

Organisms that live in the same habitat and eat the same food ☐

Organisms that reproduce together to form fertile offspring ☐

(1)

(b)　**Figure 1** is a photograph of the Grand Canyon.

The layers of rock contain fossils.

Figure 1

© Sumikophoto/iStock/Thinkstock

Scientists found five fossils of different species of animal, **P**, **Q**, **R**, **S** and **T**, at the positions shown in **Figure 1.**

(i)　What is the evidence in **Figure 1** that animals **P** and **Q** were alive at the same time?

_____

_____

(1)

(ii) Was animal **R** alive at an earlier time or at a later time than animals **P** and **Q**?

Give the reason for your answer.

_____

_____

(1)

(iii) Which **two** of the following would be evidence that animal **T** may have evolved from animal **S**?

Tick (✓) **two** boxes.

The fossils of animals **S** and **T** have many features in common, but **T** is more complex than **S**. ☐

The fossils of animals **S** and **T** are the same size. ☐

The fossils of animals **S** and **T** have the same skin colour. ☐

The fossil of animal **S** was found in a deeper layer of rock than the fossil of animal **T**. ☐

The fossil of animal **T** is more similar to the fossil of animal **R** than to the fossil of animal **S**. ☐

(2)

(c) **Figure 2** shows two species of ground squirrel, **W** and **X**.

Figure 2

Squirrel **W** lives on the high ground to the south of the Grand Canyon.

Squirrel **X** lives on the high ground to the north of the Grand Canyon.

The land to the north of the Grand Canyon is about 300 metres higher than the land on the south side. The north side also has lower winter temperatures and has more rain and snow than the south side.

(i) The two species of squirrel are very similar.

Describe **one** way, which you can see in **Figure 2**, in which squirrel **X** is different from squirrel **W**.

_____

_____

(1)

(ii) The Grand Canyon was formed about 6 million years ago.

Explain how the two different species of squirrel could have developed from a common ancestor.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(iii) Squirrels **W** and **X** are separate species, but they are still very similar.

Suggest why the two species have **not** become more different over time.

_____

_____

_____

_____

(2)

(Total 14 marks)

3 Some genetic disorders are caused by alleles inherited from the parents.

(a) What are **alleles**?

_____

_____

(1)

(b)   Describe how embryos can be screened for the alleles that cause genetic disorders.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c)   Polydactyly is a genetic disorder that leads to extra fingers or toes.

Polydactyly is caused by a dominant allele, **D**.

The photograph shows the hand of a person with polydactyly.

© Adem Demir/Hemera.

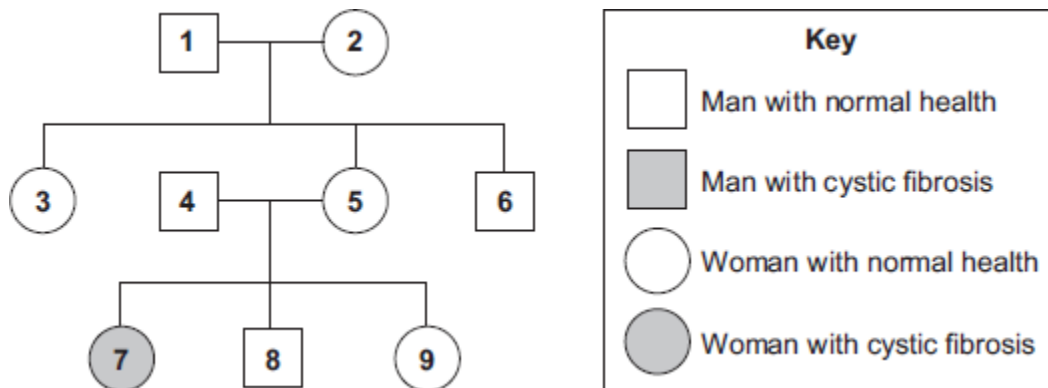A man has polydactyly. His wife does not have polydactyly.

This couple's children have a 50% chance of having polydactyly.

Draw a genetic diagram to explain why.

(3)

(d)   Cystic fibrosis is another genetic disorder. It is caused by a recessive allele.

The diagram shows the inheritance of cystic fibrosis in one family.

Woman **5** is pregnant with her fourth child.

What is the probability that this child will have cystic fibrosis?

