Genetic technology applied to medicine

Question Paper 3

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Genetic Technology
Sub Topic	Genetic technology applied to medicine
Booklet	Theory
Paper Type	Question Paper 3

Time Allowed : **63 minutes**

Score : **/ 52**

Percentage : **/100**

Grade Boundaries:

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

1 **(a)** Describe the role of the hormone insulin in maintaining a constant blood glucose concentration. [6]

(b) The hormone human chorionic gonadotrophin (HCG) is produced by a woman in the early stages of pregnancy. Describe how a pregnancy test kit can detect the presence of HCG. [9]

[Total: 15]

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2 Green fluorescent protein (GFP) is a small protein that emits bright green fluorescence in blue light. It was first isolated from the jellyfish, *Aequorea victoria*.

The gene coding for GFP can be expressed in bacteria, such as *Escherichia coli*, and so it is often used as a marker to show successful uptake of a gene by the bacterium.

(a) (i) Outline how a gene from another species can be inserted into *E. coli*.

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(ii) Explain how a marker gene, such as the gene for GFP, is used to show successful uptake of a gene for a wanted protein.

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(b) Genes for enzymes that produce fluorescent substances are often used as markers in gene technology.

GFP is **not** an enzyme.

Suggest **one** disadvantage of using the gene for GFP to produce easily detectable fluorescence, rather than using a gene for an enzyme that produces a fluorescent substance.

Explain your answer.

disadvantage .....

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explanation .....

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..... [2]

[Total: 8]

3 The artificial plasmid, pBR322, was constructed to act as a vector. It has often been used to insert human genes, such as the human insulin gene, into the bacterium, *Escherichia coli*.

The plasmid was constructed to include two genes, each giving resistance to a different antibiotic: an ampicillin resistance gene and a tetracycline resistance gene. The plasmid also has a target site for the restriction enzyme, *Bam*HI, in the middle of the tetracycline resistance gene.

A pBR322 plasmid was cut using *Bam*HI and the cDNA gene for human insulin inserted into it.

Fig. 2.1 shows pBR322 and the recombinant plasmid.

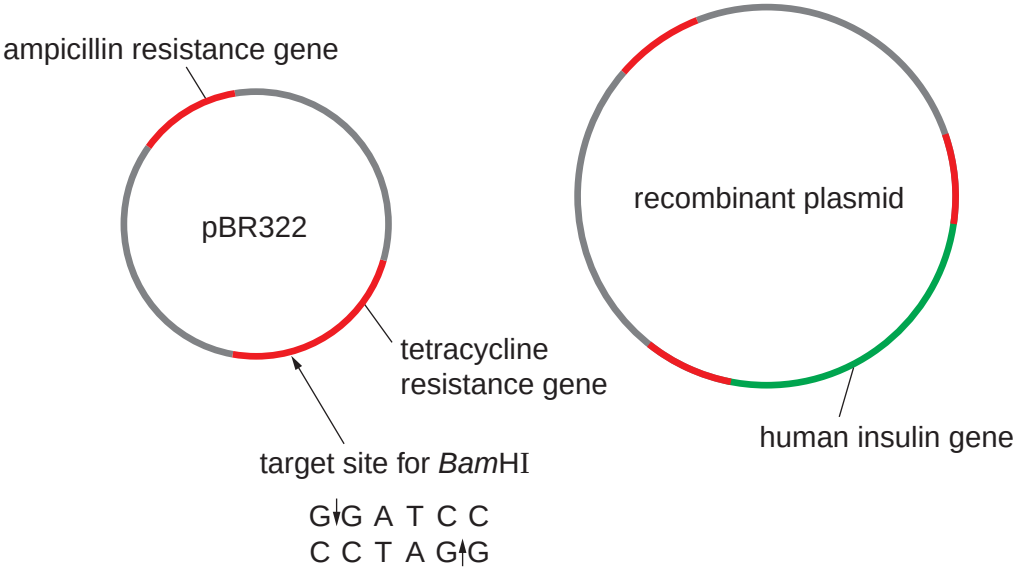

Fig. 2.1

(a) With reference to Fig. 2.1, describe how a cDNA human insulin gene can be inserted into pBR322 that has been cut by *Bam*HI.

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(b) Bacteria were then mixed with the recombinant plasmids. Those bacteria which had successfully taken up recombinant plasmids were identified using the following steps:

step 1 – the bacteria were spread onto culture plates containing nutrient agar and ampicillin and incubated to allow colonies to form

step 2 – some bacteria from each of the colonies growing on these plates were transferred to plates containing nutrient agar and tetracycline, as shown in Fig. 2.2.

