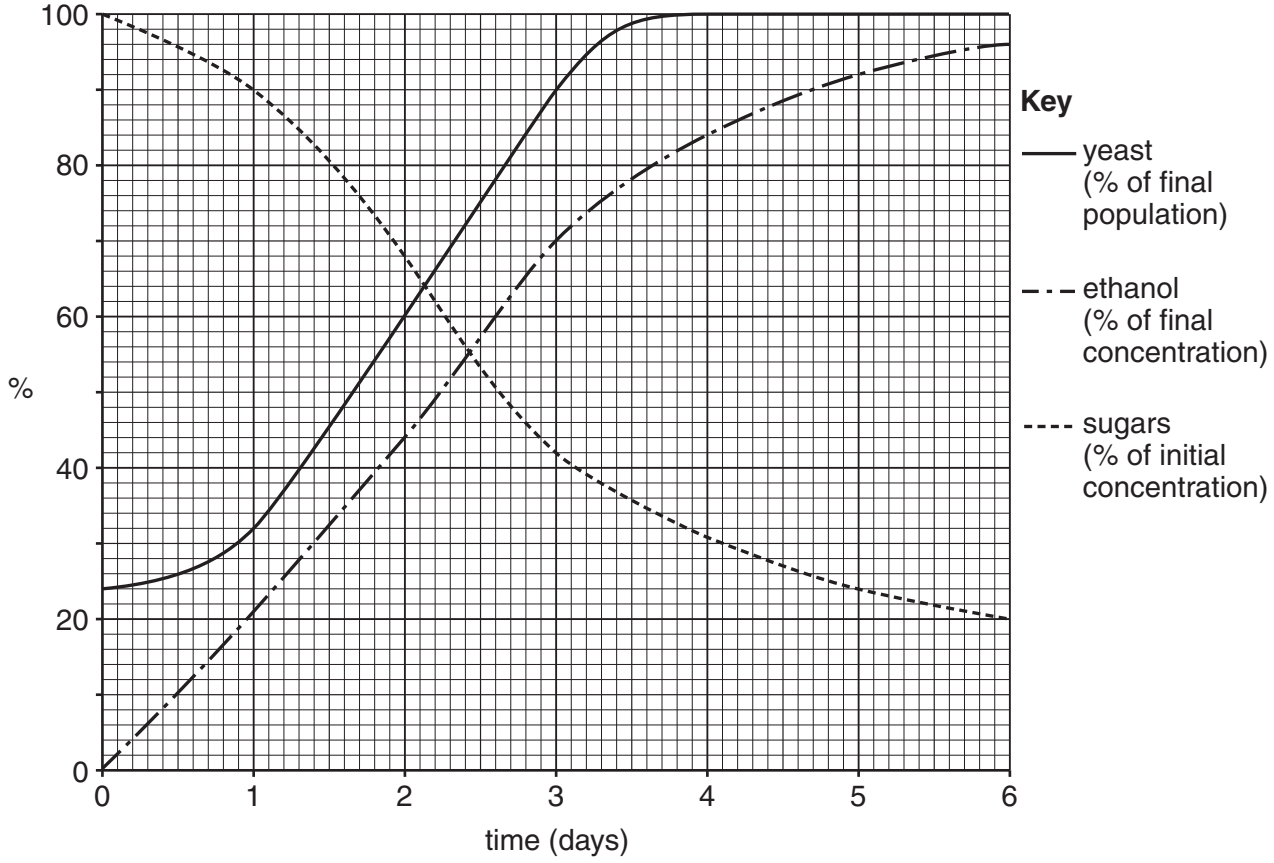

Fig. 5.1(a)

