Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

STEM | Exam Builder

Biotechnology and genetic modification

Time allowed: 1 hour 35 minutes

Subject code **0610**

Biology

Questions from Paper 3 and Paper 4

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 97

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 10 questions worth 97 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1 Complete the sentences about genetic engineering.

Use words from the list.

Each word may be used once, more than once, or not at all.

adding **bacteria** **crops** **family** **insects**

minerals **organism** **removing** **viruses**

vitamin **weeds**

In genetic engineering the genetic material of an ..... is changed by ..... , changing or inserting individual genes.

An example of this is inserting a human gene into ..... so that they produce human insulin.

Crop plants have genes inserted into them to make them resistant to herbicides.

Herbicides kill ..... .

Crop plants can also be genetically engineered by inserting a gene so that they produce a ..... which is a nutrient needed by humans in very small amounts.

[5]

Genetic modification Click for more variations

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1	organism ; removing ; bacteria ; weeds ; vitamin ;	**5**

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2 The development of biological washing powders using enzymes from bacteria is an example of biotechnology.

(a) State **two** reasons why bacteria are useful in biotechnology, such as in the development of biological washing powders.

1 .....

.....

2 .....

.....

[2]

(b) Fig. 7.1 shows part of a label taken from a packet of '5 Star Bio' washing powder.

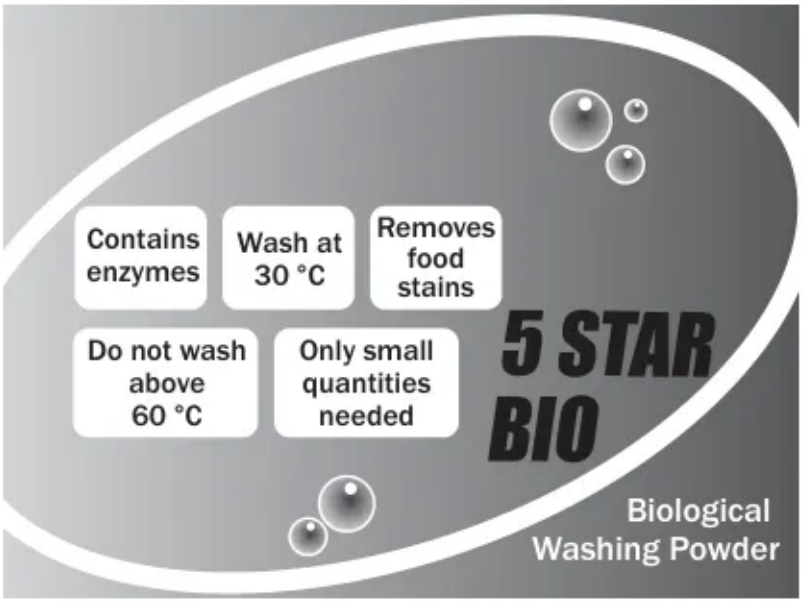


Fig. 7.1

Use the information shown in Fig. 7.1 to:

(i) explain how this washing powder removes food stains

.....

.....

.....

.....

.....[2]

(ii) explain why the manufacturer recommends washing at 30 °C and not above 60 °C

.....

.....

.....

.....

.....[2]

(iii) suggest why only small quantities of washing powder are needed to wash a large quantity of clothes.

.....

.....[1]

(c) Name an enzyme that could be used to remove fat stains from clothing.

.....[1]

[Total: 8]

Biotechnology: bacteria, yeast, enzymes and fermenters Click for more variations

Reduced to 78% to fit the page (wider than A4).

2 **(a)**	rapid reproduction ; can make complex molecules ; cheaper to produce ;	[max 2]	
(b) (i)	(contain) enzymes; break down / digests food molecules (in stain);	[2]	
(ii)	at high temperature enzymes, do not function / inactive / destroyed ; enzymes more active at 30°C ; AVP ;	[max 2]	**A** denatured **R** enzymes die / killed **A** optimum temperature is 30°C e.g. 60°C uses more energy than 30°C
(iii)	enzymes are catalysts / not used up in the reaction ;	[1]	
(c)	lipase ;	[1]	
		[Total: 8]	

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3 Biotechnology is used in the process of bread-making.

Fig. 1.1 shows some of the steps in making bread.