Draw a genetic diagram to explain your answer.

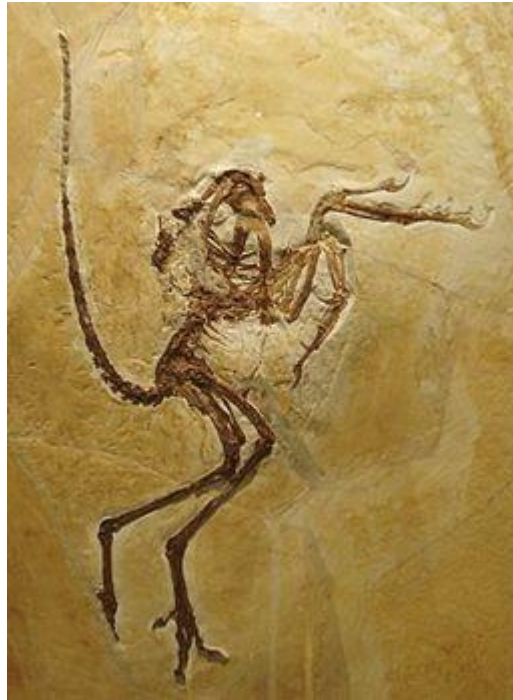Use the following symbols.

N = allele for normal health
n = allele for cystic fibrosis

(4)
(Total 12 marks)

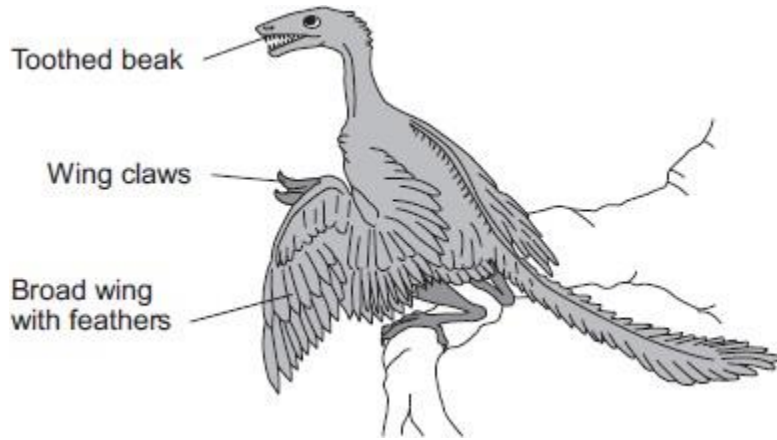**4**   The photograph shows a fossil of a prehistoric bird called *Archaeopteryx*.

(a)   Describe **three** ways fossils can be made.

_____

_____

_____

_____

_____

_____

(3)

(b)   The drawing shows what an *Archaeopteryx* might have looked like when it was alive.

Scientists think that *Archaeopteryx* was a predator.

(i)   Look at the drawing.

Write down **three** adaptations that might have helped *Archaeopteryx* to catch prey.

How would **each** adaptation have helped *Archaeopteryx* to catch prey?

Adaptation 1 _____

How it helps _____

_____

Adaptation 2 _____

How it helps _____

_____

Adaptation 3 _____

How it helps _____

_____

(3)

(ii) *Archaeopteryx* is now extinct.

Give **two** reasons why animals may become extinct.

1. _____

_____

2. _____

_____

(2)
(Total 8 marks)

5 Glyphosate is a herbicide.

Crop plants have been genetically modified to make them resistant to glyphosate.

(a) Why is it an advantage to make crop plants resistant to glyphosate?

_____

_____

_____

_____

_____

_____

(3)

(b)   **Figure 1** shows how scientists produce genetically modified (GM) crop plants.

The scientists use a GM-bacterium that can invade plant cells.

