

# Chapter 20

## Biotechnology and genetic engineering

01. 0610\_p20\_qp\_40 Q: 5

Penicillin is an antibiotic produced by the fungus *Penicillium chrysogenum*.

Fig. 5.1 shows the process used to produce penicillin.

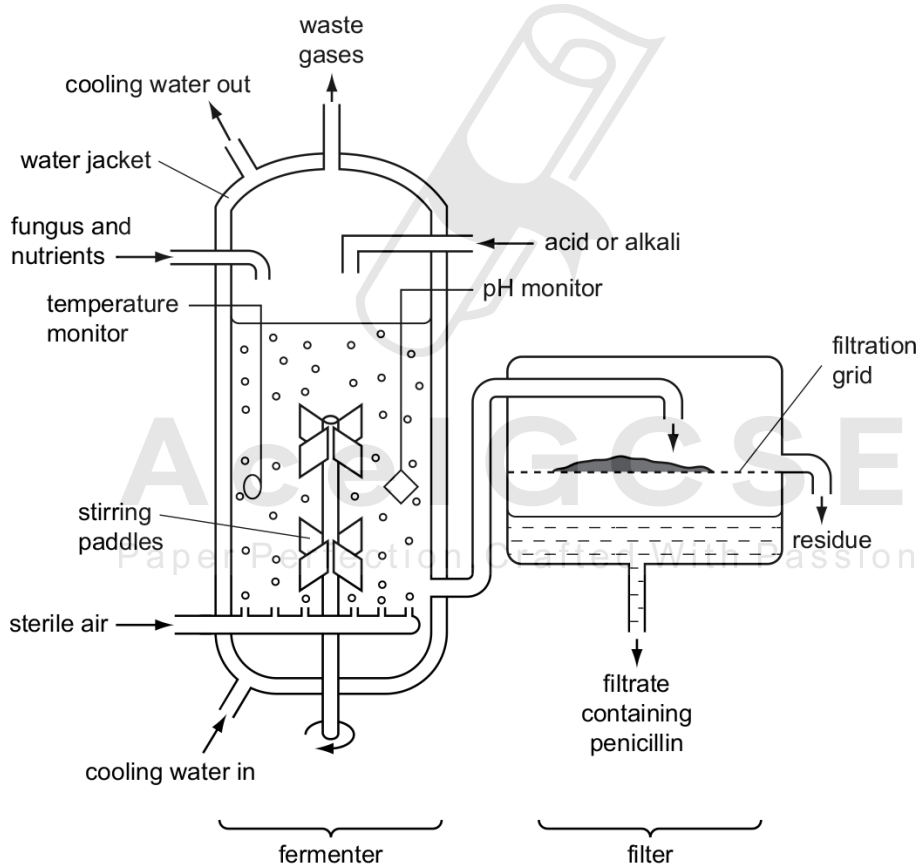


Fig. 5.1



(b) Fig. 5.2 shows the mass of fungus and the yield of penicillin during the fermentation process.

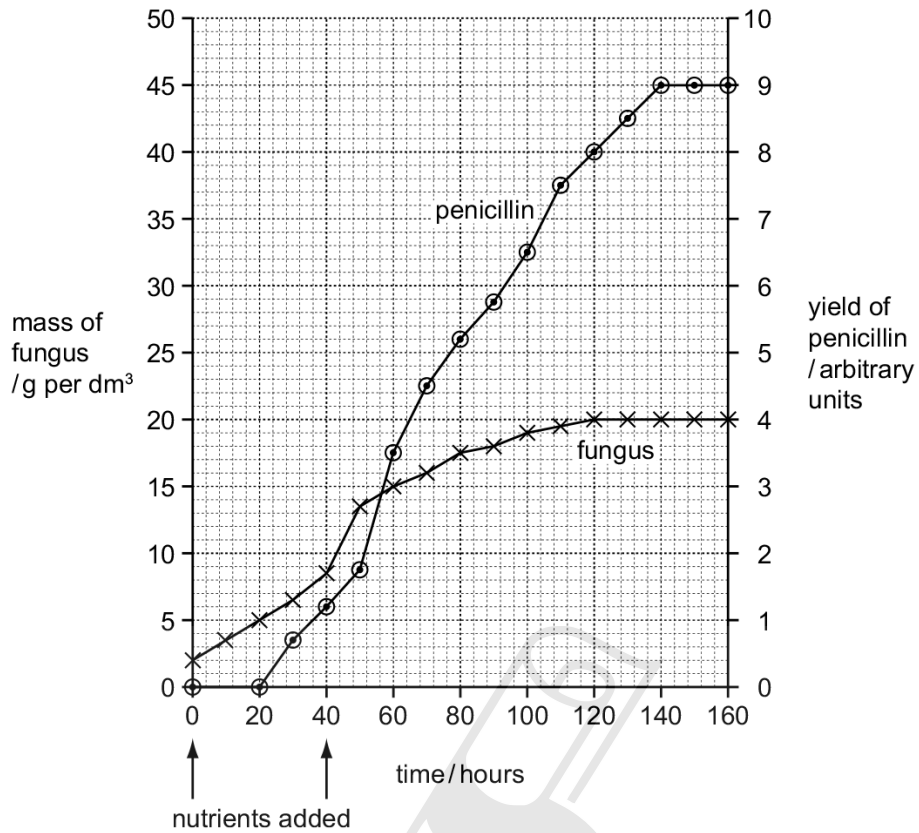


Fig. 5.2

(i) State the time interval over which the fungus grew at its maximum rate.

..... hours [1]

(ii) As the fungus grows in the fermenter, the nuclei in the fungal hyphae divide.

State the type of nuclear division that occurs during the growth of the fungus in the fermenter.

..... [1]

(iii) Explain why the growth of the fungus slows down and stops.

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

(c) Penicillin is not needed for the growth of *P. chrysogenum*.

(i) State the evidence from Fig. 5.2 that shows that penicillin is not needed for this growth.

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

(ii) The people in charge of the penicillin production emptied the fermenter after 160 hours. Use the information in Fig. 5.2 to suggest why they did not allow the fermentation to continue for longer.

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

Biological washing powders contain enzymes that break down food stains.

- (a) Complete Table 2.1 by naming the enzymes that break down three substances in food stains and by stating the product or products.

**Table 2.1**

substance	enzyme	product(s)
starch		
fat		
protein		

[3]

Some students compared how effective biological and non-biological washing powders are at removing stains at temperatures between 10 °C and 60 °C.

- Pieces of stained cloth were washed using two different washing powders.
- The degree of stain removal was measured by using a light meter to record the percentage of light reflected from the cloth.
- A light meter gave a value of 100% when the cloth was completely clean.
- Any stain left on the cloth reduced the percentage of light reflected.



- (c) The students suggested that the enzymes in the biological washing powder were denatured at high temperatures.

Explain why enzyme molecules do not function when they are denatured.

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

- (d) Forensic scientists often try to find DNA on items of stained clothing. The DNA can be used to identify individual people.

Suggest why DNA can be used to identify individual people.

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

[Total: 11]



The student took samples of the water outside the dialysis tubing at 5 minute intervals and tested the samples with Benedict's solution.

The results are shown in Table 3.1.

**Table 3.1**

time /minutes	results of the Benedict's tests on the water outside the dialysis tubing
0	blue
5	green
10	yellow
15	red

(i) Describe and explain the results shown in Table 3.1.

.....

.....

.....

.....

.....

.....

.....

.....

..... [3]

(ii) The student repeated the investigation with a higher concentration of glucose in the dialysis tubing.

Predict the results that the student would observe.

.....

.....

..... [1]





Biotechnology is used in the process of bread-making.