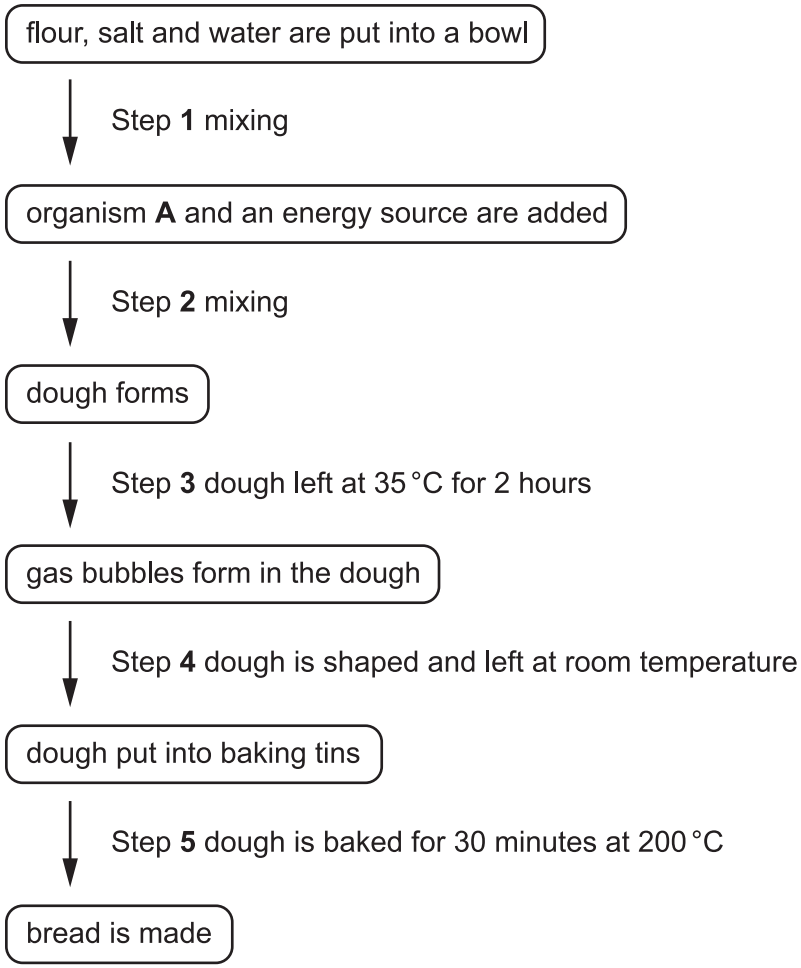


Fig. 1.1

(a) State the name of organism **A** in Fig. 1.1.

..... [1]

(b) **(i)** State the name of the source of energy used by organism **A**.

..... [1]

(ii) State the name of the process that occurs at step **3** that causes gas bubbles to form in the dough.

..... [1]

(iii) State the name of the gas that forms to create the gas bubbles in the dough.

..... [1]

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(c) Explain the reasons for the different temperatures used in step **3** and step **5**.

.....

.....

.....

.....

..... [2]

(d) State the name of **two** products of biotechnology, other than bread, that make use of microorganisms.

1 .....

2 .....
[2]

[Total: 8]

Biotechnology: bacteria, yeast, enzymes and fermenters Click for more variations

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3(a)	yeast **;**	**1**	
3(b)(i)	flour / starch / sugar / glucose / sucrose / carbohydrate **;**	**1**	
3(b)(ii)	respiration **;**	**1**	
3(b)(iii)	carbon dioxide **;**	**1**	
3(c)	*step 3 / 35 °C / low(er) temperature:* optimum / best / suitable / AW, temperature for, respiration / enzymes / gas production **;** to allow the dough to, rise / expand / AW **;** *step 5 / 200 °C / high(er) temperature* organism **A** / microorganisms / yeast, killed / enzymes denature **;** to cook the dough **;** to allow ethanol to evaporate **;**	**2**	
3(d)	biofuels **;** wine / beer, making **;** penicillin / antibiotic (production) **;** AVP **;;**	**2**	

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4 **(a)** **(i)** State **two** reasons why bacteria are useful in genetic modification and biotechnology.

1 .....

2 .....

[2]

(ii) Describe the ways in which genetic modification can improve crop plants.

.....

.....

.....

.....

.....

.....

..... [3]

(b) Scientists investigated two enzymes that could be used in washing powders.

The activity of each enzyme was measured at pH values between 2 and 10.

Fig. 7.1 shows the results of the investigation.

