19.1 Principles of Genetic Technology

Question Paper

Course	CIE A Level Biology
Section	19. Genetic Technology
Topic	19.1 Principles of Genetic Technology
Difficulty	Medium

Time allowed: 50

Score: /41

Percentage: /100

Question 1a

Seven skeletons were discovered in a house in Pompeii, three of which were children. It is believed they were inhabitants and workers within the house when Mount Vesuvius erupted in 79 AD. Researchers were able to isolate very small amounts of DNA from these skeletons. The DNA obtained was used in the polymerase chain reaction (PCR). Genetic fingerprinting was then carried out on this DNA to identify the skeletons.

Fig. 1 shows some of the results of the genetic fingerprinting of the three children and four adults.

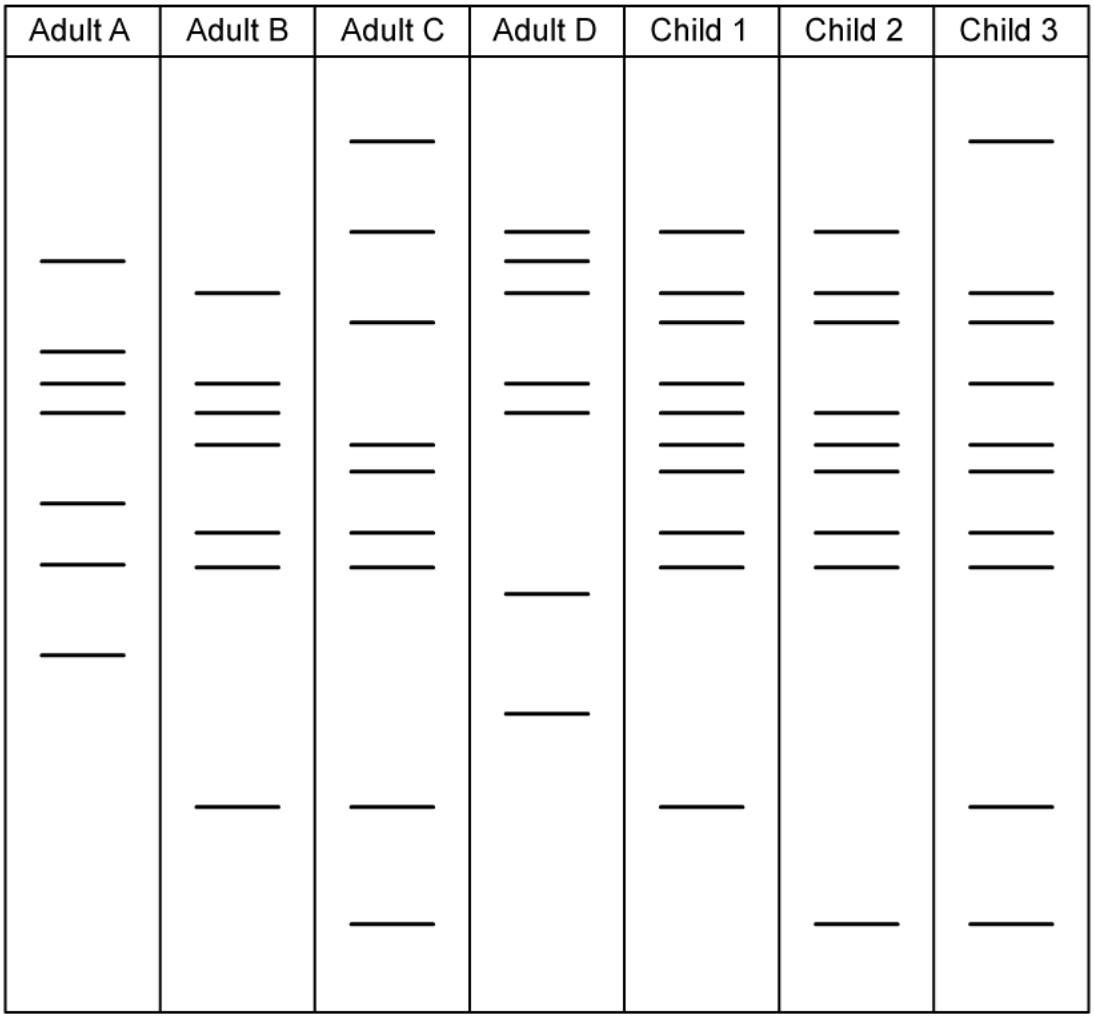

Fig. 1

Explain why the researchers used PCR in their investigation.

