

- 1 The polar bear, *Ursus maritimus*, preys on seals and fish. Polar bears are adapted to live in cold Arctic regions.



Polar bear
Magnification $\times 0.04$

A recent study has shown that all polar bears are descended from populations that diverged from the Irish brown bear, *Ursus arctos*, approximately 120 000 years ago.

In this study, DNA from modern polar bears, the remains of historic polar bears and the remains of Irish brown bears was analysed.

- (a) The first part of the study involved the amplification of DNA to give large enough samples for analysis.
- (i) Describe how small samples of DNA can be amplified.

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(ii) Name **one** technique that could be used to analyse the amplified DNA samples.

(1)

(b) Suggest how the scientists who conducted the study had their results accepted by other scientists.

(2)

(c) Suggest how each of the following may have contributed towards the divergence of polar bears and Irish brown bears into two separate species.

(i) Separation of the Arctic and Irish regions by sea

(2)

(ii) Genetic mutation

(2)

(Total for Question 1 = 11 marks)

2 The Human Genome Project is helping in the design of new drugs to treat a variety of human diseases and in the development of synthetic tissues.

(a) (i) Explain the meaning of the term **Human Genome**.

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(ii) Describe **one** ethical implication associated with the use of information obtained from the analysis of the human genome.

(1)

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(b) Melanoma is an aggressive form of skin cancer.

Very few patients with this cancer survive for more than five years. Some melanomas are associated with a genetic mutation identified by the Human Genome Project.

Drug R (R05185426) has been developed to treat patients with these melanomas. In clinical trials, drug R has been shown to cause a 50% shrinkage of melanomas in only a few months.

(i) Suggest how work on the Human Genome Project helped in the development of drug R.

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(ii) Suggest how drug R may have caused the melanoma to shrink in only a **few months**.

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(iii) Drug R needs one more round of testing, in a phase III trial, before it can be approved for use.

Explain what is meant by a **phase III trial**.

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(c) Yeast cells were genetically modified, using human DNA, to produce collagen. This collagen can be used to make synthetic corneas.

Ten patients who were blind were each given a synthetic cornea. They were all able to see with no reported complications due to tissue rejection.

Suggest why these synthetic corneas were not rejected.

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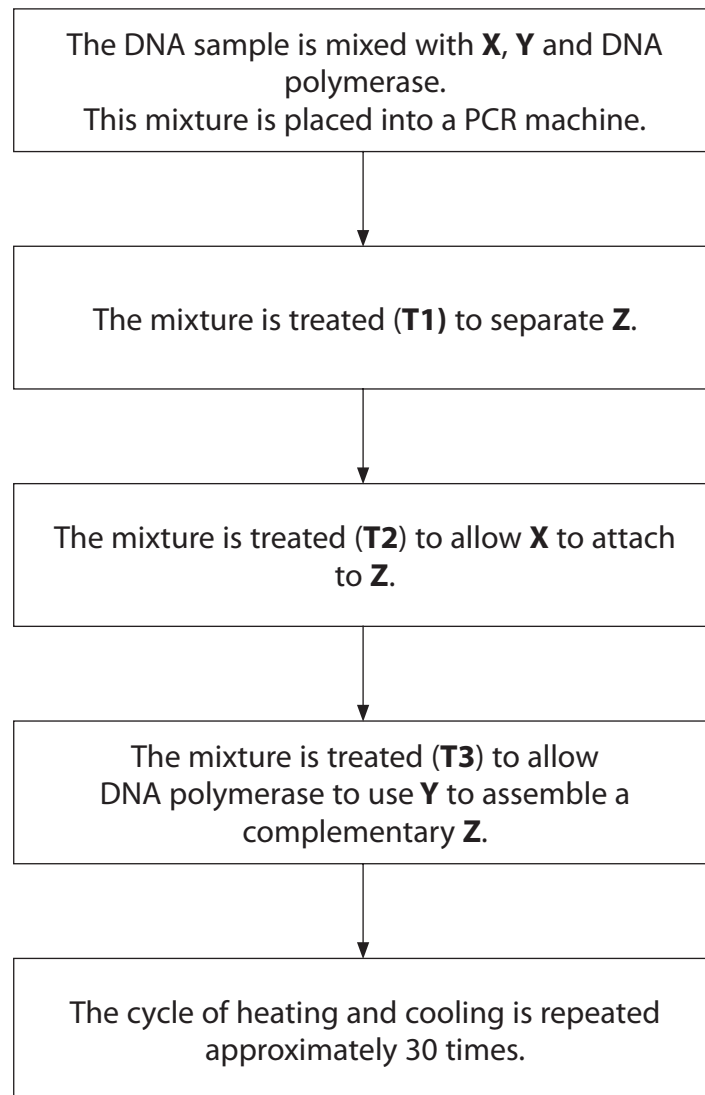
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(Total for Question 2 = 13 marks)

- 3** During DNA profiling, the polymerase chain reaction (PCR) can be used to amplify a sample of DNA.