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

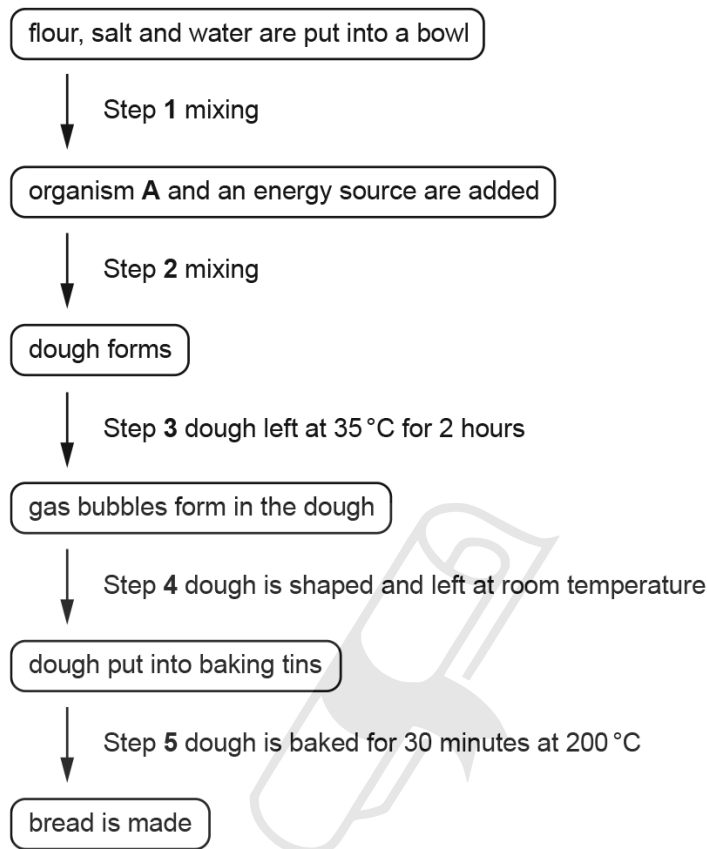


Fig. 1.1

(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]

(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]

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Microbiologists test strains of bacteria for antibiotic resistance.

They do this by soaking paper discs in antibiotics and placing them on bacteria growing in Petri dishes.

The paper discs in the centre of Petri dishes **E** and **F** in Fig. 2.1 have been soaked in penicillin.

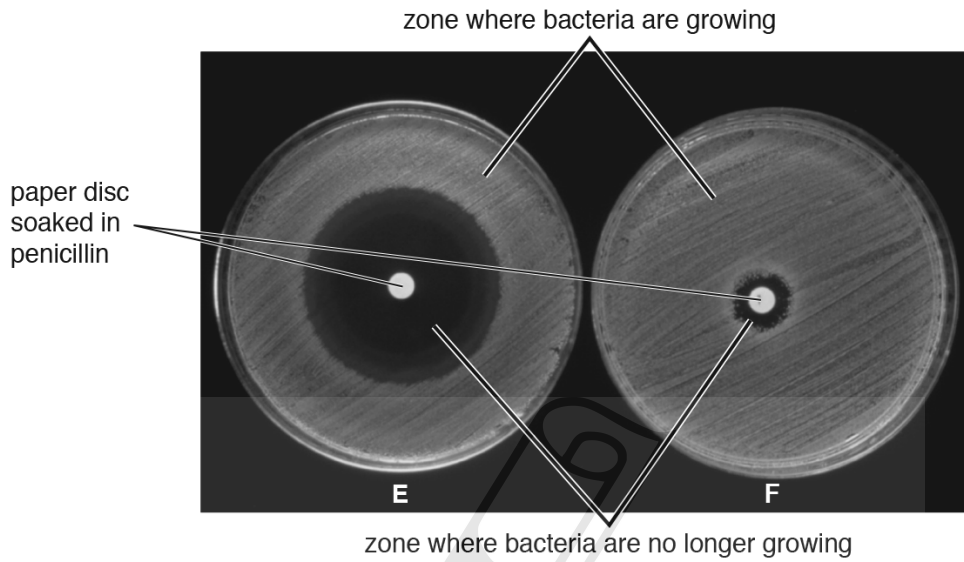


Fig. 2.1

(a) State the **type** of microorganism that produces penicillin.

.....[1]

(b) State **and** explain the evidence from Fig. 2.1 that suggests that the bacteria in dish **F** are resistant to penicillin.

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



The kingdom Fungi contains a great diversity of organisms including yeasts, moulds and mushrooms.

Like plants, fungi contain nuclei and mitochondria.

**(a) (i)** State the function of mitochondria.

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

**(ii)** State **two** characteristics of fungi that are used to distinguish them from plants.

1 .....

2 .....[2]

**(b)** Yeast is a single-celled fungus that is used in bread-making.

Explain why yeast is used in bread-making.

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





Yeast is used in bread-making. It respire anaerobically, producing carbon dioxide.

- (a) Write the balanced chemical equation for anaerobic respiration of yeast in bread-making.  
 .....[2]

A baker wants to increase the rate of carbon dioxide production in the bread-making process. The baker trialled different concentrations of glucose solution in the bread dough. Fig. 3.1 shows the results.

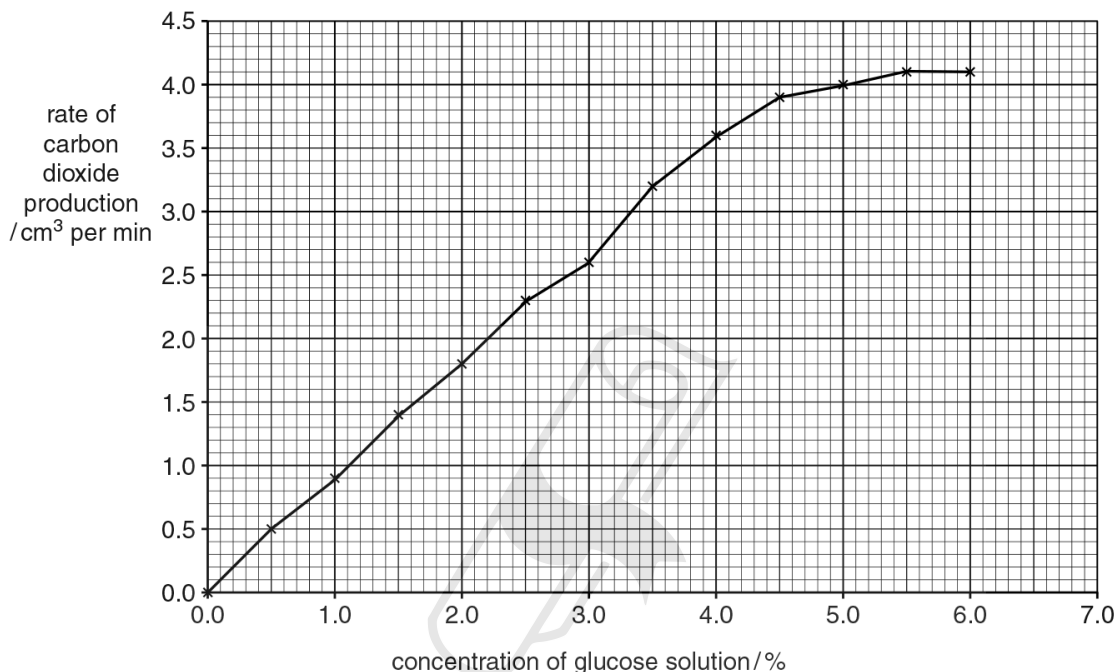


Fig. 3.1

- (b) (i) Predict the rate of carbon dioxide production if the concentration of the glucose solution was 7.0%.  
 ..... cm<sup>3</sup> per min [1]

- (ii) The baker carried out the trials at 30 °C. The trials were repeated at 20 °C. Draw a line on Fig. 3.1 to show the rate of carbon dioxide production at 20 °C. [2]

- (iii) The baker carried out another trial at 80 °C. No carbon dioxide was released. State why no carbon dioxide was produced.  
 .....[1]

- (c) Name **one** other industrial process that uses yeast.  
 .....[1]

(d) During the production of penicillin, large fermenters are used. Fig. 3.2 shows a fermenter.

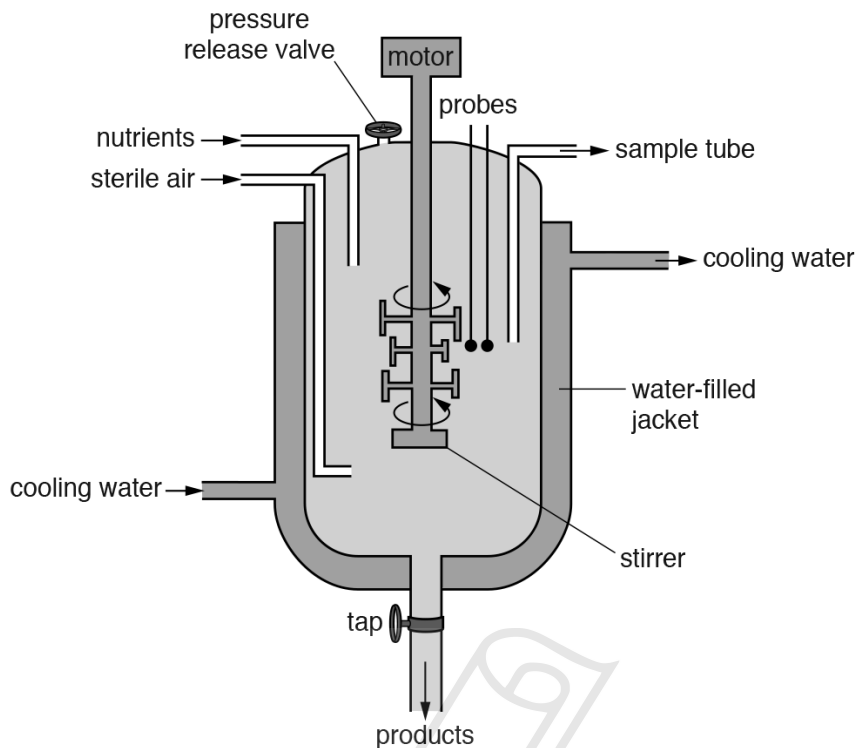


Fig. 3.2

(i) Explain the functions of the following parts of the fermenter:

stirrer .....