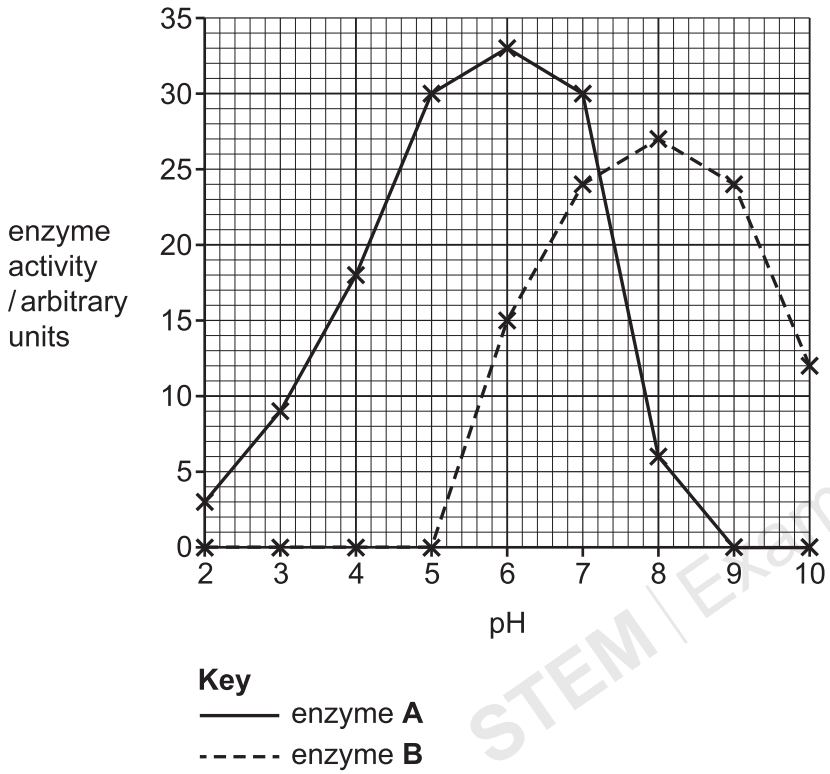


Fig. 7.1

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(i) The list shows six conclusions.

Tick (✓) the conclusions that can be made from the data shown in Fig. 7.1.

At pH 10, enzyme **B** is more active than enzyme **A**.	
Enzyme **A** and enzyme **B** are **not** active at pH 4.	
Enzyme **B** has a greater maximum activity than enzyme **A**.	
Enzyme **A** has a maximum activity of 33 arbitrary units.	
Enzyme **A** shows activity over a pH range of 6 to 10.	
The largest difference in activity between enzyme **A** and enzyme **B** is at pH 5.	

[3]

(ii) Many washing powders have a pH of approximately 9.

Identify the best enzyme, **A** or **B**, to use in these washing powders.

Give **one** reason for your choice.

enzyme .....

reason .....

.....

.....

[1]

[Total: 9]

Enzymes Click for more variations

STEM | Exam Builder

4(a)(i)	*any two from:* rapid reproduction rate ; ability to make complex molecules ; **AVP** ;	**2**	e.g.no / low, ethical concerns
4(a)(ii)	*any three from:* to confer resistance to herbicides ; confer resistance to, insect / pests ; to increase, yield / product ; to improve nutritional qualities ; **AVP** ;;	**3**	e.g. confer resistance to pathogens / stress tolerance (drought or extreme temperatures) / increase shelf life

4(b)(i)	At pH 10, enzyme **B** is more active than enzyme **A**. ✓ ; Enzyme **A** and enzyme **B** are **not** active at pH 4. Enzyme **B** has a greater maximum activity than enzyme **A**. Enzyme **A** has a maximum activity of 33 arbitrary units. ✓ ; Enzyme **A** shows activity over a pH range of 6 to 10. The largest difference in activity between enzyme **A** and enzyme **B** is at pH 5. ✓ ;	**3**	**R** each additional tick
4(b)(ii)	(enzyme) B ***and*** *idea of* only enzyme **B** is active at pH 9 / optimum of enzyme **B** is closer to pH 9 / AW ;	**1**	

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5 **(a)** Define the term *genetic engineering*.

.....

.....

.....

.....

.....[2]

(b) **(i)** Outline why bacteria are useful in genetic engineering.

.....

.....

.....

.....

.....[2]

(ii) Table 6.1 contains six statements about biological processes. Only **two** of these use genetic engineering. Identify these two processes. Place a tick in the box (✓) next to your choices.

Table 6.1

statement	uses genetic engineering
producing fruit juice using pectinase	
introducing genes into crop plants to provide additional vitamins	
selective breeding to produce organisms with desirable features	
placing a section of DNA into bacteria to produce human insulin	
using yeast to produce ethanol	
using a contraceptive implant as a method of birth control	

[2]

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(c) Scientists have used genetic engineering to develop crop plants which are resistant to herbicides.

(i) Explain why farmers use herbicides.

.....

.....

.....

.....

.....[2]

(ii) A field contains genetically modified crop plants which are resistant to herbicides. It also contains some weeds. The plants are sprayed with herbicides.

State how the herbicide affects:

the weeds

.....

.....

the crop plants.

.....