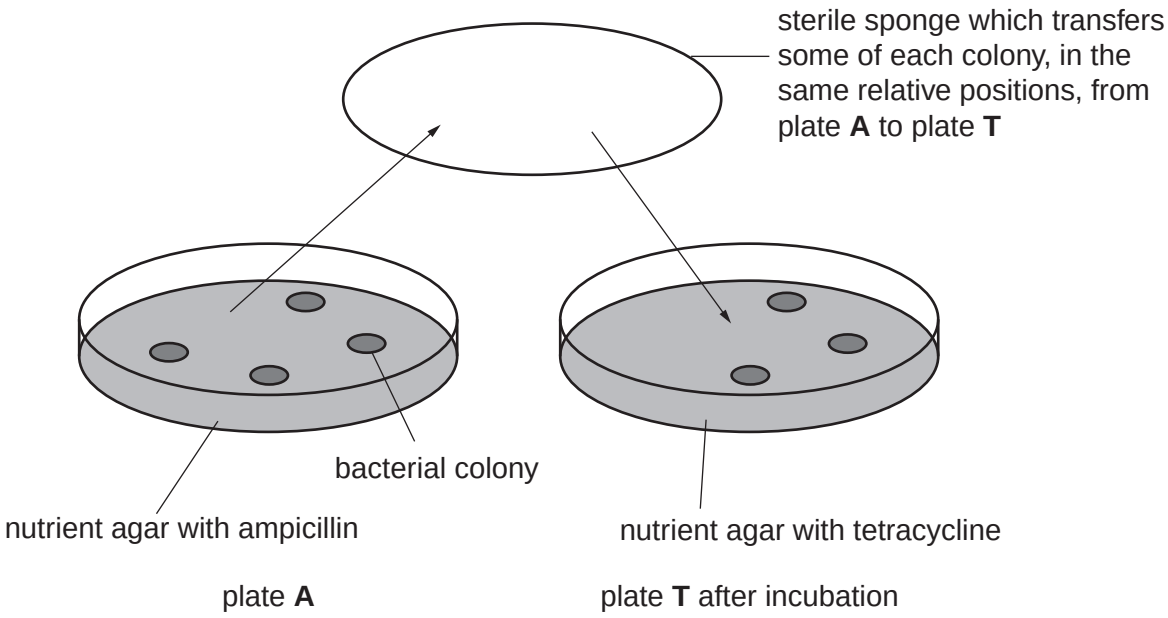

Fig. 2.2

(i) Explain why the bacteria were first spread onto plates containing ampicillin.

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(ii) Explain why it is important, for identifying bacteria that have successfully taken up the recombinant plasmid, that on pBR322 the target site for *Bam*HI is in the middle of the tetracycline resistance gene.

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(iii) Use a label line and the letter **C** to identify, on Fig. 2.2, a colony of bacteria that contain the recombinant plasmid.

Put your answer onto Fig. 2.2 on page 5. [1]

(c) Plasmid vectors carrying antibiotic resistance genes are now rarely used in gene technology.

(i) Explain why antibiotic resistance genes are now rarely used.

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(ii) State one type of gene that has replaced antibiotic resistance genes in plasmid vectors and indicate how its presence can be detected.

type of gene .....

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detection .....

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[Total: 15]

4 In humans, the gene *RPE65* encodes a protein responsible for regenerating visual pigment in rod and cone cells after they have been exposed to light. A recessive allele of this gene causes impaired vision from birth, progressing to complete blindness in early adulthood. This condition is called LCA.

In 2008, trials were carried out into the possibility and safety of treating LCA using gene therapy.

(a) Suggest and explain why LCA is suitable for treatment using gene therapy.

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(b) Six adults with this condition were used in the study. Genetically modified adenoviruses (a type of virus that can cause respiratory infections) were used as vectors. The vectors were injected beneath the retina of one eye of each of the participants.

Suggest two ways in which the genome of the adenoviruses used as vectors would differ from that of normal adenoviruses.

1. .....

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2. .....

..... [2]

(c) Improvements were found in the vision of all the participants, but the small number in the trials made most of these improvements not statistically significant.

Suggest why these trials were designed to include such a small number of participants.

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[Total: 7]

5 Insulin can be produced on a large scale using gene technology and prokaryotes such as *Escherichia coli.*

Table 7.1 summarises the sequence of steps in one method of production of insulin by *E. coli.*

Complete Table 7.1 by adding one statement in each of the empty boxes.

Table 7.1

step	reason for step
obtain copies of gene with sticky ends	the gene codes for the synthesis of insulin
	acts as a vector for the transfer of the gene into the host
use restriction endonuclease enzyme	
mix vector and gene	
	to seal the sugar-phosphate backbone
	to obtain transformed host *E. coli* cells
screen for, and obtain, successfully transformed cells	
	to obtain large amounts of insulin for extraction and purification

[7]

[Total: 7]