Principles of genetic technology

Question Paper 1

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Genetic Technology
Sub Topic	Principles of genetic technology
Booklet	Theory
Paper Type	Question Paper 1

Time Allowed : **56 minutes**

Score : **/ 46**

Percentage : **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** Describe how electrophoresis is used in genetic fingerprinting. [9]

(b) Explain the advantages of treating diabetic people with human insulin produced by gene technology. [6]

[Total: 15]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

2 The pink bollworm moth, *Pectinophora gossypiella*, is a pest of cotton crops. The size of its population can be reduced by releasing large numbers of sterile male moths into cotton fields. The sterile male moths mate with wild females from the cotton fields, but no offspring are produced.

Over a period of three years, 20 million genetically modified (GM) sterile male moths were released in the USA. Each insect contained a gene coding for a red fluorescent protein (DsRed) taken from a species of reef coral. The added DNA also included a promoter.

(a) Explain why, in gene technology:

(i) genes for fluorescent proteins such as DsRed are now more commonly used as markers than are genes for antibiotic resistance

.....

.....

.....

.....

.....

..... [2]

(ii) a promoter needs to be included when transferring a gene from a coral into an insect.

.....

.....

.....

.....

.....

.....

.....

..... [3]

(b) DsRed is visible at all stages of the life cycle of the moth, but the presence of the gene in a particular individual can be confirmed by genetic fingerprinting, using gel electrophoresis.

(i) Outline the principles of gel electrophoresis.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(ii) Explain how the presence of the gene for DsRed in a moth can be confirmed once electrophoresis is complete.

.....

.....

.....

..... [2]

(c) DsRed allows sterile male moths to be distinguished from wild moths when caught in an insect trap in a field of cotton plants.

Suggest why it is important to be sure whether a moth caught in such a trap is a released sterile male or a wild insect.

.....

.....

.....

..... [2]

(d) The United States Department of Agriculture has ruled that the release of sterile males to control insect pest numbers is environmentally preferable to all other alternatives.

Suggest what information would be needed to determine whether the release of the sterile male moths, carrying the gene for DsRed, has a damaging effect on the environment.

.....

.....

.....

..... [2]

[Total: 15]

3 Variable number tandem repeats (VNTRs) are repetitive, non-coding sections of DNA. A particular VNTR is located at the same locus in different individuals, but the number of repeats in that VNTR varies between individuals.

(a) Explain how, in the process of genetic fingerprinting, gel electrophoresis is able to distinguish between the VNTRs that occur at the same loci of different individuals.

.....

.....

.....

.....

.....

..... [3]

(b) Gel electrophoresis is also used in genetic screening.

The mutation of the β-globin gene which gives rise to sickle cell anaemia removes a recognition site of a restriction enzyme, **R**, as shown in Fig. 3.1. **R** cuts DNA at the sites indicated by arrows (↓). The lengths of the resulting fragments are shown in kilobases (kb).

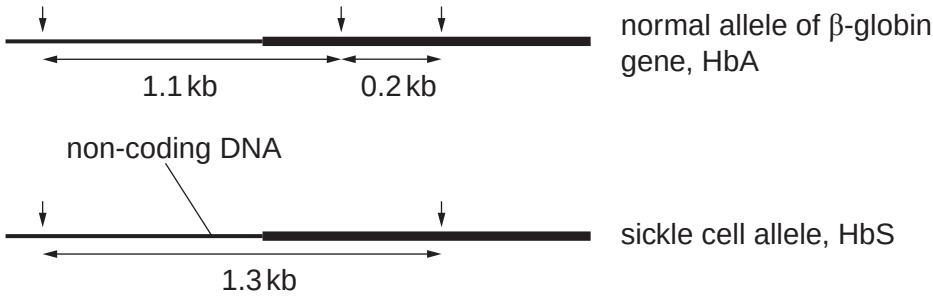

Fig. 3.1

Fig. 3.2 shows an electrophoresis gel with a stained band of DNA from an individual who was homozygous for the normal allele for β-globin, HbA HbA. This band is the 1.1 kb fragment shown in Fig. 3.1. The 0.2 kb fragment is **not** shown.

Complete Fig. 3.2 by drawing the stained DNA that would result from an individual who is heterozygous for the sickle cell allele, HbA HbS.