.....
[2]

[Total: 10]

Genetic modification Click for more variations

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<table>
<tr><td>5 (a)</td><td>Change the genetic material (of an organism) ;
By removing / changing / inserting (individual) genes ;
From one organism / species to another ;</td><td>[max 2]</td><td></td></tr>
<tr><td>(b) (i)</td><td>rapid reproduction ;
can make complex molecules ;
cheaper to produce ;
ref. to no ethical issues ;</td><td>[max 2]</td><td></td></tr>
<tr><td>(ii)</td><td><table><tr><th>statement</th><th>uses genetic engineering?</th></tr><tr><td>producing fruit juice using pectinase</td><td></td></tr><tr><td>introducing genes into crop plants to provide additional vitamins</td><td>✓ ;</td></tr><tr><td>selective breeding to produce organisms with desirable features</td><td></td></tr><tr><td>placing a section of DNA into bacteria to produce human insulin</td><td>✓ ;</td></tr><tr><td>using yeast to produce ethanol</td><td></td></tr><tr><td>the use of contraceptive implants in birth control</td><td></td></tr></table></td><td>[2]</td><td>3 ticks–deduct 1 mark
4, 5 or 6 ticks = 0 marks</td></tr>
<tr><td>(c) (i)</td><td>to kill weeds;
to reduce competition, with weeds / for resources;
to increase crop yield;</td><td>[max 2]</td><td></td></tr>
<tr><td>(ii)</td><td>(the weeds) kills them AW ;
(the crop plants)no effect / does not kill them ;</td><td>[2]</td><td></td></tr>
<tr><td></td><td></td><td>[Total: 10]</td><td></td></tr>
</table>

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6 **(a)** Starch, glucose and fructose are carbohydrates. Fructose syrup is used as a sweetening agent as an alternative to sucrose.

The flow chart in Fig. 3.1 shows how fructose is prepared from maize starch.

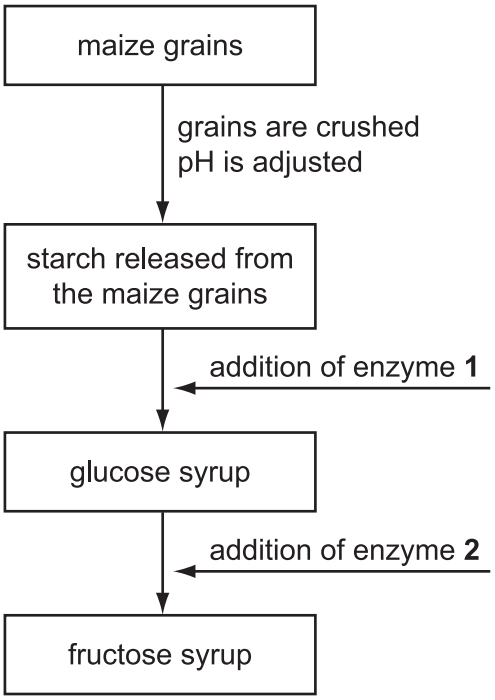


Fig. 3.1

(i) Name enzyme **1**.

.....

[1]

(ii) State why it is necessary to adjust the pH before an enzyme is added to the process.

.....

.....

[1]

(b) Maize grains contain protease enzymes. With reference to the processes shown in Fig. 3.1, suggest why it is important that these enzymes do not contaminate the glucose syrup.

.....

.....

[1]

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(c) The formation of fructose syrup from glucose syrup is carried out at a temperature of 60 °C.

Suggest an important property of enzyme **2** that allows it to be used at temperatures as high as 60 °C.

.....

.....

..... [1]

(d) Enzyme **2** is found naturally in many bacteria. Enzymes for use in washing powders are obtained from bacteria.

Describe how bacteria are used to produce enzymes for washing powders.

.....

.....

.....

.....

.....

.....

..... [3]

(e) Pectinase is an enzyme that breaks down compounds known as pectins. Cell walls of fruits, such as apples and mangoes, contain pectins.

Explain the **advantages** of using pectinase in fruit juice production.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 10]

Biotechnology: bacteria, yeast, enzymes and fermenters Click for more variations

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6 (a) (i)		amylase ;	[1]	
(ii)		pH is a factor that influences / affects enzyme activity / AW; to give the optimum pH ; extreme pH could denature enzyme / **AW** ;	[max 1]	**ORA**
(b)		*idea that* protease , would break down, enzymes / enzyme 2 ;	[1]	
(c)		stable at high temperatures / does not denature at 60 °C / optimum temperature near 60 °C ;	[1]	I bears / tolerates hot temperatures I heat resistant I ref to denatures > 60 ºC
(d)	**1** **2** **3** **4** **5** **6** **7**	(bacteria grown in) fermenters ; (bacteria provided with) substrate / food (substances) / glucose / minerals / whey / waste substances / nutrients / culture medium / AW ; oxygen / aerobic conditions ; **A** air bubbled through (bacteria) grow / reproduce / increase in number ; enzymes, secreted / released / AW ; enzymes separated from, bacteria / mixture ; **A** ref to filtration AVP ; e.g. conditions – 26 °C / pH 5–6	[max 3]	**A** extracted by crushing bacteria
(e)		extracts more juice / speeds up juice extraction ; pectin converted to sugars ; so juice is sweeter ; cell wall material is removed from juice / pectin digested to soluble product(s) ; so the juice is clearer ; AVP; humans don't produce pectinase i.e. humans can digest the juice.	[max 3]	I easier…….
			[Total:10]	

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7 **(a)** Define the term *genetic engineering*.

.....

.....

.....