Figure 1
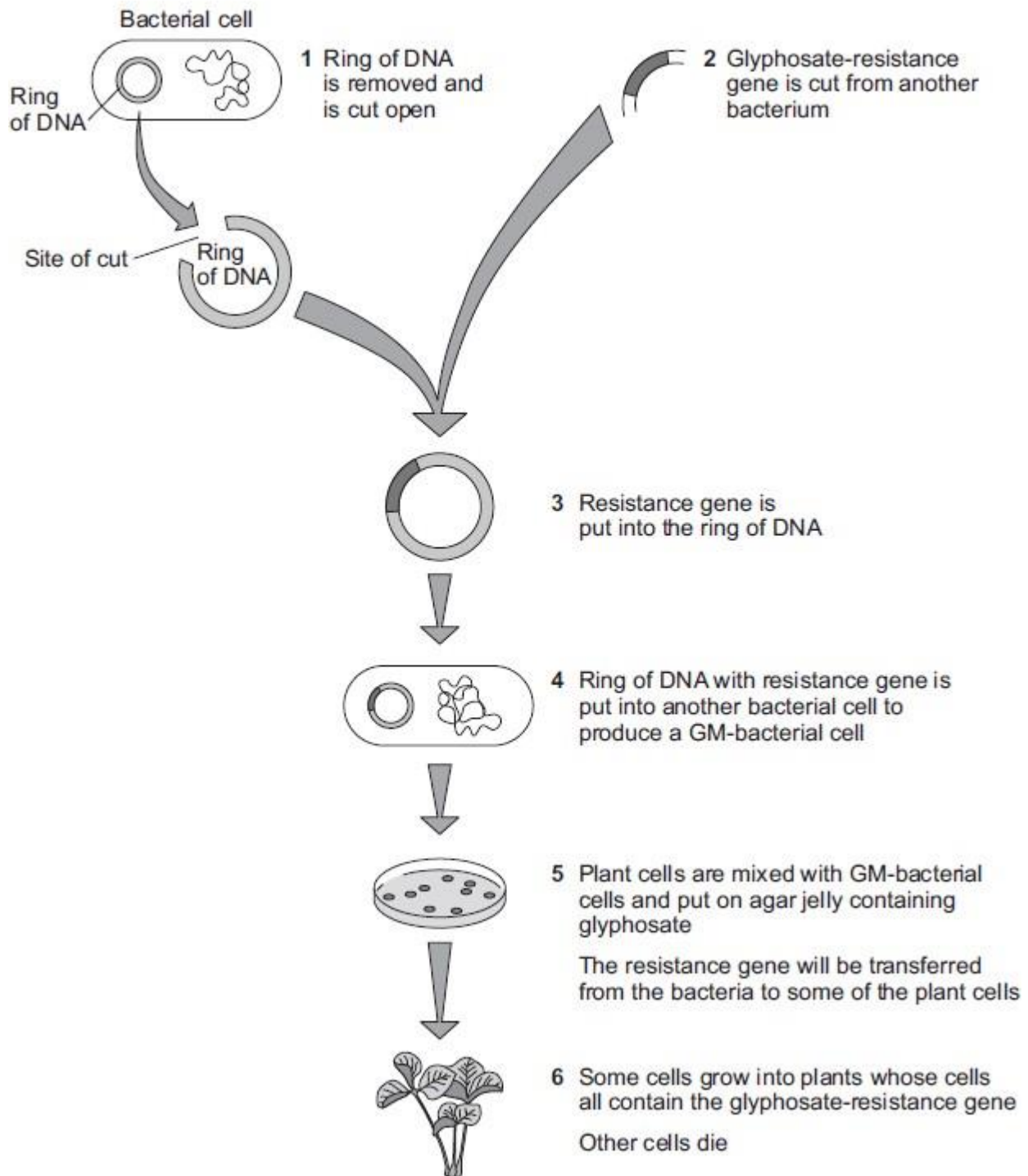
(i)   The ring of DNA shown in **Figure 1** acts as a vector for the resistance gene.

What is the scientific name for this ring of DNA?

_____

(1)

(ii)   At step **1** in **Figure 1**, the ring of DNA is cut open.

How do scientists cut open the ring of DNA?

_____

_____

(1)

(iii)   At step **5** in **Figure 1**, plant cells and GM-bacteria are put on agar containing glyphosate.

Explain why the scientists add glyphosate to the agar.

_____

_____

_____

_____

(2)

(c)   Some people disagree with the use of GM herbicide-resistant crop plants.

Figure 2 shows data published on a website in 2013.