.....

water-filled jacket .....

.....

probes .....

.....

[3]

(ii) The air and nutrients that are added to the fermenter are sterile.

State why they must be sterile.

.....

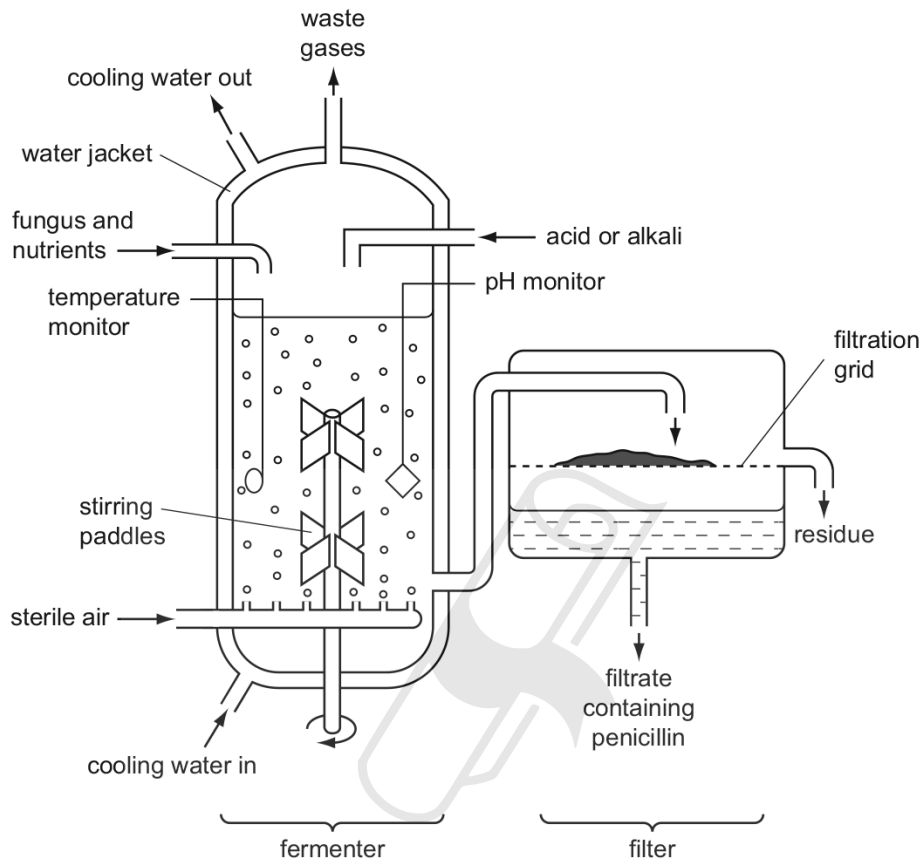
.....

.....[1]

[Total: 11]

Penicillin is an antibiotic produced by the fungus *Penicillium chrysogenum*.

Fig. 5.1 shows the process used to produce penicillin.



**Fig. 5.1**

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(b) Fig. 5.2 shows the mass of fungus and the yield of penicillin during the fermentation process.

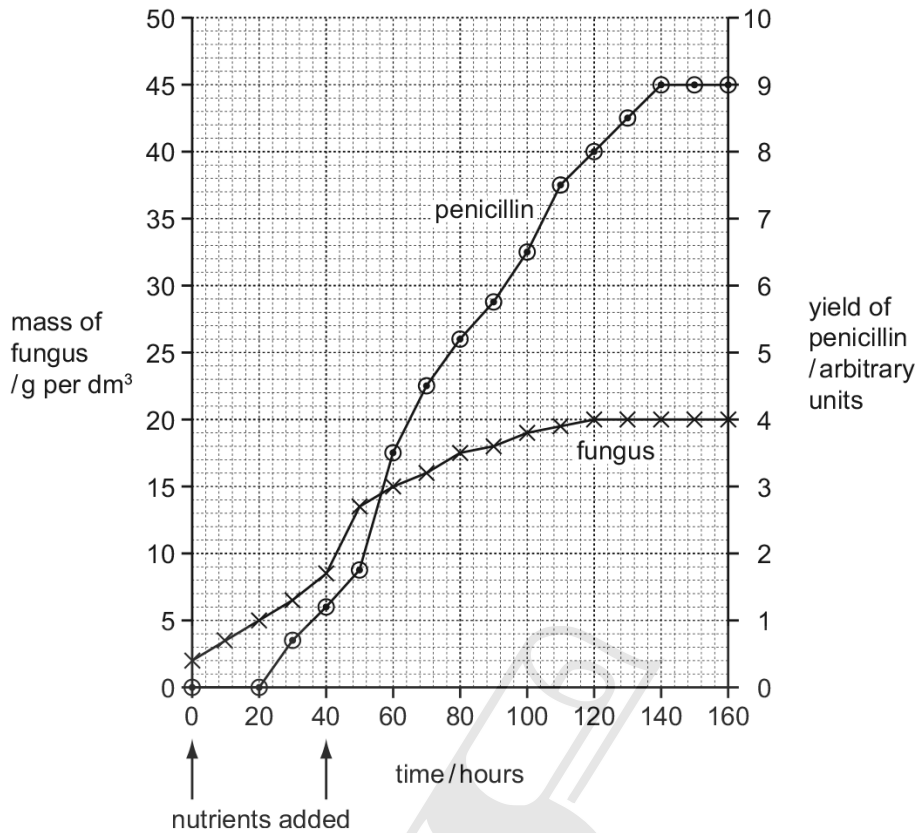


Fig. 5.2

(i) State the time interval over which the fungus grew at its maximum rate.

..... hours [1]

(ii) As the fungus grows in the fermenter, the nuclei in the fungal hyphae divide.

State the type of nuclear division that occurs during the growth of the fungus in the fermenter.

..... [1]

(iii) Explain why the growth of the fungus slows down and stops.

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

(c) Penicillin is not needed for the growth of *P. chrysogenum*.

(i) State the evidence from Fig. 5.2 that shows that penicillin is not needed for this growth.

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

(ii) The people in charge of the penicillin production emptied the fermenter after 160 hours. Use the information in Fig. 5.2 to suggest why they did not allow the fermentation to continue for longer.

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

10. 0610\_w16\_qp\_41 Q: 1

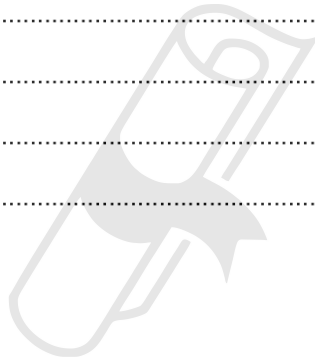
Penicillin is an antibiotic.

**(a) (i)** Explain why doctors give antibiotics to people who are ill.

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

**(ii)** Explain why it is important to complete a full treatment of antibiotics.

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



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(b) Penicillin was discovered in 1928 by Alexander Fleming.

Name the type of microorganism that produces the antibiotic penicillin.

.....[1]

(c) Penicillin is produced commercially in fermenters as shown in Fig. 1.1.