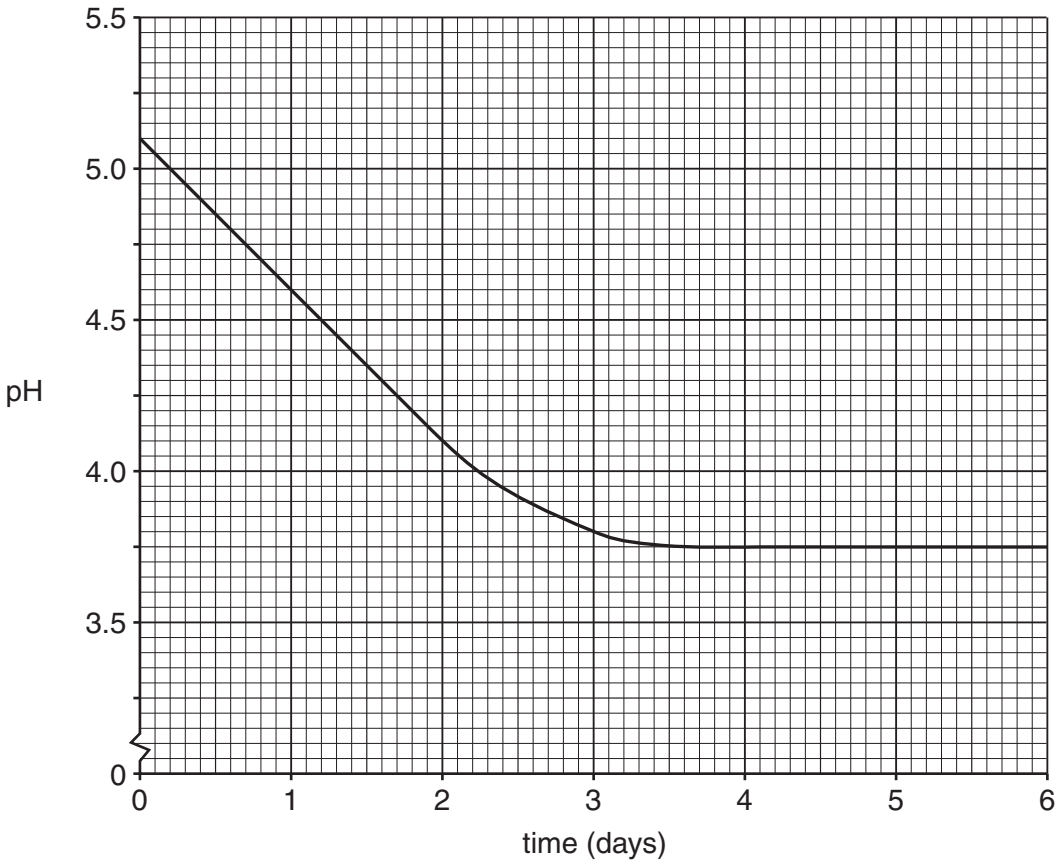

Fig. 5.1(b)

1 A batch fermenter is used during the production of beer.

Fig. 5.1(a) and Fig. 5.1(b), **on the insert**, show some changes that take place in the fermenter over the first 6 days.

(a) (i) Describe the pattern of growth of the yeast population in this fermenter.

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..... **[4]**

(ii) Fig. 5.1(a) shows that as the sugar concentration decreases the ethanol concentration increases.

Explain this relationship.

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..... **[3]**

(iii) Using the information from Fig. 5.1(a), explain why ethanol is considered to be a primary metabolite of yeast.

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..... **[1]**

(iv) Using only the information from Fig. 5.1(a) and Fig. 5.1(b), outline how **two** factors may limit the maximum size of the yeast population.

1 .....

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2 .....

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[2]

(b) A mixture of three sugars is added to the batch fermenter at the beginning of the process:

- the monosaccharide glucose, which the yeast uses up first, during days 0 to 2
- the disaccharide maltose, which is used during days 1 to 5
- the trisaccharide maltotriose, which is used during days 4 to 6.

Suggest why the yeast uses the sugars in this order.

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..... **[3]**

(c) Ethanol is an important chemical that is manufactured on a large scale.

One large-scale process to produce ethanol uses biotechnology, with yeast acting on sugar in a fermenter.

Another large-scale process uses a chemical method instead of microorganisms. This method needs:

- ethene (obtained from oil)
- a high temperature of 300 °C
- high pressure steam.

Discuss the advantages and disadvantages of **using yeast** to make ethanol rather than using the chemical method.

In your answer you should give a balanced account of both the advantages and disadvantages.

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..... **[6]**

[Total: 19]

2 Enzyme immobilisation is an important technique in biotechnology.

Figs 1.1 and 1.2 show two stages in making a bioreactor to remove lactose sugar from milk.

In Fig. 1.1 the enzyme lactase is immobilised in alginate beads.

In Fig. 1.2 milk flows over the beads and the lactose sugar is hydrolysed to two other sugars.