Figure 2

Key

■ Number of cases of kidney disease

— Glyphosate applied to maize and soya beans
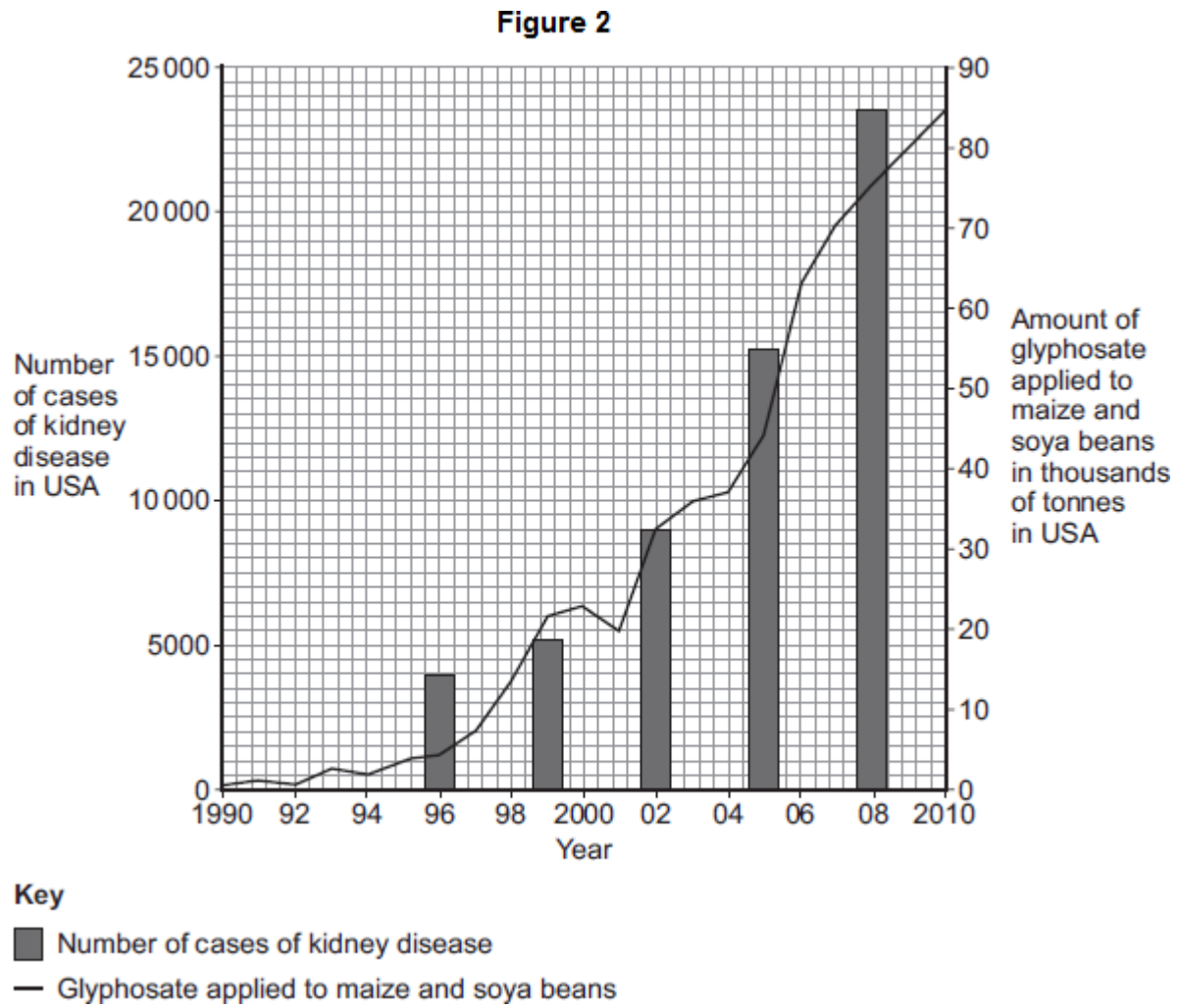
A journalist used the data to claim: 'Scientists show that GM crops cause kidney disease in humans.'

Use information from **Figure 2** to evaluate the evidence for this claim.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)
(Total 11 marks)

6   DNA is the genetic material of human cells.

Figure 1 shows the structure of part of a DNA molecule.

Figure 1

(a)   (i)   Describe where DNA is found in a human cell.

_____

_____

_____

(2)

(ii)   When a cell divides by mitosis the new cells are genetically identical.

What causes the cells to be genetically identical?