Put your answer on to Fig. 3.2. [2]

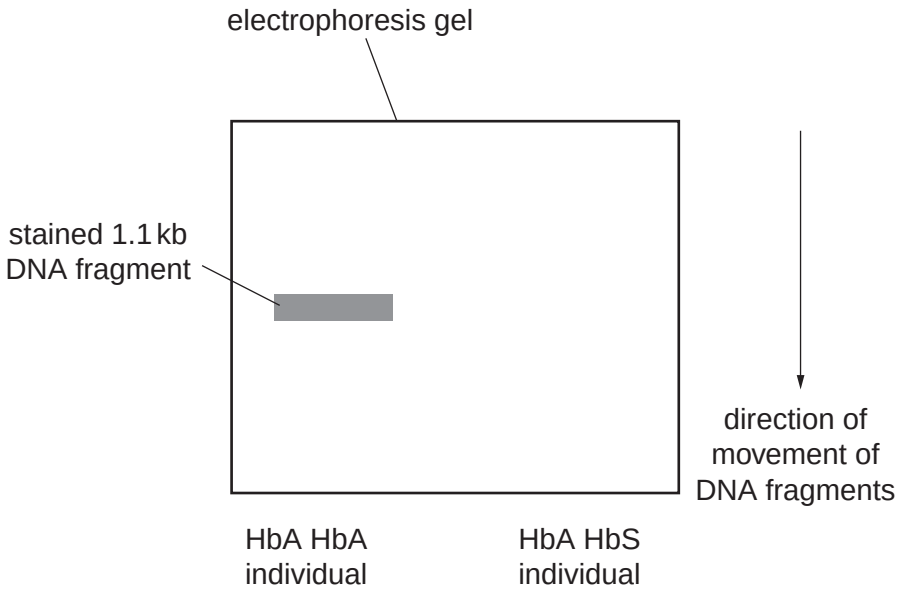

Fig. 3.2

(c) Describe the different circumstances in which this genetic screening for the sickle cell allele, HbS, might be used.

.....

.....

.....

.....

.....

..... [3]

[Total: 8]

4 In order to sequence the DNA of a gene, it is first denatured to separate its two strands.

Then, in the presence of a large supply of each of the four nucleotides, the single-stranded DNA is replicated by DNA polymerase.

(a) Explain what determines the sequence of nucleotides in the newly replicated strand of DNA.

.....

.....

.....

..... [2]

(b) A low concentration of specially prepared nucleotides is also present. Once added to the chain, these nucleotides do **not** allow the chain to continue growing.

Each special nucleotide is labelled with a fluorescent dye, using a different colour for each of the four bases.

Fig. 3.1 shows a replicated DNA chain ending with one of the special nucleotides.

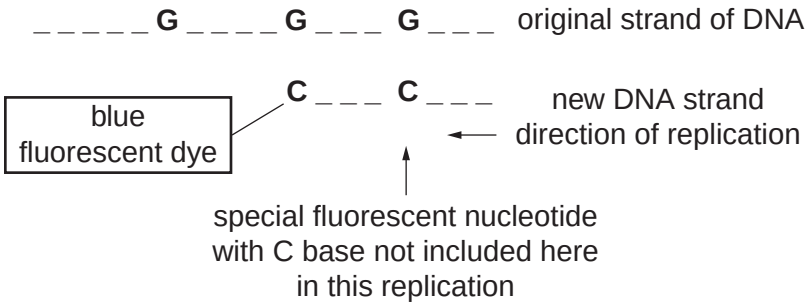

Fig. 3.1

With reference to Fig. 3.1 and to the information given, suggest why a special nucleotide with a C base was **not** included by DNA polymerase at the first site requiring a C nucleotide.

.....

.....

.....

..... [2]

(c) This method of sequencing a gene produces as many DNA fragments as there are nucleotides in the gene, each fragment differing in length by one nucleotide.

Fig. 3.2 shows part of a set of such fragments.

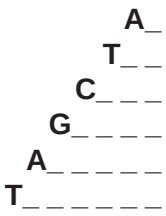

Fig. 3.2

These fragments are loaded onto a sequencing gel, shown in Fig. 3.3, and separated by electrophoresis.

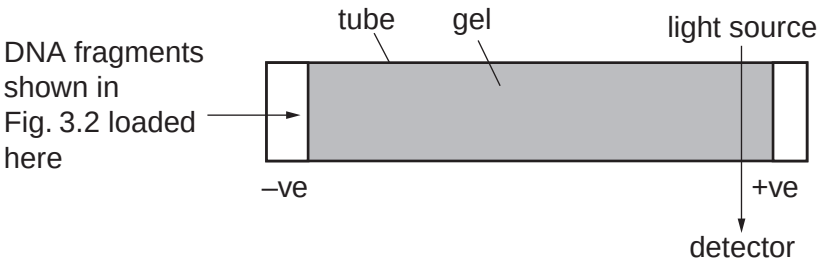

Fig. 3.3

(i) In what order will the fragments shown in Fig. 3.2 reach the light source and detector shown in Fig. 3.3?

.....

..... [1]

(ii) Explain how gel electrophoresis separates these fragments of DNA.

.....

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 8]