[2 marks]

Question 1b

During PCR DNA is heated to 94 °C and DNA primers, nucleotides and enzymes are added to the mixture.

(i)
Explain why the DNA is heated to 94 °C.

[1]

(ii)
Describe what is meant by the term **DNA primers** and explain why these are added during PCR.

[2]

(iii)
State why the enzymes used in PCR must be stable at high temperatures.

[1]

[4 marks]

Question 1c

It was determined that the three children were siblings and shared the same biological parents. Their mother is **Adult B**.

(i)
Suggest which of the other adults was the children's father.

[1]

(ii)
Give a reason for your answer to part i).

[1]

[2 marks]

Question 1d

Describe the method by which genetic fingerprinting (also known as DNA fingerprinting or DNA profiling) is undertaken.

[5 marks]

Question 2a

A scientist used a restriction enzyme to cut a section of mouse DNA into multiple pieces. They wanted to insert these pieces of DNA into plasmids and used the same restriction enzyme to cut the plasmids.

Explain why the pieces of mouse DNA would be able to join to the cut DNA of the plasmids.

[2 marks]

Question 2b

The scientist added another enzyme to the mixture used to form recombinant plasmids.

(i)
Name the other enzyme the scientist added to the mixture.

[1]

(ii)
Describe the function of the enzyme identified in part i).

[1]

[2 marks]

Question 2c

The plasmid formed from this experiment is used as a vector.

Define the term vector when used in this context.

[2 marks]

Question 2d

Outline the key steps involved in the commercial production of human recombinant insulin.

[6 marks]

Question 3a

Farmers use genetic engineering to quickly introduce genes that benefit the health and value of their livestock. Protein Q is a protein that gives pigs resistance to a disease that is killing livestock. Goats can be genetically engineered to produce Protein Q in their milk.

Fig. 1 shows the stages involved in this process.

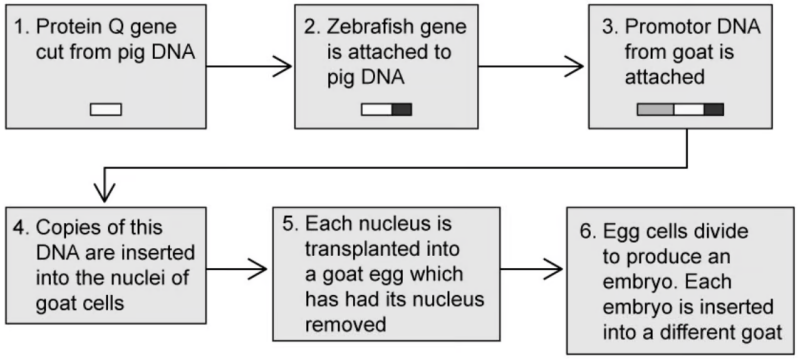

Fig. 1

The zebrafish gene attached to the pig protein Q gene codes for a protein that glows blue under fluorescent light.

Suggest why this gene has been attached.

[2 marks]

Question 3b

Fig. 1 shows the addition of goat promoter DNA

(i)
State the role of promoter DNA.

[1]

(ii)
The goat promoter DNA is taken from a gene normally expressed in milk glands.

Suggest why this is the case.

[1]

[2 marks]

Question 3c

For the process of gel electrophoresis:

(i)
Identify which electrode the DNA will move towards.

[1]

(ii)

Explain your answer to part i).

[2]

[3 marks]

Question 3d

Restriction enzymes and gel electrophoresis can be used in genetic screening to identify genes associated with a disease. The mutation of the Beta-globin gene which gives rise to sickle-cell anaemia removes a recognition site of the restriction enzyme *Dde*I as shown in Fig. 2 below. The lengths of some fragments are shown in numbers of base pairs (bp).