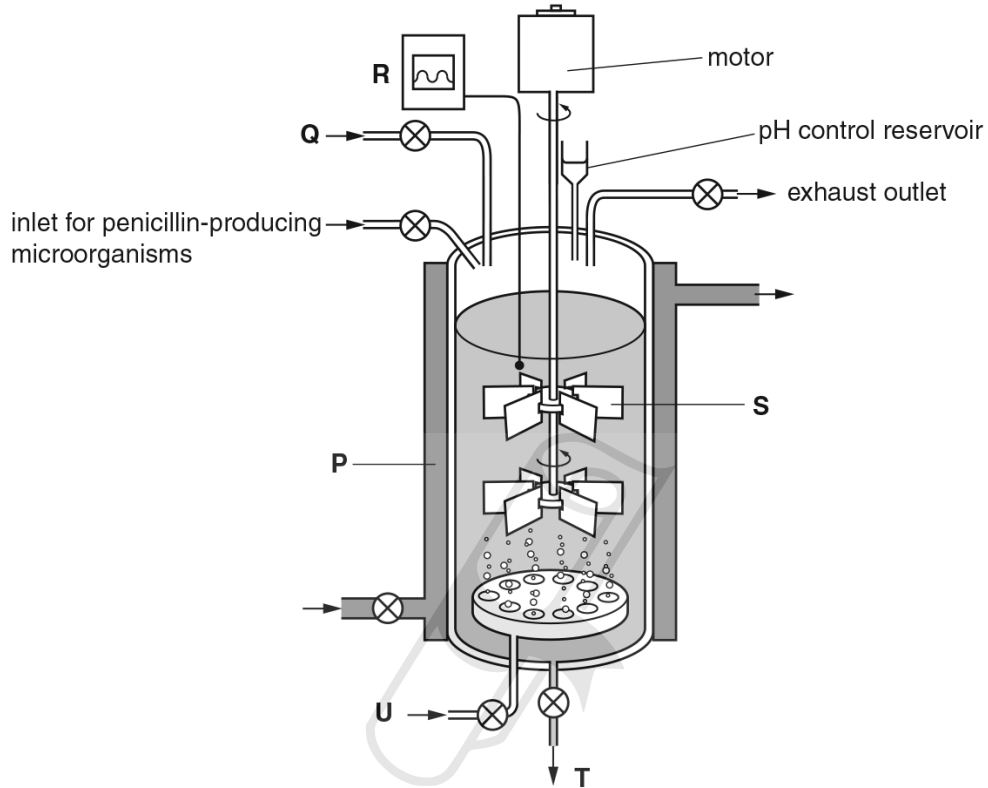


Fig. 1.1

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(i) Describe how a fermenter can be sterilised.

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

(ii) Table 1.1 shows some names of the parts of the fermenter and their functions.

Complete Table 1.1.

One row has been done for you.

**Table 1.1**

letter from Fig. 1.1	name	function
	water jacket	
<b>S</b>		
	nutrient inlet	
<b>R</b>		
	air supply	
<b>T</b>	outlet	allows collection of the liquid containing penicillin after fermentation

[5]

(d) Describe what happens to the liquid containing penicillin after it is collected from the fermenter.

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

Paper Perfection, Crafted With Passion **[Total: 14]**



(b) An experiment to test the effect of the size of apple pieces on the activity of pectinase was performed by a group of students. Some of their apparatus is shown in Fig. 2.1.

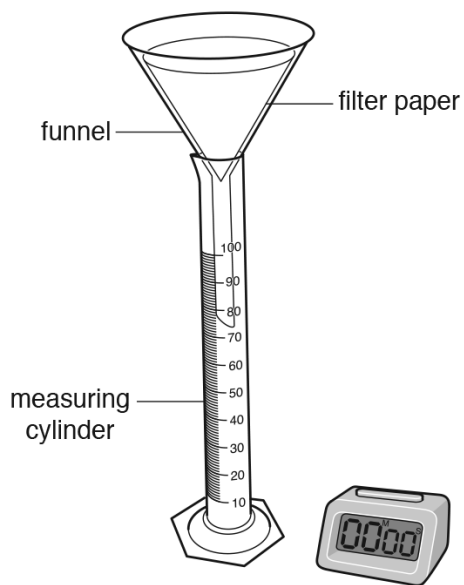


Fig. 2.1

Describe how the students should use the measuring cylinder to obtain **accurate** measurements of volume.

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.....

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.....

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.....

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[2]

(c) The students added  $1.5\text{cm}^3$  of pectinase solution to pieces of apple in a beaker.

They then poured the mixture into the funnel.

They found that it took 10 minutes to collect  $19\text{cm}^3$  of juice.

(i) Calculate the rate of the enzyme reaction.

Show your working.

Write your answer to the nearest whole number.

.....  $\text{cm}^3$  per min [2]

(ii) The students performed four experiments using different ways to prepare the apples.

The same total mass and type of apple was used each time.

A  $0.5\text{cm}^3$  apple cubes

B  $1.0\text{cm}^3$  apple cubes

C whole peeled small apples

D whole unpeeled small apples

Predict **and** explain which experiment (A, B, C or D) would result in the fastest rate of reaction.

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

[Total: 12]

(a) Fig. 2.1 shows the human population of a country between 1910 and 2020.

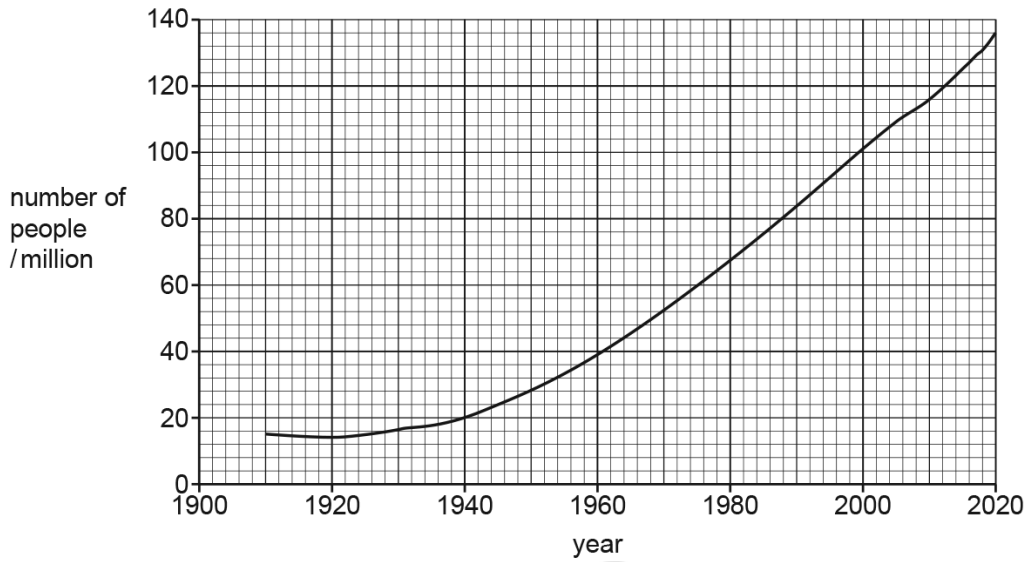


Fig. 2.1

(i) Calculate the percentage increase in the population of the country between 1940 and 2020.

Space for working.

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.....%  
[3]

(ii) Describe the factors that could cause the change in the population size between 1940 and 2020, shown in Fig. 2.1.

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

(b) Some countries have invested in biofuels such as ethanol, biomass and biodiesel.

(i) Describe how ethanol can be made by microorganisms.

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

(ii) Some countries use large areas of land to grow maize plants. This crop plant can be used to produce biofuels.

Discuss the negative impact on the **environment** of growing large-scale monocultures of crop plants such as maize.

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

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[Total: 12]

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- (a) Tissue plasminogen activators (TPAs) are human proteins that are used as drugs to break down blood clots.

TPAs break down blood clots by activating plasminogen. Plasminogen is a protein that is always present in the blood.

When activated, plasminogen forms a protease that breaks down fibrin molecules.

- (i) Plasminogen is found in the plasma.

State what is meant by the term *plasma*.

