3.4 Genetic Modification & Biotechnology

Question Paper

Course	DP IB Biology
Section	3. Genetics
Topic	3.4 Genetic Modification & Biotechnology
Difficulty	Hard

Time allowed: 80

Score: /60

Percentage: /100

Question 1a

a)
Human blood carries several proteins which are required in the mechanism of blood clotting. One of these proteins, factor VIII, is lacking in individuals with haemophilia.

A team of scientists has genetically engineered goats by introducing a gene allowing them to produce factor VIII in their milk. This milk can then be purified and the proteins can be used to treat haemophiliac patients.

Describe **two** methods by which the scientists could obtain the human gene coding for the factor VIII protein.

[4 marks]

[4 marks]

Question 1b

b)
Before carrying out PCR on the isolated gene sequence, the scientists modified the gene in two ways:

1. They attached a jellyfish gene which codes for a fluorescent protein to the start of the gene sequence.
2. They added a promotor region in front of the jellyfish gene.

After these modifications, the DNA sequence will be inserted into the nucleus of some body cells of a goat.

Suggest the purpose of attaching the jellyfish gene.

[2 marks]

[2 marks]

Question 1c

c)
The promotor region provides a base sequence compatible with the active site of the enzyme RNA polymerase.

Suggest why the addition of the promotor region is required in the production of factor VIII.

[3 marks]

[3 marks]

Question 1d

d)
One round of PCR takes approximately 75 seconds.

Calculate how many copies of DNA would be produced after a single fragment of DNA has been in the thermal cycler for 1.5 hours. Give your answer in standard form.

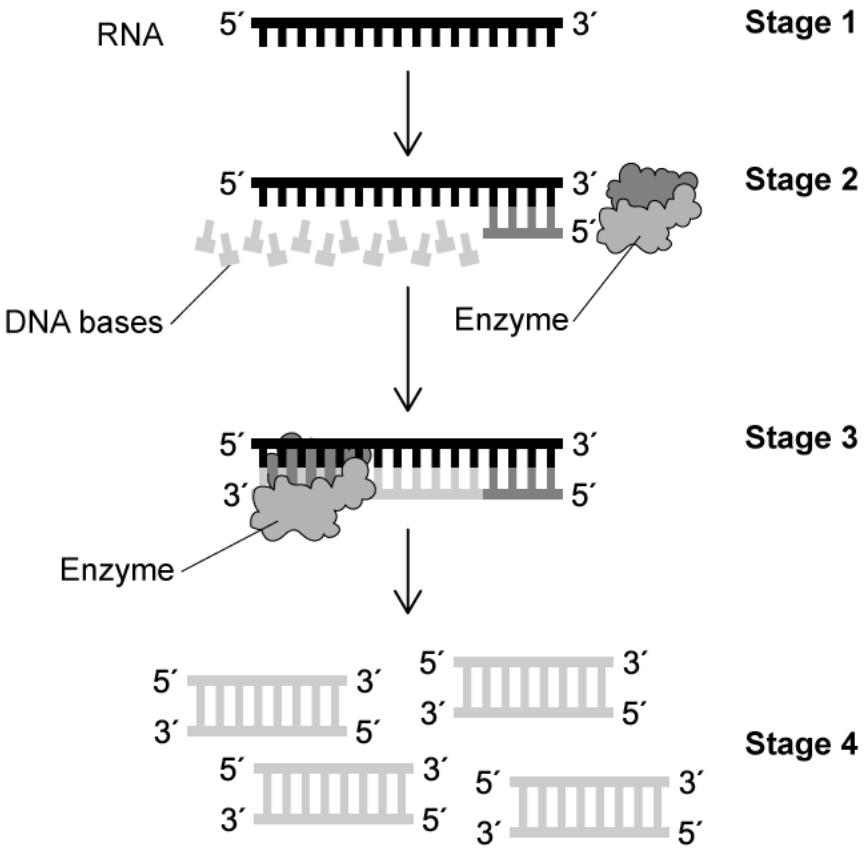
[3 marks]

[3 marks]

Question 2a

a)

The diagram below shows the processes involved in the amplification of a sample of viral RNA.



Compare and contrast the process in the image with the process used in the amplification of a fragment of DNA.

[6 marks]

[6 marks]

Question 2b

b)
The addition of RNAase enzyme occurs between stages **3** and **4** shown in the diagram from part **a)**.

Suggest why this is a necessary part of the process.