.....

.....[2]

(b) Fig. 6.1 is a flow diagram that shows how insulin can be produced using genetic engineering.

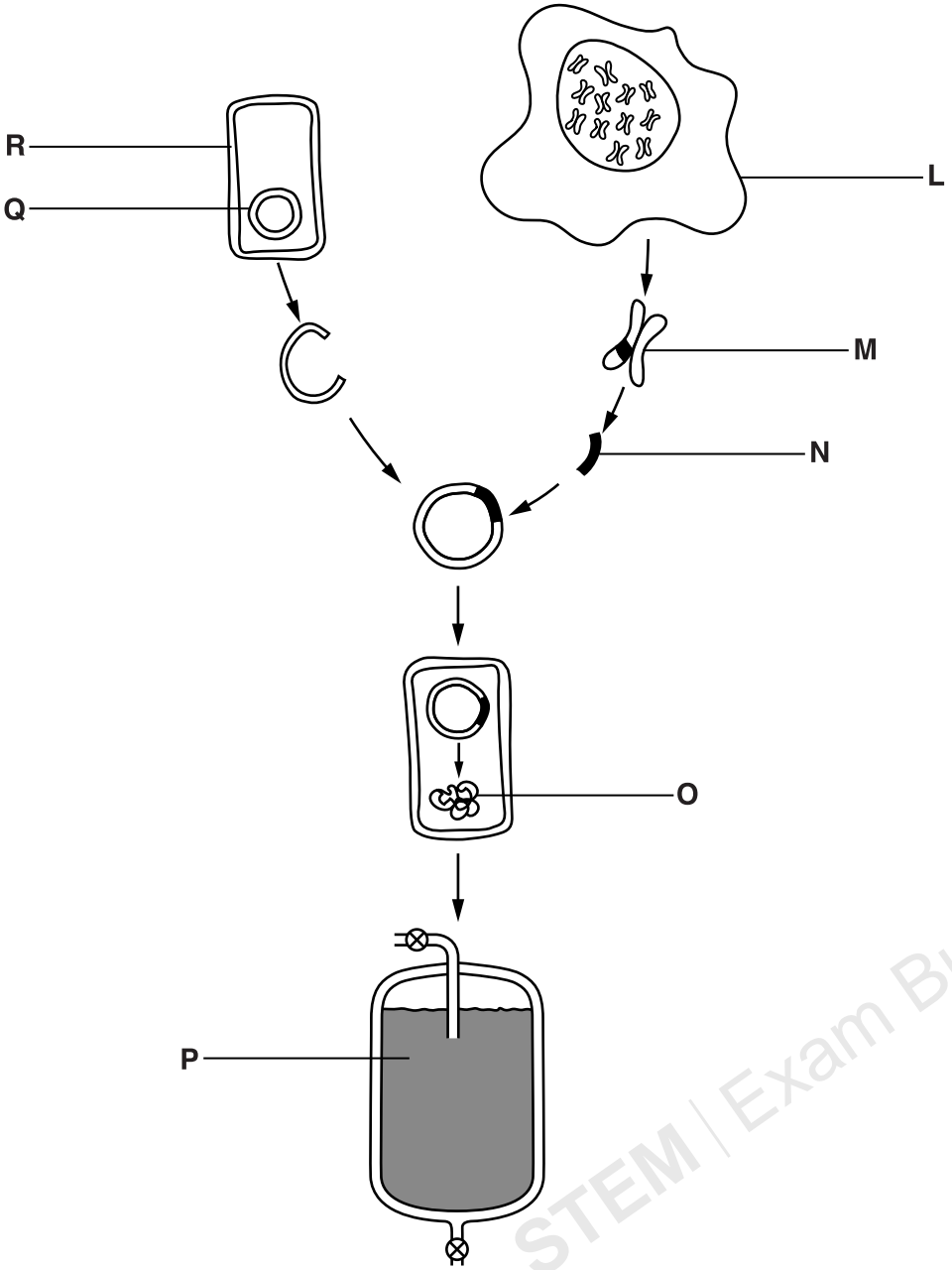


Fig. 6.1

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Table 6.1 shows stages in the production of insulin by genetic engineering.

Complete Table 6.1. The first row has been done for you.

Table 6.1

letter from Fig. 6.1	name	description
M	chromosomes	threads of DNA found in the nucleus
		section of DNA removed from human cell
	plasmid	
		type of cell that is genetically engineered
		specific chain of amino acids coded by the section of DNA removed from the human cell
	fermenter	

[5]

(c) The genetically engineered cells in Fig. 6.1 reproduce asexually.

Explain the advantages of asexual reproduction for insulin production by genetic engineering.

.....

.....

.....

.....

.....

.....