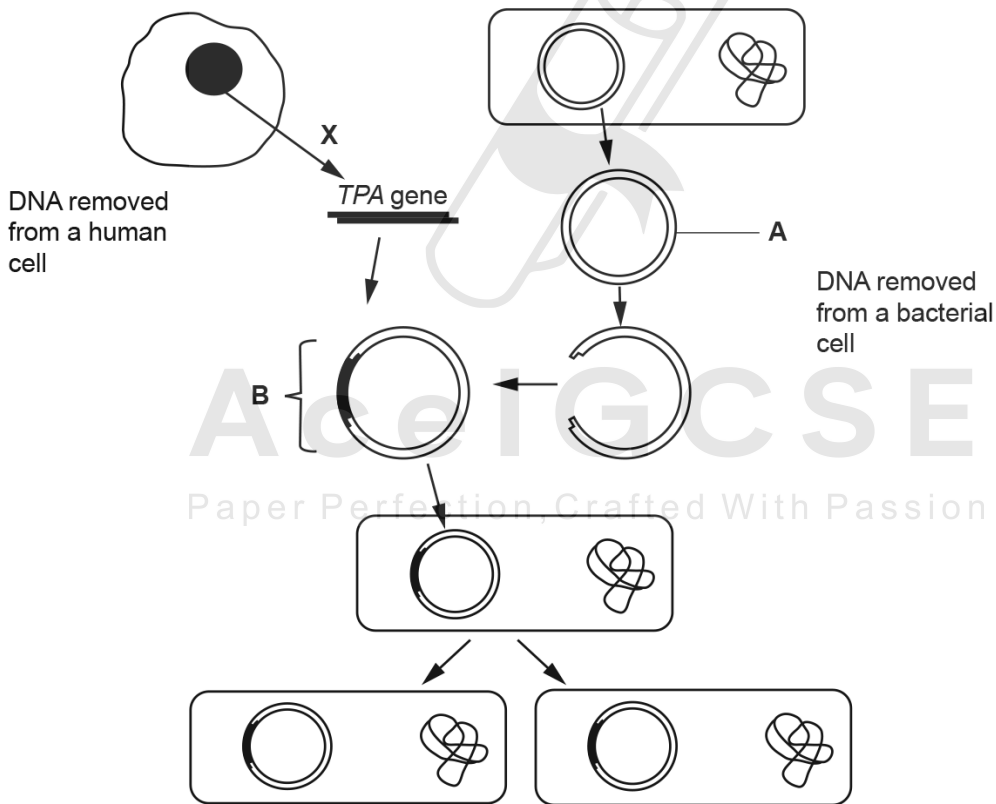
..... [1]

- (ii) State the products of the action of protease on the protein fibrin.

..... [1]

TPAs can be produced by genetically-engineered bacteria.

Fig. 5.1 shows some of the stages involved in genetically engineering a bacterium to make a TPA.



not to scale

Fig. 5.1

(b) (i) State the name of structure **A** in Fig. 5.1.  
..... [1]

(ii) In the flow chart, **X** represents the action of an enzyme on a molecule of DNA.  
State the name of this enzyme.  
..... [1]

(iii) The *TPA* gene is inserted into structure **A**.  
Explain how the gene is inserted into structure **A** to form structure **B** as shown in Fig. 5.1.  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
..... [3]

(iv) Before *TPA* was made by genetically-engineered bacteria it was only available from blood donated by people.  
Suggest **one** advantage of producing *TPA* by genetically-engineered bacteria.  
.....  
..... [1]

(v) The genetically-engineered bacteria produce mRNA that is a copy of the human *TPA* gene.  
Explain the role of mRNA in the bacterium.  
.....  
.....  
.....  
.....  
..... [2]

[Total: 10]

14. 0610\_s19\_qp\_43 Q: 3

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.

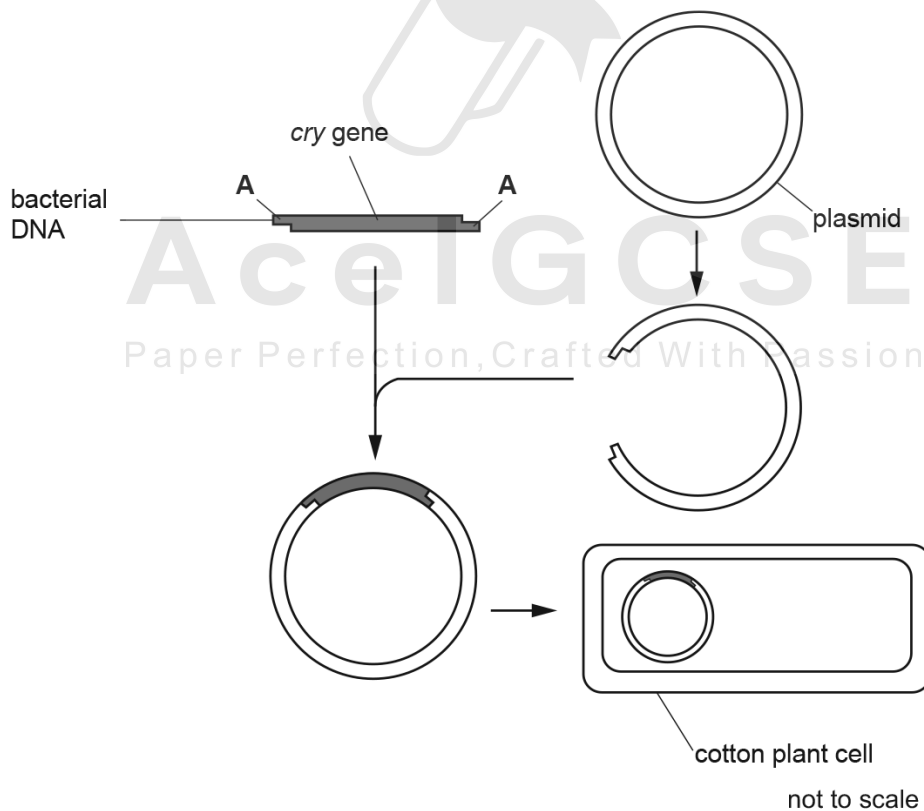


Fig. 3.2







(c) Aphids are used by investigators to discover how plants transport sucrose.

Fig. 2.2 shows an aphid with its mouthparts inserted into a plant stem to feed on the liquid in the phloem.



Fig. 2.2

A plant was put in a dark cupboard for several days. Four aphids, **A**, **B**, **C** and **D**, were then placed on the plant in the dark cupboard as shown in Fig. 2.3.

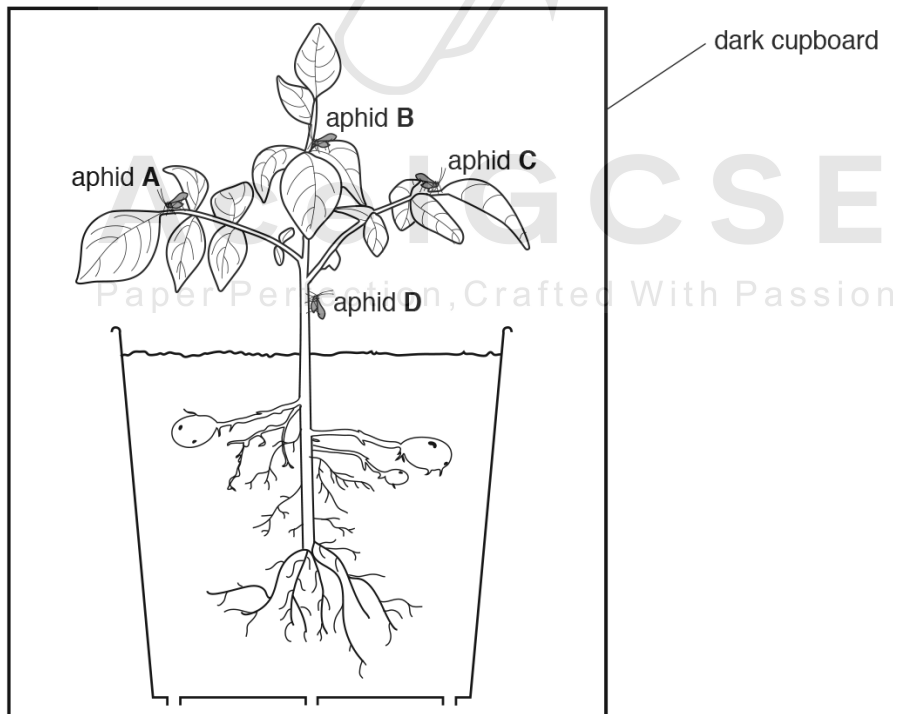


Fig. 2.3



16. 0610\_w19\_qp\_43 Q: 5

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 .....

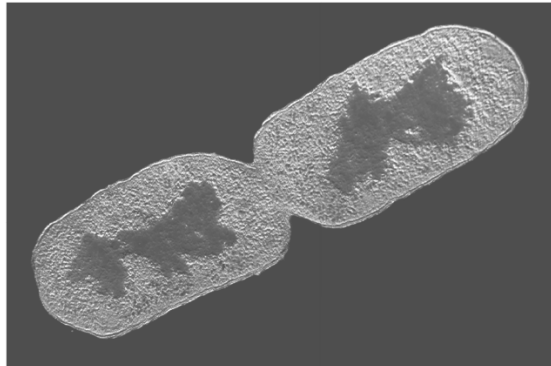
[2]

[Total: 11]

17. 0610\_s18\_qp\_42 Q: 6

Bacteria are useful in biotechnology and genetic engineering.