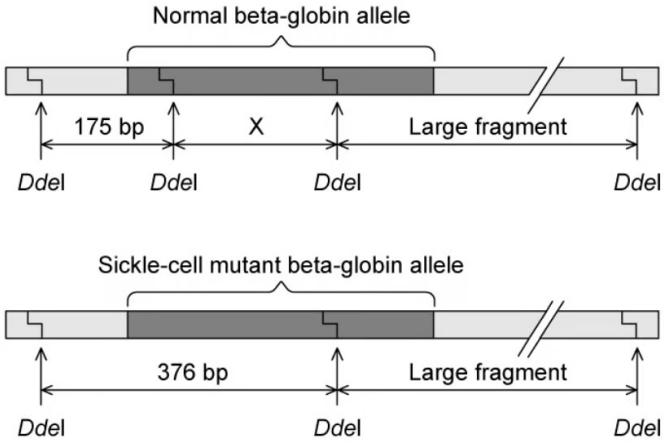

Fig. 2

(i)
Calculate the length of fragment **X**.

[1]

(ii)
*Dde*I digested DNA from an individual who was a carrier for the sickle-cell beta-globin gene was analysed with gel electrophoresis as shown in Fig. 4.3 below.

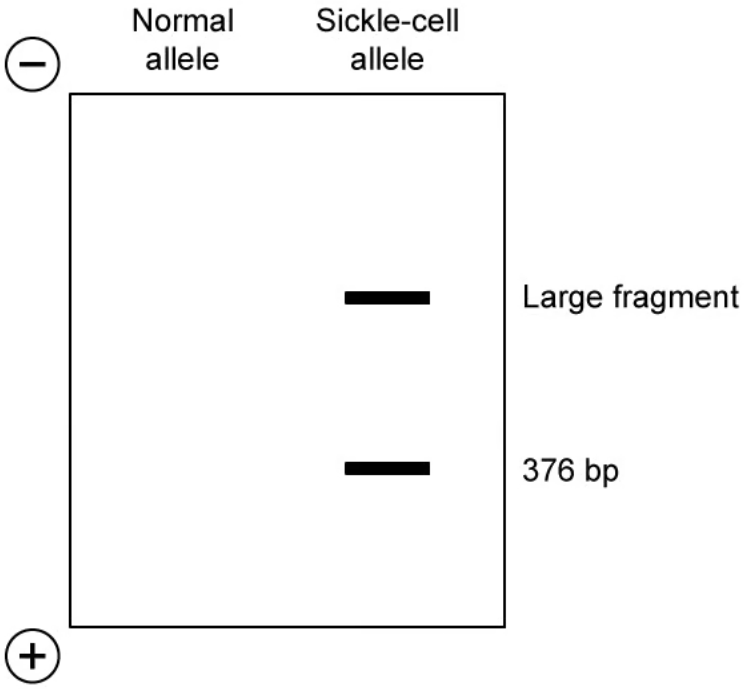

Fig. 3

Draw the DNA fragments that would result from a normal individual in Fig. 4.3. Label these DNA fragments clearly.

[2]

[3 marks]

Question 4a

A researcher wanted to detect and measure accurately the amount of RNA present in a liver tissue sample in order to determine the types of proteins being expressed. They carried out a process called RT-PCR (reverse transcriptase-polymerase chain reaction) in order to accomplish this.

RT-PCR uses a reaction mixture containing:

- the sample for testing
- DNA polymerase
- primers
- reverse transcriptase
- DNA nucleotides
- fluorescent dye

Suggest the roles of DNA polymerase and reverse transcriptase in RT-PCR.

[2 marks]

Question 4b

Before commencing the study the researcher added hydrolytic enzymes to the sample to ensure all DNA is hydrolysed.

Suggest why the researcher carried out this step.

[1 mark]

Question 4c

The polymerase chain reaction will only run for a finite amount of time, even if the researcher does not return to it.

Suggest why this is the case.

[1 mark]

Question 4d

Researchers have used the RT-PCR method to detect the presence of different hepatitis viruses; a family of RNA viruses that affect the liver.

Explain why the researchers needed to produce a variety of primers for this procedure.

[2 marks]