

# Genetic technology applied to medicine

## Question Paper 4

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 4

Time Allowed : 74 minutes

Score : / 61

Percentage : /100

Grade Boundaries:

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

- 1 (a) The steps involved in a method of production of human insulin by gene technology are listed in Table 5.1.  
The steps are **not** listed in the correct order.

**Table 5.1**

step	description
<b>A</b>	DNA coding for human insulin inserted into cut plasmid vector
<b>B</b>	genetically modified bacteria identified
<b>C</b>	mRNA for human insulin isolated in $\beta$ cells
<b>D</b>	plasmid vector inserted into bacterium
<b>E</b>	genetically modified bacteria cloned
<b>F</b>	DNA for human insulin cloned
<b>G</b>	human insulin harvested
<b>H</b>	cDNA coding for human insulin synthesised

- (i) Complete Table 5.2 to show the steps in the correct order.

Two of the steps have been done for you.

**Table 5.2**

correct order	letter of step
1	<b>C</b>
2	
3	
4	
5	<b>D</b>
6	
7	
8	

[4]

- (ii) Name the enzymes responsible for the following steps:

**step A** .....

**step H** .....

[2]

- (b) Explain **two** advantages of treating diabetes with human insulin produced by gene technology rather than using insulin from animals.

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[2]

[Total: 8]



- 2 The secretion of insulin by the islets of Langerhans in the pancreas stimulates the liver to reduce the blood glucose concentration.

(a) Describe how the **liver** reduces blood glucose concentration, when insulin is secreted.

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(b) Almost all insulin used to treat type I diabetes is produced by genetically engineered bacteria or yeast. A summary of this procedure is shown in Fig. 4.1.

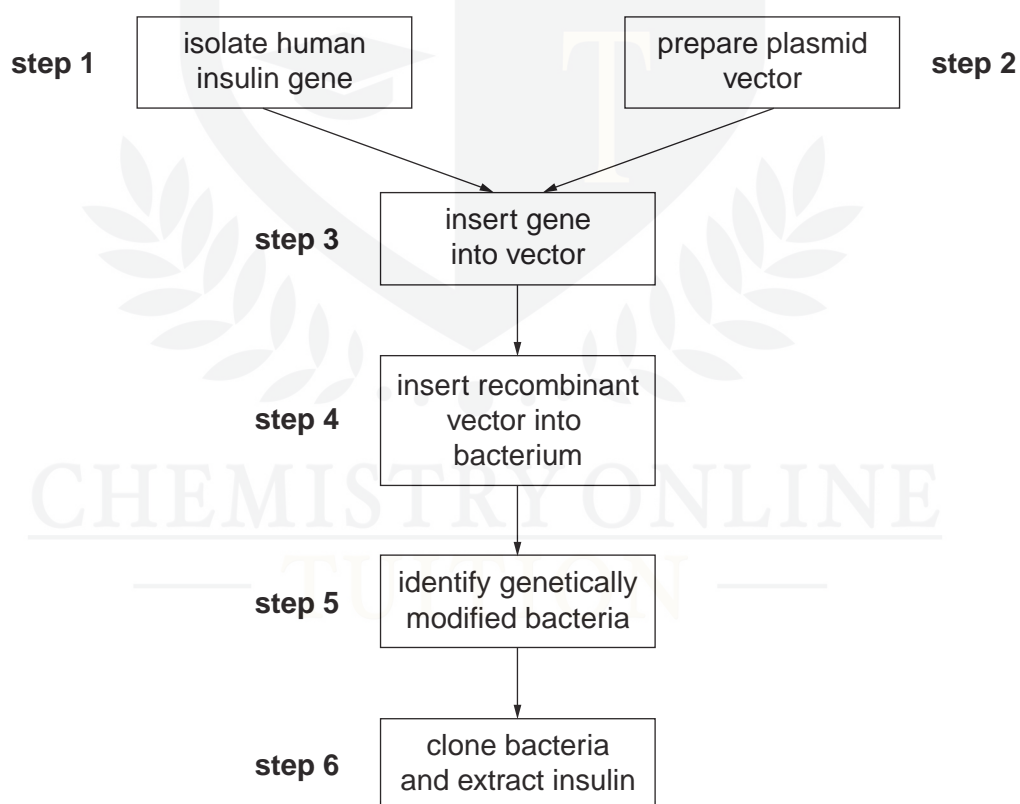


Fig. 4.1

- (i) One way of carrying out **step 1** is to collect mRNA from  $\beta$  cells from the pancreas. The relevant mRNA is then isolated and used to make DNA.