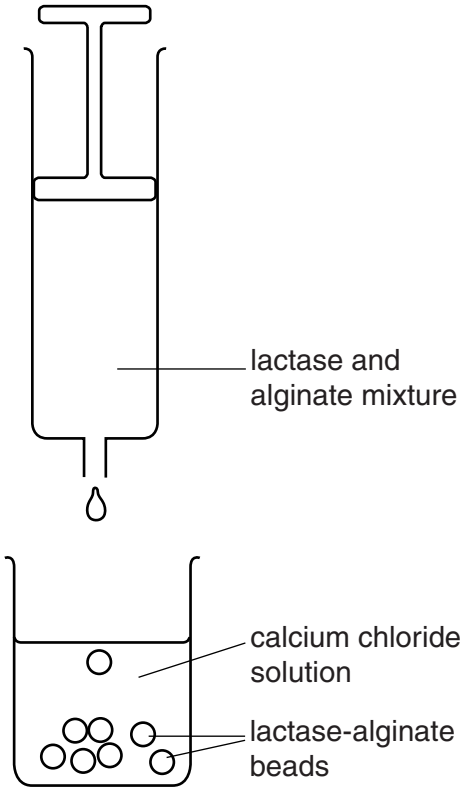

Fig. 1.1

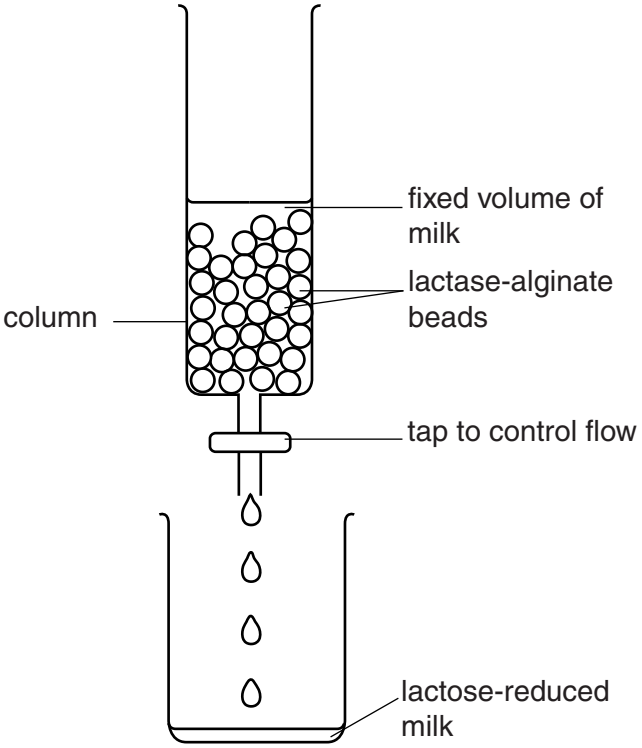

Fig. 1.2

(a) Suggest **and** explain how you might use the method shown in Fig. 1.2 to obtain milk that was **lactose-free**.

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..... **[2]**

(b) (i) Fig. 1.1 and Fig. 1.2 show that alginate beads can be used to immobilise an enzyme.

Outline **two other** methods of immobilising enzymes.

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..... **[2]**

(ii) Enzyme immobilisation is used in the biotechnology industry for the large-scale production of materials.

Discuss the benefits of using immobilised enzymes for large-scale production.

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[Total: 8]

3 Microorganisms are often used in biotechnological processes.

Fig. 6.1 shows the standard growth curve for a culture of bacteria.