Fig. 6.1 shows a photomicrograph of a bacterium.



magnification  $\times 27\,000$

**Fig. 6.1**

**(a)** State the name of the process that is taking place in Fig. 6.1.

..... [1]

**(b) (i)** Write the formula that would be used to calculate the actual width of the bacterium.

**(ii)** The actual width of the bacterium is 0.0008 mm.

Convert this value to micrometres ( $\mu\text{m}$ ).

Space for working.

.....  $\mu\text{m}$  [1]

**(c)** Genetically modified bacteria can produce human insulin.

**(i)** State the name of the disease that can be treated with insulin injections.

..... [1]

(ii) Insulin is a protein.

Describe the process of using bacteria in genetic engineering to produce human proteins.

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

(d) Genetically modified bacteria are often grown in fermenters.

(i) Suggest why steam is used to clean fermenters.

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

(ii) State **three** conditions inside a fermenter that are measured and controlled.

1 .....  
2 .....  
3 ..... [3]

(iii) State the name of **one** commercial product, **other than** insulin, that is made in fermenters.

..... [1]

- (e) Crop plants can also be genetically modified.

Describe the advantages of genetically modifying crops.

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 19]

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01.0610\_p20\_MS\_40 Q: 5

**(a) water jacket**

Any four from:

maintain optimum / constant temperature;

allow: prevent overheating

to prevent enzymes denaturing;

(because as) fungus respire;

releases heat so temperature in the fermenter increases;

which would kill fungus;

(therefore) no product / no penicillin / owtte;

*addition of acids and alkalis*

Any two from:

maintains pH / keeps pH constant;

enzymes need optimum pH;

to give maximum enzyme activity / rate of reaction at its fastest;

to give maximum yield / owtte;

allow: stop enzymes denaturing

[max 6]

**(b) (i) 40–50;**

[1]

**(ii) mitosis;**

[1]

**(iii) Any three from:**

nutrients are used up;

limiting (factors);

explanation of limiting factor;

allow: factor in shortest supply / owtte

waste products accumulate;

wastes are toxic;

penicillin could inhibit growth;

population reaches carrying capacity;

avp;

[max 3]

**(c) (i) fungus grows when no penicillin produced;**

during first 20 hours;

[2]

**(ii) Any one from:**

no more growth of fungus / fungus is dead;

no further production of penicillin / no advantage in continuing;

[max 1]

(d) Any three from:

- purifying or separating penicillin;
- from waste or toxins / owtte;
- concentration;
- making into pills / owtte;
- avp; e.g. colour / taste

[max 3]

(e) Any two from:

- viruses have no metabolism;
- allow: viruses do not have ribosomes
- idea that viruses have no target for antibiotics / owtte;
- antibiotics stop cell wall growth;
- viruses have no cell wall;
- antibiotics stop enzymes working;

[max 2]

02. 0610\_s20\_MS\_41 Q: 2

(a)	<p><i>one mark per row:</i></p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">substance</th> <th style="text-align: center;">enzyme</th> <th style="text-align: center;">product(s)</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">starch</td> <td style="text-align: center;">amylase</td> <td style="text-align: center;">maltose / glucose / (simple) sugar(s)</td> </tr> <tr> <td style="text-align: center;">fat</td> <td style="text-align: center;">lipase</td> <td style="text-align: center;">fatty acid(s) and glycerol</td> </tr> <tr> <td style="text-align: center;">protein</td> <td style="text-align: center;">protease / pepsin / trypsin</td> <td style="text-align: center;">amino acids</td> </tr> </tbody> </table> <p style="text-align: right;">***</p>	substance	enzyme	product(s)	starch	amylase	maltose / glucose / (simple) sugar(s)	fat	lipase	fatty acid(s) and glycerol	protein	protease / pepsin / trypsin	amino acids	<b>3</b>
substance	enzyme	product(s)												
starch	amylase	maltose / glucose / (simple) sugar(s)												
fat	lipase	fatty acid(s) and glycerol												
protein	protease / pepsin / trypsin	amino acids												
(b)	<p><i>any four from:</i></p> <p>biological washing powder is more effective, at lower temperatures / between 10 °C and 40 °C / 10 °C and 43 °C ;                      comparative data quote for the difference at a stated temperature ;                      biological washing powder removes all stain between 30 °C and 40 °C ;                      non-biological removes all stain only at 60 °C ;                      effectiveness is similar, at high temperatures / between 50 and 60 °C ;                      same trend, below 30 °C / at low temperatures / from 50 °C ;                      idea of effectiveness of biological washing powder decreases between 40 °C and 44 °C, no such decrease for non-biological washing powder ;</p>	<b>4</b>												
(c)	<p><i>any two from:</i></p> <p><u>active site</u> changes shape ;                      substrate no longer fits into, enzyme / active site ;                      no enzyme-substrate complex / no successful collisions ;</p>	<b>2</b>												
(d)	<p><i>any two from:</i></p> <p>individual people have, different / unique, DNA ;                      DNA has genes or alleles have, sequences of bases ;                      AVP ;</p>	<b>2</b>												

03. 0610\_s20\_MS\_41 Q: 3

(a)(i)	<p><i>any three from:</i>                      blue at time 0 indicates no glucose present ;                      ensures that no glucose on outer surface of dialysis tubing / in water, as a result of an error ;                      green / yellow / red, indicates presence of glucose ;                      glucose, diffuses / moves, out of dialysis tubing / into water ;                      (movement is) <u>down the concentration gradient</u> / high to low concentration ;                      dialysis tubing is permeable to glucose ;                      AVP ;</p>	3
(a)(ii)	<p><i>idea that</i> (Benedict's solution) changes colour quicker / gives more intense colour / AW ;</p>	1
(b)	<p><b>A</b> are microvilli ;  <i>function:</i> allow movement of substances into the cell / increase surface area for absorption by diffusion OR active transport / have proteins in the membrane for active transport ;</p> <p><b>B</b> is the (rough) endoplasmic reticulum / (R)ER ;  <i>function:</i> site of protein synthesis / modify proteins / assemble amino acids in a specific sequence to make (named) protein ;</p> <p><b>C</b> is a mitochondrion ;  <i>function:</i> <u>aerobic respiration</u> / provides energy for (named) cell process(es) ;</p>	6
(c)(i)	<p>chloride ;</p>	1
(c)(ii)	<p><i>any four from:</i>                      loss of water ;                      by osmosis / down water potential gradient ;                      diarrhoea ;                      dehydration ;                      loss of other, (named) ions / salt(s) ;                      AVP ;</p>	4

04. 0610\_s19\_MS\_42 Q: 1

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

05. 0610\_s19\_MS\_43 Q: 1

	Answer	Mark	Partial Marks
(a)	nucleus ; mitochondria ; (rough) endoplasmic reticulum ; AVP ;	2	
(b)(i)	<i>nitrogen</i> for making, amino acids / proteins ; <i>glucose</i> for respiration / source of energy ;	2	
(b)(ii)	for even / uniform, distribution / concentration, of contents / AW ; ensure more access of bacteria with, medium / AW ; prevent settling / clumping of, contents / AW ; so oxygen / glucose / nutrients, dissolves ; so that growth is not limited ; so bacteria can absorb substances (more easily) ; bacteria need oxygen for respiration ;	3	
(c)	<i>description:</i> at least two correctly named phases ; any two phases described correctly ; i.e. <b>A:</b> level, <b>B:</b> increasing, <b>C:</b> level, <b>D:</b> decreasing (numbers of live bacteria)  correct relevant data quote for any phase ;;  <i>A is the lag, phase / stage:</i> bacteria, growing / dividing, slowly ; bacteria adjusting to conditions / absorbing resources ;  <i>B is the exponential / log, phase / stage:</i> resources are, not limiting / AW ; bacteria, growing / dividing, rapidly ; growth / birth, rate greater than death rate ;  <i>C is the stationary, phase / stage:</i> growth / birth, rate equal to death rate ;  <i>D is the death, phase / stage:</i> death rate greater than growth, birth / rate ;  <i>C or D:</i> many bacteria are dying ; concentration of resources decreasing / resources become limiting ; space becomes limiting / AW ; (named) toxins building up ;	6	