Suggest why isolating the mRNA coding for insulin in a  $\beta$  cell is easier than isolating the DNA for insulin in a  $\beta$  cell.

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..... [2]

- (ii) Outline the use of restriction enzymes in **step 2**.

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..... [2]

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- (c) Most people with type I diabetes inject insulin. A recent product contains insulin that can be administered using a nasal spray. The spray is inhaled and the insulin is taken up through the lungs.

Fig. 4.2 shows the concentration of insulin in the blood plasma in the 480 minutes after injecting or inhaling insulin. In both cases, the insulin was of the same type, obtained from genetically engineered *Escherichia coli*.

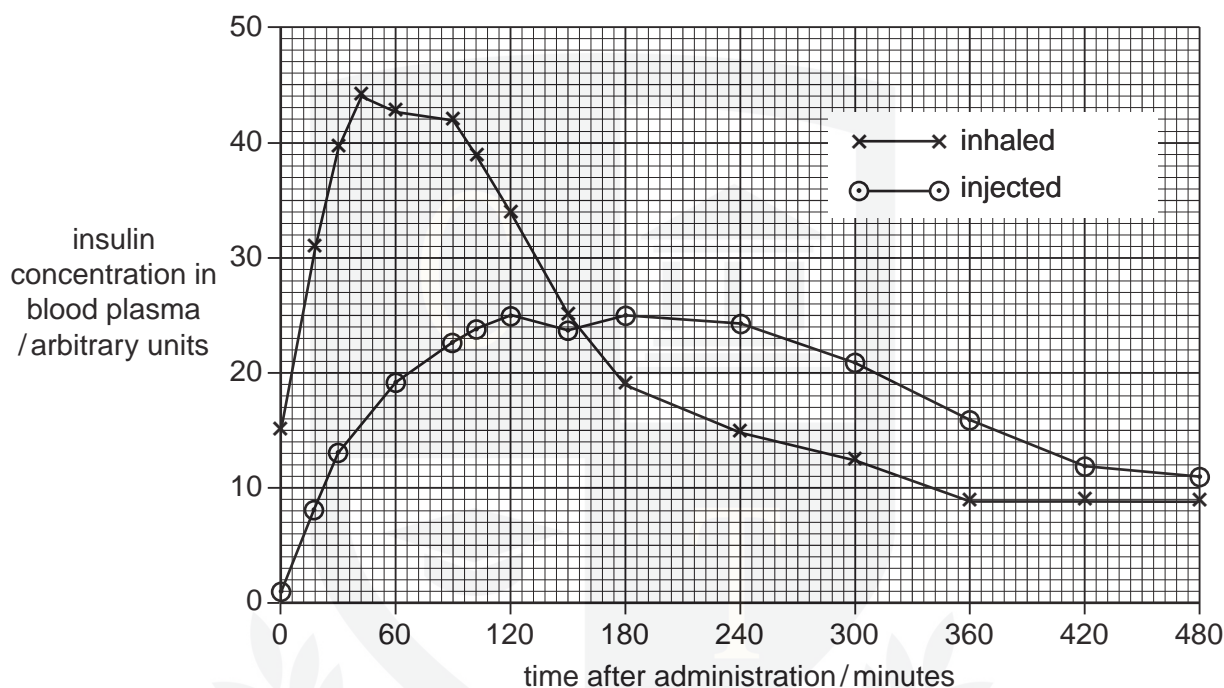


Fig. 4.2

Fig. 4.3 shows the concentration of glucose in the blood plasma in the 480 minutes after injecting or inhaling insulin.