The diagram below shows how substances **X**, **Y** and **Z** are involved in the PCR. It also gives the temperature treatments **T1**, **T2** and **T3** at various stages.



(a) Name substances **X**, **Y** and **Z**.

(3)

Substance **X**

Substance **Y**

Substance **Z**

(b) Place a cross in the box next to the correct statements for treatments **T1**, **T2** and **T3**.

(3)

(i) Treatment **T1**

A heated to 90–95 °C

B heated to 75 °C

C cooled to 55–60 °C

D cooled to 4 °C

(ii) Treatment **T2**

A heated to 90–95 °C

B heated to 75 °C

C cooled to 55–60 °C

D cooled to 4 °C

(iii) Treatment **T3**

A heated to 90–95 °C

B heated to 75 °C

C cooled to 55–60 °C

D cooled to 4 °C

(c) Suggest reasons for each of the following.

(i) DNA polymerase from human sources is not suitable for use in a PCR machine.

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(ii) Species of plants cannot be identified from woody (xylem) material using PCR and DNA profiling.

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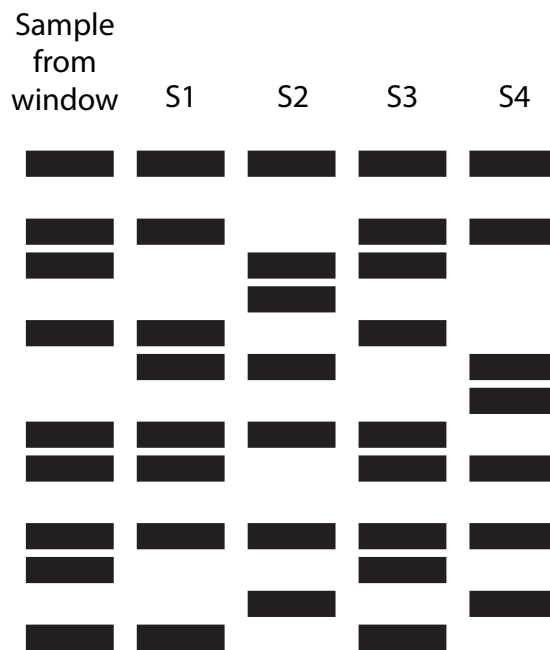
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(Total for Question 3 = 10 marks)

- 4 Following a burglary, a DNA profile was created using a small sample of blood left behind on a broken window pane. This DNA profile was then compared with DNA profiles from four suspects, S1, S2, S3 and S4. These DNA profiles are shown in the diagram below.



- (a) (i) Place a cross ☒ in the box next to the name of the enzyme used in the process used to amplify the DNA in the small sample of blood taken from the crime scene.

(1)

- A endonuclease
- B invertase
- C polymerase
- D transcriptase

- (ii) Place a cross ☒ in the box next to the name of the process that could be used to separate DNA fragments to create the profiles shown in the diagram above.

(1)

- A amniocentesis
- B electrophoresis
- C endocytosis
- D chromatography

(iii) Suggest which of the suspects is most likely to have left the blood sample on the broken window pane. With reference to the theory used in DNA profiling, explain how you came to this conclusion.

(5)

Suspect

Explanation

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(b) Explain why evidence from DNA profiles may not be absolutely conclusive.

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(c) Suggest how DNA profiling could be useful to scientists who examine fossils of animals and plants.

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(Total for Question 4 = 11 marks)

5 Grey tree frogs are found in the USA.

The photograph below shows a grey tree frog.



Magnification $\times 1$

Cope's grey tree frog and the eastern grey tree frog are both found in the USA.

These species of grey tree frog are very similar in appearance, but have different mating calls.

A number of scientists believe that the eastern grey tree frog evolved from Cope's grey tree frog during the last ice age.

These species have different numbers of chromosomes in their nuclei. Cope's grey tree frog has two copies of each chromosome. The eastern grey tree frog has four copies of each chromosome. As a result, the cells of the eastern grey tree frog are larger.

- (a) The genetic relationship between these two species of grey tree frog has been studied using DNA profiling (DNA fingerprinting).

A small sample of DNA was taken from each species of grey tree frog. This DNA was amplified, fragmented and used to produce a DNA profile (DNA fingerprint) for each species.

- *(i) Describe how a DNA profile was produced from this small sample of DNA.

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(ii) Suggest how these DNA profiles were compared.

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(b) Scientists in different parts of the USA are investigating the possibility that the difference in cell size is responsible for the different mating calls. This is contributing to an understanding of the evolution of grey tree frogs.

Suggest **two** ways in which the results of their investigations can be shared.

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(Total for Question 5 = 11 marks)