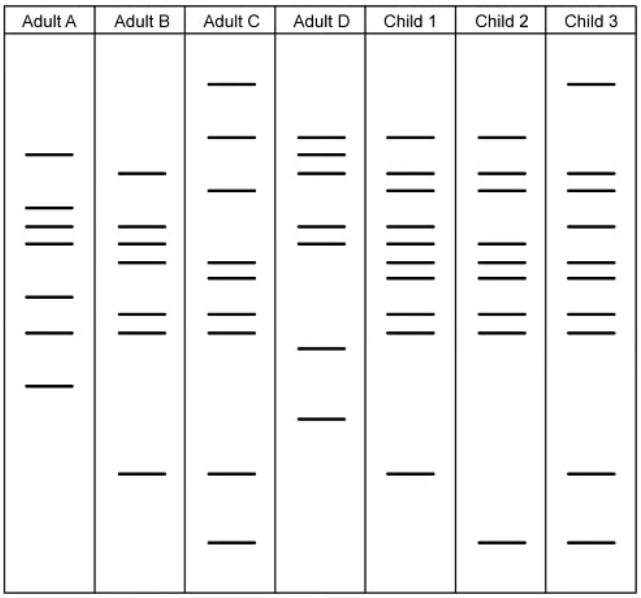
[2 marks]

[2 marks]

Question 2c

c)
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.

The image below shows some of the results of the genetic fingerprinting of the three children and four adults.



Explain why the researchers used PCR in their investigation.

[2 marks]

[2 marks]

Question 2d

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

Identify, with a reason, which of the other adults was the children's father.

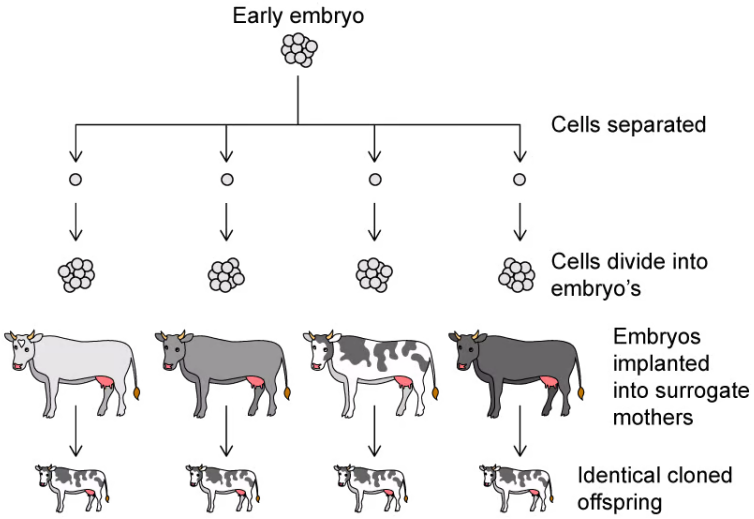
[2 marks]

[2 marks]

Question 3a

a)

Embryo splitting is a process which can be used to produce larger numbers of high quality cattle for farmers. The process can be seen below.



An embryo with more than 8 cells cannot be used in embryo cloning, suggest why.

[2 marks]

[2 marks]

Question 3b

b)

Clones produced in the process in part **a)** may show different phenotypes to each other.

Explain why.

[2 marks]

[2 marks]

Question 3c

c)
Describe three natural cloning methods used by plants and animals.

[3 marks]

Question 4a

a)
An investigation was carried out to show the affect of different rooting powders on the growth of roots in cuttings taken from bean plants.

The results from the investigation are shown in the table.

SE refers to the standard error of the data, which is the spread of data around the calculated mean value.

Rooting hormone	Mean number of roots ± SE	Mean root length ± SE
1	5.86 ± 0.42	6.20 ± 0.14
2	4.41 ± 0.13	5.01 ± 0.03
3	4.27 ± 0.25	4.98 ± 0.27
Control	2.16 ± 0.005	2.65 ± 0.35

Suggest the conclusions that can be drawn from these results.

[4 marks]

[4 marks]

Question 4b

b)
A company selling rooting powder 1 to gardeners made the following claim:

With this rooting powder, your plant cuttings will grow more roots of a greater length than other rooting powders.

Evaluate the validity of this claim.

[3 marks]

[3 marks]

Question 4c

c)
Outline a method that could have been used to determine how rooting powders affect the growth of roots in bean plants.

[6 marks]

[6 marks]

Question 5a

One mark is available for clarity of communication throughout this question.

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

Explain the purpose of these steps.

[4 marks]

[4 marks]

Question 5b

b)
Scientists have proposed a method to genetically engineer mosquitos as a method of controlling disease spread by the insects.

Analyse the ethics surrounding the use of genetically engineered mosquitos as a public health tool.

[6 marks]

[6 marks]

Question 5c

c)
Discuss the use of cloning methods to produce genetically identical copies of organisms in agriculture.

[6 marks]

[6 marks]