.....[3]

[Total: 10]

Asexual and sexual reproduction Click for more variations

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7 (a)

taking a, gene / DNA / allele, from one species ;
inserting it into another organism ;

OR

changing the, genetic material / chromosome of, an organism / cell ;
by removing / changing / inserting, genes / DNA / alleles ;

max [2]

(b)

Letter from fig	Name	Description
M	chromosomes	threads of DNA found in the nucleus
N	gene / allele ;	section of DNA removed from human cell
Q	plasmid	vector / loop / circle, of DNA (that can carry a foreign section of DNA) / separate piece of DNA (from chromosome) ;
R	bacterial (cell) ; **A** yeast	type of cell that is genetically engineered
O	insulin / protein ;	specific chain of amino acids coded by the section of DNA removed from the human cell
P	fermenter	(container in which) bacteria / microorganisms / cells, reproduce / grow / produce insulin ;

[5]

(c)

clone / (genetically) identical ;
rapid / less energy to reproduce (asexually) / only one parent / no gametes ;
large quantity of insulin produced ;
all bacteria, have the insulin gene / produce insulin ;
same insulin produced ;
once cells are engineered does not have to be repeated ;
AVP ; e.g. cheap / ethical *or* religious reasons / less allergic reaction / no immune rejection / more efficient / no risk of disease (transmission)

max [3]

A no variation

only accept in context of comparisons with animal insulin extraction methods

[Total: 10]

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8 Genetic engineering is an example of an important biotechnology.

(a) Complete the passage below by filling in each space with a suitable word.

DNA is a biological molecule found in the ..... of an animal cell. The sequence of the ..... in mRNA determines the order of the amino acids that will be assembled into a ..... .

When carrying out genetic engineering, sections of human DNA called ..... are cut using restriction enzymes. Next bacterial plasmids are cut with the ..... restriction enzymes to form complementary ..... ends.

The cut section of human DNA is inserted into the cut plasmid and they are joined together to form a ..... plasmid. These plasmids are inserted into ..... and replication occurs. This process is used to produce human ..... that is used to treat people with diabetes.

[9]

(b) In addition to genetic engineering, enzymes are also useful in other biotechnologies.

State **two** examples of how enzymes are used in another biotechnology.

1 .....

2 .....

[2]

[Total: 11]

Genetic modification Click for more variations

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8(a)	**1** nucleus / chromosome(s) ; **2** bases ; **3** protein ; **4** genes / alleles ; **5** same ; **6** sticky ; **7** recombinant ; **8** bacteria / vectors / viruses / yeast / (prokaryotic / host) cells ; **9** insulin ;	**9**	
8(b)	washing powders ; (pectinase) for (fruit) juice production ; (lactase) for lactose-free milk ; AVP ;	**2**	

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9 Cotton, *Gossypium hirsutum*, is grown for the fibres that form within the fruits after fertilisation, as shown in Fig. 3.1.

Fibres from the fruits of cotton plants are used in the textile industry.



Fig. 3.1

Cotton plants have been genetically engineered to produce a protein that is toxic to the caterpillars of several insect pests. This gives the cotton plants resistance to the pests.

The *cry* gene for pest resistance was isolated from the bacterium *Bacillus thuringiensis* and inserted into the cells of cotton plants as shown in Fig. 3.2.