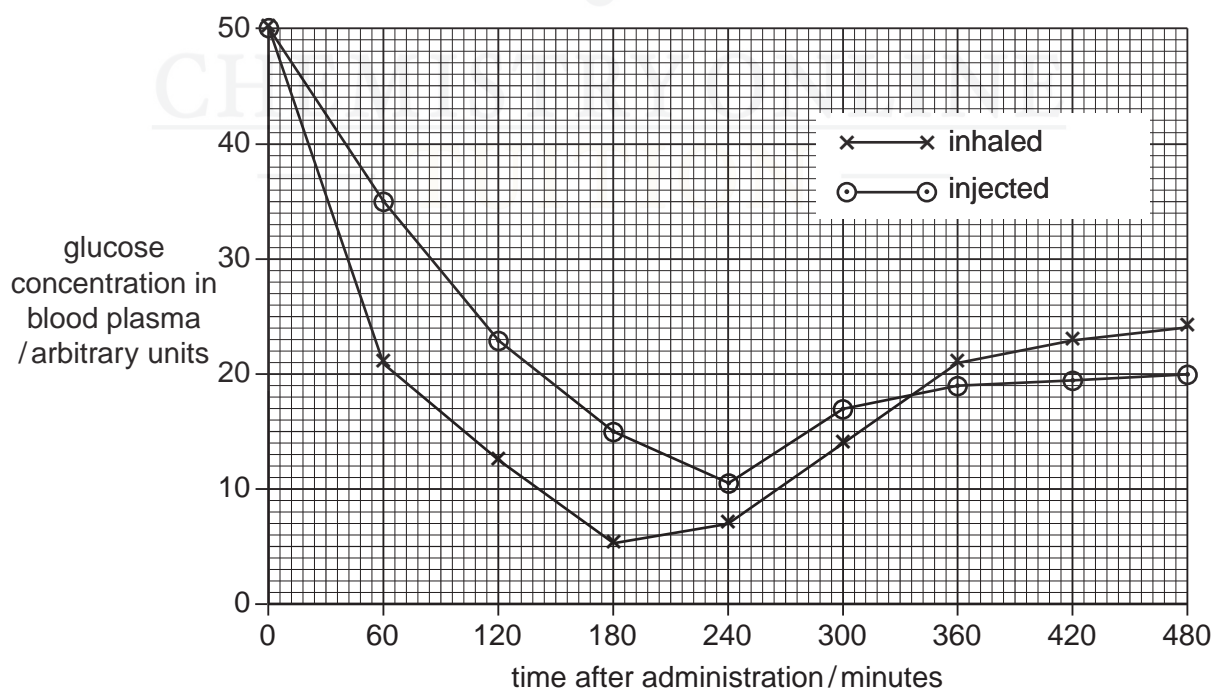


Fig. 4.3

- (i) Compare the results for injected insulin and inhaled insulin shown in Fig. 4.2.

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- (ii) With reference to Fig. 4.2, explain the differences in the blood glucose levels after injecting or inhaling insulin shown in Fig. 4.3.

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- (iii) With reference to Figs. 4.2 and 4.3, suggest one advantage and one disadvantage of inhaling insulin rather than injecting it.

*advantage* .....

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*disadvantage* .....

..... [2]

[Total: 15]

3 Many attempts have been made to find methods of using gene therapy to treat cystic fibrosis. One approach uses viruses to deliver normal alleles of the CFTR gene into epithelial cells of the airways. Viral delivery systems have two main problems:

- The virus may trigger an immune response which destroys the infected cells.
- Most non-pathogenic viruses are not very good at getting into cells, so very few cells receive the allele.

A team of researchers in the USA developed a new strain (AAV2.5T) of AAV, a non-pathogenic virus. AAV2.5T has an improved ability to bind with epithelial cells of the airways. Genes for the CFTR protein and for an enzyme, luciferase, were added to the DNA of the viruses. Luciferase produces a fluorescent green protein when luciferin is added.

The normal AAV strain and the AAV2.5T strain were added to cultures of epithelial cells from the airways. After adding luciferin, the numbers of cells that had taken up the viral genes was estimated using the intensity of the green fluorescence which developed.

The results are shown in Fig. 5.1.