	Answer	Mark	Partial Marks
(a)	fungus ;	1	
(b)	small / no, clear area / AW ; ora (antibiotic in disc), not killing bacteria / (continued) reproduction ; ora	2	A more bacteria growing
(c)(i)	<p>1 correct ref. to mutation (of bacteria) / have resistance gene ;</p> <p>2 mutation is a change in the DNA / base sequence ;</p> <p>3 mutations can be caused by, (ionising) radiation / (named) chemicals ;</p> <p>4 <u>variation</u> (in ability of bacteria to survive antibiotic treatment) ;</p> <p>5 ref. to (natural) selection / evolution ;</p> <p>6 bacteria with resistance (survive and) reproduce / breed / multiply / produce offspring ;</p> <p>7 bacteria with, no / little, resistance, die / do not reproduce ;</p> <p>8 (bacteria that survive) pass on the resistance, <u>allele / gene</u>, to more bacteria ;</p> <p>9 bacteria reproduce quickly ;</p> <p>10 exposure to antibiotics acts as a selection pressure ;</p> <p>11 only use antibiotics when essential ;</p> <p>12 complete the full course of prescribed antibiotics ;</p> <p>13 isolation of patients with infections ;</p> <p>14 improved, healthcare / sanitation / nutrition / good diet / hygiene / cleanliness / screening / AW ;</p> <p>15 and 16 AVP ;;</p>	6	
(c)(ii)	viruses, are not alive / not made of cells / AW ; ora viruses do not have, a cell wall / named cell component ;	1	
(d)	<p>small / take up little space ;</p> <p>reproduce rapidly / easy to grow ;</p> <p>contain plasmids ;</p> <p>transformation described / genetic modification / inserting genes ;</p> <p>no ethical concerns ;</p> <p>same genetic code as other organisms ;</p> <p>same DNA ;</p> <p>can make complex molecules / AW ;</p> <p>AVP ;</p>	3	

07. 0610\_w17\_MS\_43 Q: 5

	Answer	Mark	Partial Marks
(a)(i)	respiration ; aerobic (respiration) ; release energy / make ATP ;	2	A respiration using oxygen A provide energy R produce / generate, energy
(a)(ii)	different composition of cell wall ; no, chlorophyll / chloroplasts / heterotrophic ; extracellular digestion / saprophytic / decomposer / AW ; hyphae / mycelium ; no (central) vacuole ; AVP ;	2	A not, autotrophic / photosynthetic / AW A enzymes secreted from cells to digest food I spores  e.g. multinucleate / reproduction by budding
(b)	respiration / fermentation ; carbon dioxide released ; (bubbles / carbon dioxide) causes, dough / bread, to rise ; (yeast produces) enzymes ; enzymes / amylase, digest starch ; AVP ;	3	          e.g. yeast, are not toxic / does not produce toxins / reproduce rapidly / can be stored dry / are single celled / cheap
(c)(i)	(fungus) grown / put, in fermenters ; aerobic conditions / AW ; (provide) sugars / nitrogen source / nutrients ; purification / filtration, of product / penicillin ; batch culture / AW ; sterile conditions ; AVP ;	3	A bioreactors A bubble air through e.g. ammonia / amino acids / protein   e.g. described maintenance of culture / penicillin produced, when sugar source decreases / in stationary phase A fermentation conditions such as stirring / use of water jacket / controlling temp / pH etc.
(c)(ii)	bacteria are made of cells ; ora	1	A viruses are not alive / do not have a cell wall
(d)	mechanical barriers ; example of mechanical barriers ;; chemical barriers ; example of chemical barriers ;;  blood clotting ;	max 3	A physical barriers / dead layer of cells for skin e.g. skin / hairs in nose / ear wax A mucus as mechanical or chemical e.g. mucus / stomach acid / vaginal acid / tears / lysozymes A scab



09. 0610\_p16\_MS\_40 Q: 5

**(a) water jacket**

Any four from:

maintain optimum / constant temperature;

allow: prevent overheating

to prevent enzymes denaturing;

(because as) fungus respire;

releases heat so temperature in the fermenter increases;

which would kill fungus;

(therefore) no product / no penicillin / owtte;

*addition of acids and alkalis*

Any two from:

maintains pH / keeps pH constant;

enzymes need optimum pH;

to give maximum enzyme activity / rate of reaction at its fastest;

to give maximum yield / owtte;

allow: stop enzymes denaturing

[max 6]

**(b) (i) 40–50;**

[1]

**(ii) mitosis;**

[1]

**(iii) Any three from:**

nutrients are used up;

limiting (factors);

explanation of limiting factor;

allow: factor in shortest supply / owtte

waste products accumulate;

wastes are toxic;

penicillin could inhibit growth;

population reaches carrying capacity;

avp;

[max 3]

**(c) (i) fungus grows when no penicillin produced;**

during first 20 hours;

[2]

**(ii) Any one from:**

no more growth of fungus / fungus is dead;

no further production of penicillin / no advantage in continuing;

[max 1]

(d) Any three from:

purifying or separating penicillin;

from waste or toxins / owtte;

concentration;

making into pills / owtte;

avp; e.g. colour / taste

[max 3]

(e) Any two from:

viruses have no metabolism;

allow: viruses do not have ribosomes

idea that viruses have no target for antibiotics / owtte;

antibiotics stop cell wall growth;

viruses have no cell wall;

antibiotics stop enzymes working;

[max 2]



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10. 0610\_w16\_MS\_41 Q: 1

	Answer	Mark	Partial Marks																					
(a)(i)	(antibiotics) kill / damage / destroy / eliminate, pathogens / bacteria / fungi; Bacteria / fungi / pathogen can cause illness / disease / infections; (antibiotics), prevent growth / reproduction of, bacteria / fungi / pathogen; AVP ref. to how antibiotics kill bacteria; e.g. ref. to cell wall / production of proteins / inhibition metabolism;	2	I virus																					
(a)(ii)	1 all (bacteria / pathogens) need to be killed / destroyed; 2 any remaining (bacteria) will reproduce / multiply; 3 illness / disease would continue; 4 ref to problem of antibiotic resistance; 5 antibiotics no longer effective; 6 new antibiotics have to be developed;	3	A prevents growth I virus  I any reference to immunity																					
(b)	fungus / mould;	1	A <i>Penicillium</i> (notatum)																					
(c)(i)	steam; autoclave / high temperature <u>and</u> high pressure; UV / gamma, radiation / X rays; bleach; AVP; e.g. sterilise nutrients / air supply / items, entering fermenter	2	A any reference to sterilizing substances that are <u>added</u> to the fermenter.																					
(c)(ii)	<table border="1"> <thead> <tr> <th>letter from Fig. 1.1</th> <th>name</th> <th>function</th> </tr> </thead> <tbody> <tr> <td>P</td> <td>water jacket</td> <td>Maintain / control, temperature;</td> </tr> <tr> <td>S</td> <td>paddles / stirrers / mixers / vanes</td> <td>mixes / stirs / maintains a suspension / stops solids settling / keeps nutrients moving / gives uniform mixture;</td> </tr> <tr> <td>Q</td> <td>nutrient inlet</td> <td>supplies glucose / ammonia / amino acids / nutrients for growth / nutrients for respiration / energy;</td> </tr> <tr> <td>R</td> <td>Probe / sensor / data logger</td> <td>monitors, temperature / pH;</td> </tr> <tr> <td>U</td> <td>air supply</td> <td>supplies oxygen for respiration;</td> </tr> <tr> <td>T</td> <td>outlet</td> <td>allows collection of the liquid containing penicillin after fermentation</td> </tr> </tbody> </table>	letter from Fig. 1.1	name	function	P	water jacket	Maintain / control, temperature;	S	paddles / stirrers / mixers / vanes	mixes / stirs / maintains a suspension / stops solids settling / keeps nutrients moving / gives uniform mixture;	Q	nutrient inlet	supplies glucose / ammonia / amino acids / nutrients for growth / nutrients for respiration / energy;	R	Probe / sensor / data logger	monitors, temperature / pH;	U	air supply	supplies oxygen for respiration;	T	outlet	allows collection of the liquid containing penicillin after fermentation	5	one mark for each correct row
letter from Fig. 1.1	name	function																						
P	water jacket	Maintain / control, temperature;																						
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R	Probe / sensor / data logger	monitors, temperature / pH;																						
U	air supply	supplies oxygen for respiration;																						
T	outlet	allows collection of the liquid containing penicillin after fermentation																						
(d)	penicillin is, separated / extracted / filtered / centrifuged / evaporated / purified / crystallised / precipitated / dried / impurities removed;	1	A downstream processing																					
		<b>Total: 14</b>																						