_____

_____

(1)

(b)   Many genes have different forms called alleles.

(i)   A person has polydactyly (extra fingers or toes). Polydactyly is caused by a dominant allele.
What is the smallest number of copies of the dominant allele for polydactyly that could be found in a body cell of this person?

_____

(1)

(ii)   Another person has cystic fibrosis. Cystic fibrosis (CF) is caused by a recessive allele.
How many copies of the recessive CF allele are there in a body cell of this person?

_____

(1)

(c)   A burglar broke into a house. The burglar cut his hand on some broken glass. Scientists extracted DNA from the blood on the broken glass.

The scientists analysed the DNA from the glass and DNA from three suspects, **A**, **B** and **C**. The scientists used a method called DNA fingerprinting.

Figure 2 shows the scientists' results.

Figure 2
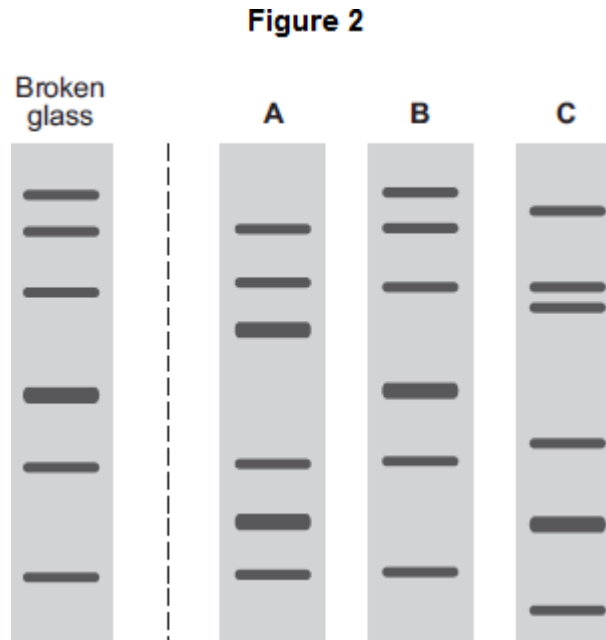
Which suspect, **A**, **B** or **C**, is most likely to have been the burglar?
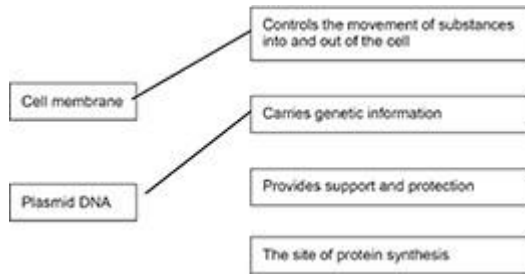
Tick (✓) **one** box.

A ☐

B ☐

C ☐

(1)
(Total 6 marks)

Mark schemes

1 (a) **Feature**   **Function**

Cell membrane → Controls the movement of substances into and out of the cell

Plasmid DNA → Carries genetic information

Provides support and protection

The site of protein synthesis

extra lines from the left negate the mark

2

(b)   Contaminated food

1

(c)   any **two** from:

- cook food (thoroughly)
- pasteurise food
- wash hands properly
- disinfect work surfaces
- keep raw and cooked foods separate
- only drink clean water

2

(d)   It will not cause sickness and diarrhoea side effects

1

(e)   **E**

1

B

1

D

1

[9]

2 (a) organisms that reproduce together to form fertile offspring

1

(b) (i) fossils of **P** and **Q** in same stratum / layer / level / height

1

(ii) earlier − fossil in deeper layer / further down

1

(iii) the fossils of animals **S** and **T** have many features in common, but **T** is more complex that **S**

1

the fossil of animal **S** was found in a deeper layer of rock than the fossil of animal **T**

1

(c) (i) **X** has white tail / shorter tail
    *allow other points eg **X** has furrier tail / smaller feet / is furrier*
    or
    ***W** has sharper claws / **W** has larger claws*

1

(ii) two (ancestral) populations separated / isolated (by geographical barrier / by canyon / river)

1

genetic variation (in each population) / different alleles / different genotypes / (different) mutation(s)

1

different environmental conditions / example described
    allow abiotic or biotic example

1

the better adapted survive / natural selection occurs
    allow survival of the fittest
    ignore they adapt to the environment

1

so (different / favourable) alleles / genes passed on (in each population)

1

eventually two types cannot interbreed successfully
    allow to produce fertile offspring

1

     (iii)   any **two** from:
- environments similar / described

  allow example, e.g. similar predator(s) / food / climate
- therefore similar adaptations / features / phenotypes suit

  accept suitable named feature
- original ancestor already well adapted

  ignore reference to not enough time for evolution.