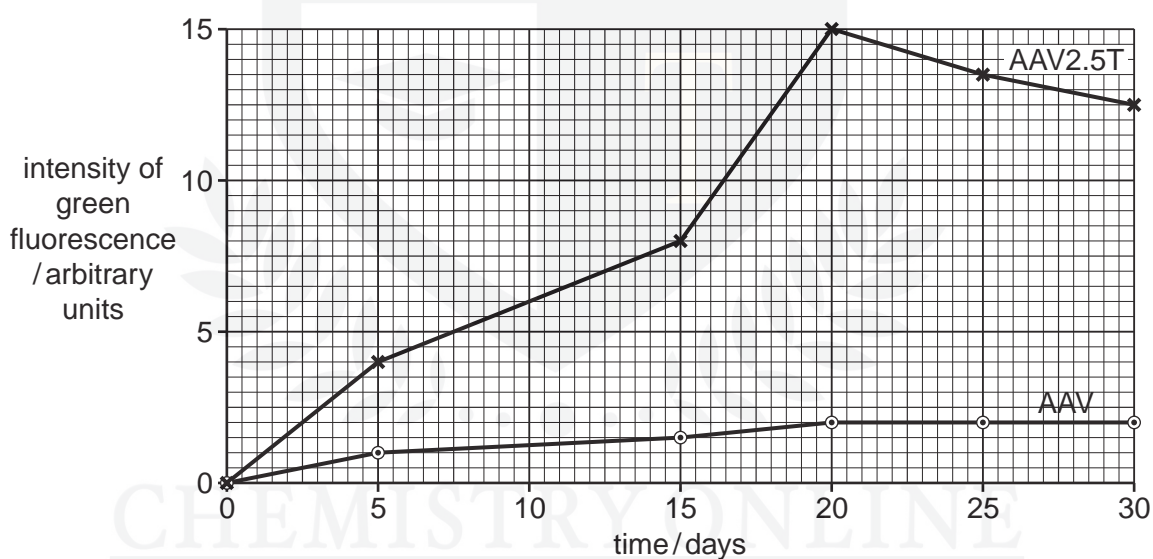


Fig. 5.1

(a) With reference to Fig. 5.1, compare the ability of the two viral strains, AAV and AAV2.5T, to infect epithelial cells from the airways.

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**(b)** Explain why the researchers added a gene for luciferase to the viral DNA.

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**(c)** Suggest how delivering normal alleles of the CFTR gene into epithelial cells in the airways could relieve the symptoms of cystic fibrosis.

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..... [4]

[Total: 8]

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- 5** When preparing infertile women for in-vitro fertilisation (IVF), it is necessary to stimulate the growth and maturation of several ovarian follicles. This is done by giving daily injections of the glycoprotein hormone, follicle stimulating hormone (FSH).

Each molecule of FSH has quaternary structure and consists of two different polypeptide chains,  $\alpha$  and  $\beta$ .

- (a)** Explain what is meant by *quaternary structure*.

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..... [1]

- (b)** Human FSH can be extracted from women's urine (u-hFSH). A procedure involving the use of monoclonal antibodies is used to produce purified u-hFSH.

Suggest how monoclonal antibodies can be used to obtain purified u-hFSH from urine.

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- (c)** Recombinant human FSH (r-hFSH) can be produced by adding the genes coding for the  $\alpha$  and  $\beta$  polypeptide chains of FSH to mammalian ovary cells.

Suggest why mammalian cells are needed to produce r-hFSH, rather than bacterial cells.

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..... [1]

- (d) In IVF treatment, a second hormone, human chorionic gonadotrophin (hCG) is injected when mature ovarian follicles (Graafian follicles) have developed.

Draw a **labelled** diagram to show the structure of a mature ovarian follicle.



[3]

- (e) The effectiveness of r-hFSH was compared with that of u-hFSH. Women starting IVF treatment were randomly divided into two groups and given **either** r-hFSH **or** u-hFSH.

The differences between the two groups of women after FSH treatment are shown in Table 2.1.

### Table 2.1

	women receiving r-hFSH	women receiving u-hFSH
number of women	119	102
mean number of mature follicles per woman	13	8
concentration of oestrogen in the blood/nmol dm <sup>-3</sup>	6.55	3.95

- (i) With reference to Table 2.1, compare the effects of treatment with r-hFSH and u-hFSH **and** suggest explanations for the differences.

  
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- (ii) The probability of the results for the mean number of mature follicles per woman occurring by chance is  $< 0.002$ .

Explain what is meant by this probability.

..... [2]