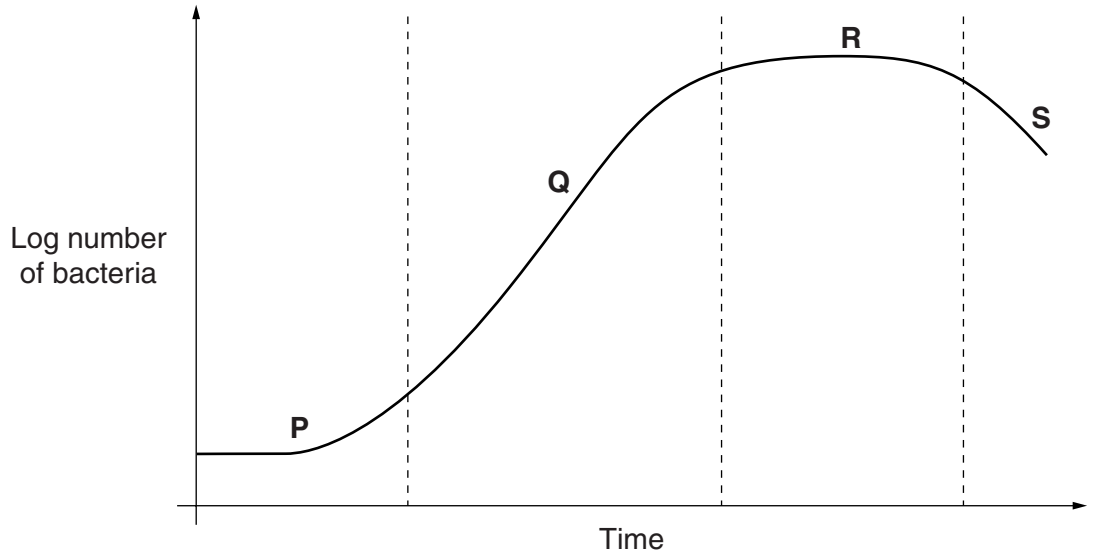

Fig. 6.1

(a) Identify the phases labelled **P**, **Q** and **R** in Fig. 6.1.

P .....

Q .....

R .....

[3]

Metabolic processes taking place in bacteria grown in a batch culture produce primary and secondary metabolites.

(b) Explain what is meant by a primary metabolite.

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..... **[2]**

(c) With reference to the information in Fig. 6.1, state the phase or phases, **P**, **Q**, **R** or **S**, when

(i) primary metabolite production is at its highest **rate**;

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(ii) most secondary metabolites are produced;

..... **[1]**

(iii) the concentration of secondary metabolites reach a maximum.

..... **[1]**

(d) Some aerobic recombinant bacteria were grown in a fermenter. They synthesised the protein human growth hormone (HGH).

(i) Suggest **two** ways in which named factors inside the fermenter could be adjusted in order to maximise the yield of HGH.

1 .....

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2 .....

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[4]

(ii) HGH made in this way is given by injection to some children who have a genetic mutation. The mutation means that they do not produce enough HGH to enable them to grow at the normal rate.

Explain why injecting recombinant HGH in this way is **not** an example of gene therapy.

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[Total: 15]

4 **(a)** A number of new techniques for manipulating cells and genomes are now available, and it is hoped this manipulation will allow cures for diseases to be developed.

Five goals that scientists would like to achieve are described below and are listed **A** to **E**:

A producing large numbers of genetically identical 'model' transgenic mice that show symptoms of diabetes

B growing a replacement kidney identically tissue-matched to an individual patient

C obtaining replacement hearts from transgenic pigs, partially tissue-matched to humans

D genetically manipulating cells of one adult to cure a genetic disease in that individual

E altering a prokaryotic pathogen for use as a vaccine.

The names of the procedures corresponding to **four** of the five goals **A** to **E** are written below.

Match the correct letters to the names. **No letter should be used more than once**.

xenotransplantation .....

somatic gene therapy .....

non-reproductive cloning .....

animal reproductive cloning .....

[4]

(b) Table 7.1 shows four different combinations of techniques used to achieve goals **A** to **E**.

Write the letters **A, B, C, D or E** in the first column of the table to match each goal to the appropriate combination of techniques needed to achieve it.

Use each letter only once.

	Technique			
Goal	**Vector used to transfer genes**	**Embryonic stem cells manipulated**	**Non-embryonic stem cells manipulated**	**Tissue designed for use in a different species**
	✓	×		
	✓	✓	×	×
	×	✓		×
	✓	✓	×	✓
	✓	×	×	

[5]

Table 7.1

[Total: 9]

5 Transgenic goats, containing a gene from a spider that codes for spider web silk protein, have been produced by genetic modification. The silk protein can be harvested from the milk of the female transgenic goats.

Spider silk protein is lightweight but has very high tensile strength. It is used to make items such as bullet-proof vests.

(a) A vector containing recombinant DNA is needed to produce transgenic goats.

Define the term *recombinant DNA*.

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..... **[1]**

(b) Complete Table 3.1 by suggesting **one** example of a suitable vector for each of the following applications of genetic modification.

Table 3.1

application of genetic modification	suitable vector
goats making spider silk protein	
somatic gene therapy for a recessive human genetic disorder	
plants that express a bacterial toxin that kills insects feeding on them	
bacteria that produce a human protein for therapeutic use	

[4]

(c) In order to make spider silk protein on a commercial basis, many transgenic goats will be needed.

Outline the process by which an animal, such as the first transgenic goat, may be cloned to produce a population.

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..... **[5]**

(d) An alternative method for producing a population of more transgenic goats is to breed the transgenic goat with normal goats.

Discuss the advantages **and** disadvantages of cloning the transgenic goat compared with breeding the transgenic goat with normal goats.

advantages .....

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disadvantages.....

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..... **[5]**

[Total: 15]