2

[14]

3   (a)   (different / alternative) forms of a gene

              *do **not** accept types of genes*

1

(b)   DNA isolated from embryo

1

(fluorescent) probe mixed with embryo DNA

1

probe (then) <u>binds</u> with embryo DNA

1

(UV light) <u>to show</u> alleles / gene for disorder

1

(c)   genotypes of parents and gametes correct (Man **D** and **d**, Wife **d** and **d**)

              *allow half-size genetic diagram with only one **d** from wife*

1

offspring genotypes correct (½ = **Dd** and ½ = **dd**)

              allow ecf if parental genotypes are wrong

1

offspring phenotypes correctly assigned to genotypes

1

 (d)   genotypes of parents and gametes correct (**N** and **n**)

              allow ecf if parental genotypes are wrong

1

offspring genotypes correct (**NN**, 2 × **Nn**, and **nn**)

1

offspring phenotypes correctly assigned to genotypes;

1

correct probability = 0.25 / ¼ / 25% / 1 in 4 / 1:3, <u>only</u>;

              *do **not** allow '3:1' / '1:4'*

1

[12]

4 (a) any **three** from:

- parts of organisms have not decayed
    accept in amber / resin
    allow bones are preserved
- conditions needed for decay are absent
    accept appropriate examples, eg acidic in bogs / lack of oxygen
- parts of the organism are replaced by other materials as they decay
    accept mineralised
- or other preserved traces of organisms, eg footprints, burrows and rootlet traces
    allow imprint or marking of organism

3

(b) (i) teeth for biting (prey)
    must give structure + explanation

1

claws to grip (prey)
    accept sensible uses

1

wing / tail for flight to find (prey)

1

(ii) any **two** from:

- new predators
- new diseases
- better competitors
- catastrophe eg volcanic eruption, meteor
- changes to environment over geological time
    accept climate change
    allow change in weather
- prey dies out **or** lack of food
    allow hunted to extinction

2

[8]

5 (a) kills weeds among crops / does not kill crops

1

(kills weeds) so less competition for <u>named</u> factor eg light / water / ions
    ignore space

1

crops grow better / higher yield

1

(b)　(i)　plasmid

1

　　　(ii)　use an enzyme

　　　　　　allow correct example

1

　　　(iii)　only some cells become GM / take up the plasmid / take up resistance gene

　　　　　　allow idea of transfer of gene / plasmid to some plant cells from
　　　　　　bacteria

1

　　　　　GM cells survive / non-GM cells are killed

1

(c)　Pro:
(positive) correlation between use of glyphosate and number of cases of kidney disease

　　　　　　*allow **1** mark for justified conclusion that the claim is not justified*

1

　　　+ any **three** from:
　　　Con:
　　　•　lack of controls / control group
　　　•　correlation does not prove a causal link
　　　•　some other factor could be the cause

　　　　　　accept obesity / infection
　　　•　no evidence that kidney patients actually consumed GM crops / crops treated
　　　　with glyphosate / no evidence about amount consumed
　　　　　　or graph shows amount of herbicide not amount of GM crops grown
　　　　　　or graph shows data only for maize and soya / not for other (GM) crops
　　　•　data have been manipulated by carefully chosen scales to make it look like they
　　　　coincide
　　　•　data from some years is missing
　　　•　no data for the dosage of herbicide used

　　　　　　allow kidney disease has been around for much longer than GM
　　　　　　crops / better diagnosis of kidney disease.

3

[11]

6 (a) (i) in the chromosome(s)

        ignore genes / alleles

1

      in the nucleus

        allow nuclei

        allow mitochondria

1

    (ii) the DNA / chromosomes / genes are replicated / copied / multiplied / doubled / duplicated

        allow DNA is cloned

        ignore same DNA / chromosomes / genes if unqualified

1

(b) (i) 1 / one

1

    (ii) 2 / two

1

(c) **B**

1

[6]