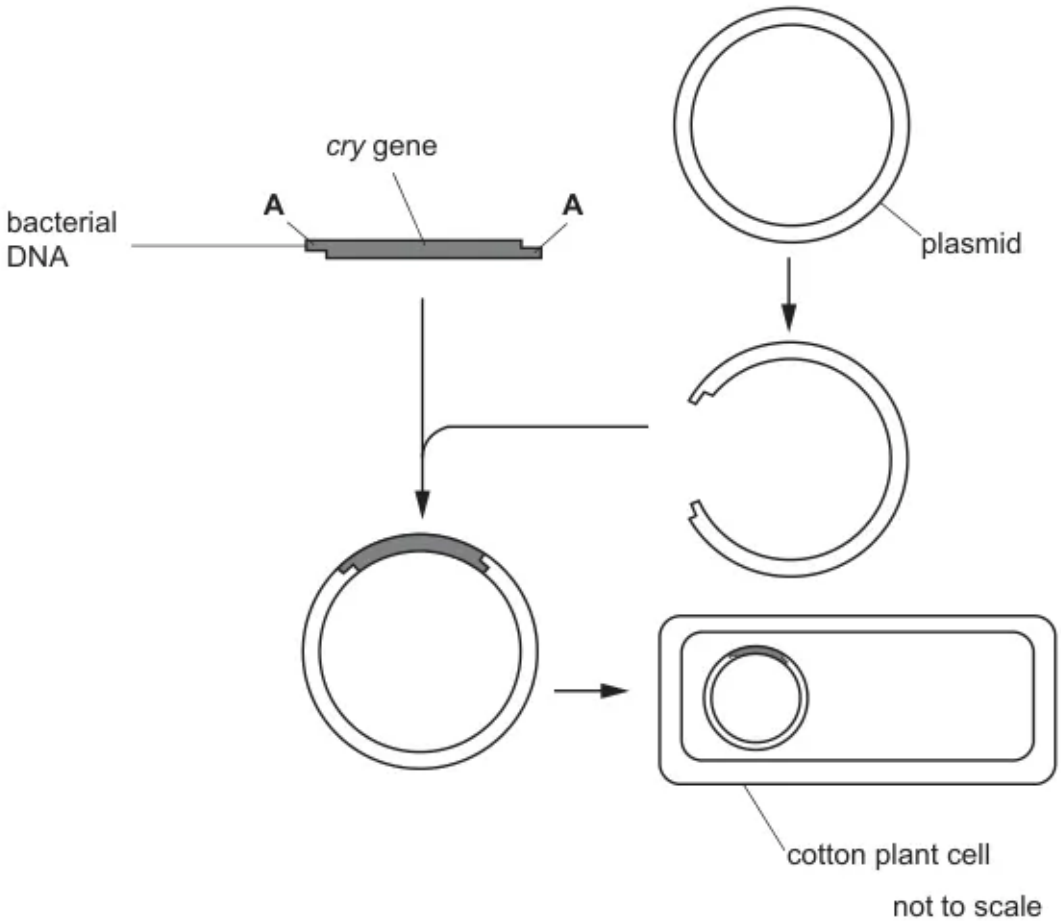


Fig. 3.2

(a) An enzyme cuts the *cry* gene from the DNA of *B. thuringiensis*.

(i) State the name of the enzyme that cuts DNA.

..... [1]

(ii) State the name of the regions labelled **A** on Fig. 3.2.

..... [1]

(iii) Explain how the DNA is inserted into the plasmid.

.....

.....

.....

.....

.....

..... [3]

(b) The plasmids containing the *cry* gene are inserted into the cells of cotton plants.

Outline how the cells of cotton plants use the *cry* gene to make the toxic protein.

.....

.....

.....

.....

.....

.....

.....

..... [4]

STEM | Exam

(c) Outline the advantages to farmers of growing genetically engineered cotton plants that contain the toxic protein.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 12]

Genetic modification Click for more variations

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9(a)(i)	restriction (enzyme) ;	**1**	
9(a)(ii)	sticky ends ;	**1**	
9(a)(iii)	plasmid is cut with the same (restriction) enzyme (as DNA) ; to form, sticky ends / region **A**, that are complementary to sticky ends of, gene / *cry* ; *reference to* base sequences (being complementary / AW) ; (DNA) ligase used to join plasmid and, *cry* / gene ; AVP ; e.g. formation of recombinant DNA / plasmid	**3**	
9(b)	gene / *cry*, codes for the sequence of amino acids in, (toxic) protein ; DNA / gene / *cry*, is copied / transcribed, to form mRNA ; *cry* / gene / DNA, remains in nucleus ; mRNA moves from nucleus to, cytoplasm / ribosome ; mRNA passes through ribosomes / AW ; ribosomes assemble amino acids (into protein molecules) ; ribosomes make proteins ; AVP ; e.g. order of amino acids determined by base sequence of, mRNA / DNA / gene	**4**	
9(c)	to kill / harm / deter, caterpillars / insects / pests ; higher yield / reduce losses due to, (certain) caterpillars / insects / pests ; higher quality of cotton ; use less insecticide ; (so) less pollution ; (so) less money spent on, insecticides / spraying ; (so) less risk to workers' health (from using insecticides) ; (so) less chance of insecticide resistance ; AVP ;	**3**	

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10 Penicillin is produced by biotechnology industries.

(a) (i) State the name of the type of pathogen penicillin is used to treat.

..... [1]

(ii) State the name of the group of medicinal drugs that includes penicillin.

..... [1]

(b) Fig. 1.1 is a flow diagram of some of the steps in the production of penicillin.