11. 0610\_w16\_MS\_43 Q: 2

	Answer	Mark	Partial Marks
(a)	1 enzymes are proteins; 2 enzymes can be reused / are unchanged in a reaction; 3 enzymes are specific; 4 (enzymes are) catalyst / speeds up reaction; 5 lowers (activation) energy needed for the reaction; 6 successful collisions; 7 enzyme-substrate complex / ESC; 8 <u>active site</u> ; 9 (enzyme and substrate) complementary shape / AW; 10 ref. to <u>optimum</u> , temperature / pH; 11 too much heat results in denatured enzymes; 12 too little kinetic energy / heat, less (successful) reactions; 13 incorrect pH results in denatured enzymes; 14 (substrate) is <u>pectin</u> / cell wall; 15 results / product, is clear juice; 16 mass / cheaper / more (volume) / yield, juice production;	6	R cellulose
(b)	read at eye level / avoid error of parallax; read bottom of meniscus; place measuring cylinder on a level / flat, surface; remove funnel / ensure all drops have fallen to the bottom;	2	A parallel / horizontal to meniscus
(c)(i)	19 ÷ 10 or 17.5 ÷ 10; 2 (cm <sup>3</sup> per min);	2	
(c)(ii)	A / 0.5 (cm <sup>3</sup> cubes); large(st) surface area (to volume);	2	A smallest cubes
		<b>Total: 12</b>	

12. 0610\_s20\_MS\_43 Q: 2

(a)(i)	population in 1940 = 20 million, population in 2018 = 136 million ; 580% ;;	3
(a)(ii)	<i>any three from:</i> increase in birth rate / decrease death rate ; immigration ; increased food supply ; reduced poverty ; ora better housing / sanitation / health care / vaccination / AW ; AVP ;	3
(b)(i)	by yeast ; (using) anaerobic respiration ;	2
(b)(ii)	<i>any four from:</i> deforestation ; loss in (variety) of, habitat / places where organisms live / described ; disruption to food chains / described ; loss of (bio)diversity / (local) extinction of species / species become endangered / AW ; soil erosion / increased risk of landslides / flooding ; disrupted nutrient cycling ; decrease in (soil) water / desertification ; outbreaks / spreading, of crop diseases ; outbreaks / spreading, of (named) pests ; overuse of herbicides ; overuse of, pesticides / insecticides / AW ; killing of non-target species ; pollution of waterways by, plant nutrients / fertilisers ; pollution of the atmosphere by NO <sub>x</sub> from fertilisers ; pollution by use of fossil fuels in machinery ; AVP ;	4

13. 0610\_s19\_MS\_41 Q: 5

	Answer	Mark	Partial Marks
(a)(i)	liquid / fluid / watery, part of blood ;	1	
(a)(ii)	amino acid(s) ;	1	
(b)(i)	plasmid ;	1	
(b)(ii)	restriction (enzyme) ;	1	
(b)(iii)	cutting / opening, <b>A</b> / the plasmid, with <u>same</u> (restriction) enzyme(s) ; forming, sticky ends ; <i>idea that</i> (sticky) ends of human DNA and plasmid DNA are <u>complementary</u> ; reference to, bases / base sequences (of sticky ends) ; correct reference to (DNA) ligase ; e.g. inserting gene / sticky ends joining / splicing AVP ; e.g. <b>B</b> is a recombinant (plasmid / DNA)	3	
(b)(iv)	reliable / constant, supply ; produce, large(er) quantities / in a fermenter / bacteria reproduce quickly (to make more genetically engineered bacteria) ; not dependent on blood donations ; <i>idea that</i> no (named) health risk(s) ; higher quality of product ; AVP ;	1	
(b)(v)	mRNA moves through the cytoplasm ; mRNA molecules, move to / through, ribosomes ; sequence of bases in mRNA determines order of amino acids (in TPA) ; for protein synthesis / to make proteins ; AVP ;	2	
(a)(i)	cell wall ; cells are a regular shape / described ; vacuole(s) ; AVP ;	1	

14. 0610\_s19\_MS\_43 Q: 3

	Answer	Mark	Partial Marks
(a)(i)	restriction (enzyme) ;	1	
(a)(ii)	sticky ends ;	1	
(a)(iii)	plasmid is cut with the <u>same</u> (restriction) enzyme (as DNA) ; to form, sticky ends / region <b>A</b> , that are <u>complementary</u> to sticky ends of, gene / <i>cry</i> ; <i>reference to</i> base sequences (being complementary / AW) ; (DNA) ligase used to join plasmid and, <i>cry</i> / gene ; AVP ; e.g. formation of recombinant DNA / plasmid	3	
(b)	gene / <i>cry</i> , codes for the sequence of amino acids in, (toxic) protein ; DNA / gene / <i>cry</i> , is copied / transcribed, to form mRNA ; <i>cry</i> / 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	
(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	

15. 0610\_w19\_MS\_41 Q: 2

	Answer	Mark	Partial Marks
(a)	<p><i>carbohydrates</i> cellulose ; for cell walls ; starch ; for energy/respiration ; to attract insects to flowers / nectar / fruits ;</p> <p><i>amino acids</i> to make (named) proteins ; for enzymes ; for growth ;</p> <p>AVP ;</p>	4	
(b)	<p>correct position labelled on the leaf ; correct position labelled on the stem ; correct position labelled on the root ;</p>	3	
(c)(i)	<p>higher concentration in the stem / aphid D is nearer the root / is before the branching of the plant ; (sucrose moves by) <u>translocation</u> ; sucrose moves up the plant ; root / tuber, is a source ; (leaves / stems / AV) are a sink ; no photosynthesis (in the dark) ; no / less, glucose/sucrose (made in the leaves) ; plant uses stored starch (from root) / AV ;</p>	3	
(c)(ii)	<p>insert gene / ref. to genetic engineering / ref. to genetic modification ; gene, for insect / aphid resistance ; ref. to insecticide / described ; AVP ; description of how insecticide applied / biological control / grow in glasshouses / netting</p>	3	
(c)(iii)	<p>pollination ; AVP ; e.g. biological control described / insect products e.g. honey</p>	1	

16. 0610\_w19\_MS\_43 Q: 5

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

17. 0610\_s18\_MS\_42 Q: 6

	Answer	Mark	Partial Marks
(a)	(asexual) reproduction ;	1	R sexual reproduction
(b)(i)	image size + magnification ;	1	
(b)(ii)	0.8 (µm) ;	1	
(c)(i)	(Type 1) diabetes ;	1	A Type 2 diabetes
(c)(ii)	ref. to (human) <u>gene</u> / DNA that codes for (human) protein ; (human) DNA / gene, is, identified / isolated ; DNA / gene / plasmid, cut (out) using <u>restriction enzymes</u> ; forming, <u>complementary</u> / <u>sticky</u> , ends ; DNA / gene / plasmid, cut with the same restriction enzymes ; formation of recombinant, DNA / plasmid ; into plasmid (DNA) <u>ligase</u> used to join plasmid and, gene / DNA ; plasmids (with gene) inserted into bacteria ; bacteria (with the plasmid), replicate / reproduce / multiply ; AVP ; e.g. purification / identification of transformed bacteria /	5	<i>procedures must be in the correct sequence</i>
(d)(i)	kills (named) microorganisms / pathogens ; prevents contamination (by bacteria / microorganisms) ; steam does not contaminant, product / medicines (with chemicals) ; steam reaches all the crevices of fermenter ;	2	
(d)(ii)	pH ; temperature ; oxygen ; carbon dioxide ; (named) nutrients ; waste ; turbidity ; AVP ; (gas) pressure / rate of stirring / amount of (named) product	3	
(d)(iii)	penicillin ; AVP ;	1	
(e)	disease resistance ; large(r) / fast(er), yield ; drought resistance ; salt resistance ; frost resistance ; (named) nutritional enrichment ; pest / insect, resistance ; herbicide resistance ; vaccine production ; ref to benefits to, environment ; ref to more desirable, product / increased income / AW ; ref to a qualified benefit to humans ; e.g. food shortage / described health benefit AVP ; growth modification e.g. short stems / adaptations to extreme environments / rapid improvement to crop / improvements using characteristic that are not present in natural population	4	

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