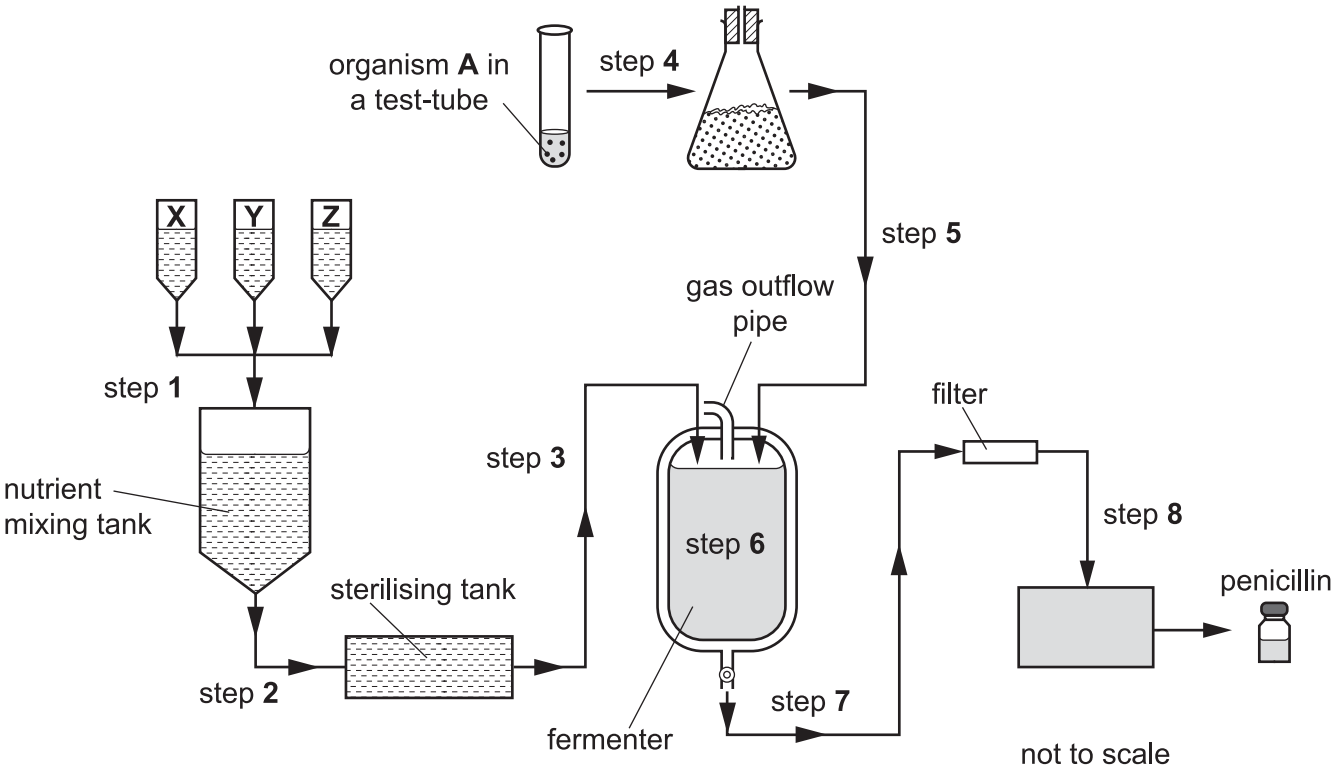


Fig. 1.1

(i) Organism **A** belongs to the fungus kingdom.

State **two** main features of fungal cells that are used to distinguish them from the cells of prokaryotes.

1 .....

2 .....

[2]

(ii) State the genus name of organism **A** in Fig. 1.1.

..... [1]

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(iii) Penicillin is produced in the fermenter shown in Fig. 1.1. A variety of nutrients, **X**, **Y** and **Z**, are mixed together and added to the fermenter in step **1**.

List **two** nutrients that need to be added to a fermenter to produce penicillin.

1 .....

2 .....

[2]

(iv) Explain why the nutrients are sterilised (step **2**) before they are added to the fermenter (step **3**).

.....

.....

..... [1]

(v) Explain why the fermenter has a gas outflow pipe.

.....

.....

.....

.....

..... [2]

(vi) Using the information in Fig. 1.1, outline the events occurring from step **4** to step **8** during the production of penicillin.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 14]

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Biotechnology: bacteria, yeast, enzymes and fermenters Click for more variations

10(a)(i)	bacteria **;**	**1**	
10(a)(ii)	antibiotic **;**	**1**	
10(b)(i)	*any two from:* nucleus **;** mitochondria **;** (r)ER **;** vacuole **;** AVP **;**	**2**	e.g., hyphae / structure of cell wall
10(b)(ii)	*Penicillium* **;**	**1**	
10(b)(iii)	*any two from:* glucose **;** ammonia / amino acids **;** (named mineral) salts **/** ions **;;** water **;**	**2**	
10(b)(iv)	stops the growth of microorganisms / AW **;**	**1**	**A** prevent contamination
10(b)(v)	*any two from:* release of, waste gas / carbon dioxide **;** (carbon dioxide / gas) is produced during fermentation / respiration **;** to prevent fermenter exploding / to reduce pressure **;** carbon dioxide is toxic (to fungus if it builds up) **;**	**2**	
10(b)(vi)	*any four from:* 1 (step 4) is reproduction (of **A** before adding to fermenter) **;** 2 (step 5) inoculation in a fermenter / AW **;** 3 (step 6) exponential growth (of organism **A** in fermenter) **;** 4 sampling to check when penicillin is ready ; 5 penicillin is, a byproduct of maximum growth / a toxin / fermentation **;** 6 (step 7) cells / product / penicillin, are removed ; 7 (step 8) purification / filtering / described ; 8 idea of packaging of penicillin ; 9 AVP **;**	**4**	**A** idea of adapting to environment **A** drying / AW e.g., batch cultures (described) / limited resources / stationary phase triggers production of penicillin

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