Answer **all** the questions.

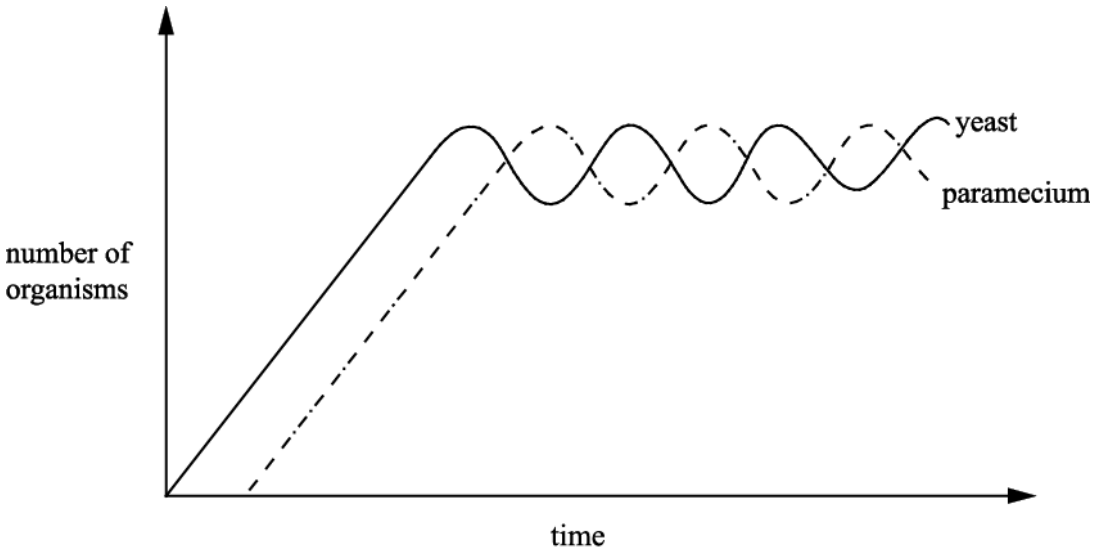
1. Immobilised enzymes can be produced by which of the following methods?

A binding enzyme to a soluble matrix
B intermolecular hydrogen bonding of enzymes
C absorbing enzymes onto the surface of a gel
D enclosing enzymes within a partially permeable membrane

Your answer ☐

[1]

2. The graph shows a population of yeast and a unicellular organism, *Paramecium,* grown in a fermentation chamber.



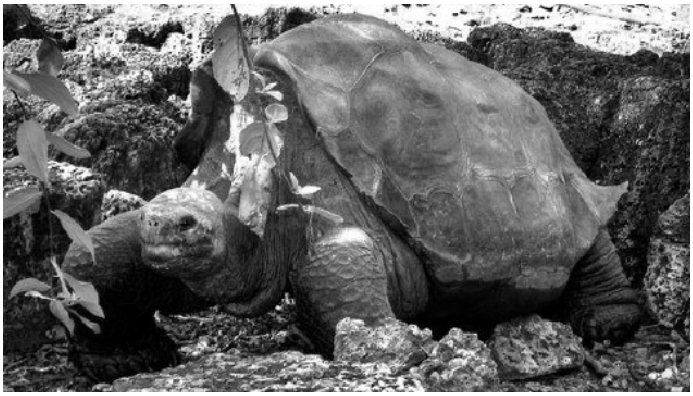
Which **one** of the following statements best describes the relationship between the two organisms?

A The *Paramecium* and yeast populations are complementary to each other.
B The yeast thrives in the relationship at the expense of the *Paramecium* population.
C The *Paramecium* feeds on the yeast and reduces the number in the yeast population.
D The two populations are in equilibrium and stable due to a type of negative feedback.

Your answer ☐

[1]

3. The last giant Galapagos tortoise died in 2012. Scientists froze some of the tortoise's cells.



The following statements describe processes involved in potential cloning of the giant Galapagos tortoise using the cells. They are **not** in the correct order.

1 A donor egg is enucleated.
2 The embryo develops into a mature egg, which is incubated.
3 A somatic cell from the tortoise is defrosted and the nucleus is removed.
4 Electrofusion of the host cell and new nucleus.
5 The somatic cell nucleus is inserted into the enucleated oocyte.
6 The transformed egg divides *in vitro.*

Which option states the correct order for producing a clone of the giant Galapagos tortoise?

A 1, 3, 4, 5, 6, 2
B 3, 5, 1, 4, 2, 6
C 1, 6, 3, 5, 4, 2
D 3, 1, 5, 4, 6, 2

Your answer ☐

[1]

4. Some humans are lactose intolerant. Milk can be treated with lactase to reduce the concentration of lactose present. Fresh milk is passed over lactase molecules immobilised on a suitable matrix.

Give two **economic** advantages of immobilising enzymes for large-scale production.

1

2

[2]

5. Laboratory techniques are used by workers in various professions, and by scientists.

A patient has been coughing blood, and it is suspected that bacteria will be found in the blood.

A medical technician cultures the blood on an agar plate. What measures should the technician take to keep the agar plate culture sterile?

---

[2]

6. Many plants can produce natural clones of themselves. Gardeners and farmers take advantage of this natural process by taking cuttings.

When a genetically modified plant is created, it may be cloned into many plantlets in the process called micropropagation.

Compare the equipment and techniques of taking cuttings with those used for micropropagation.

---

[2]

7. A student investigated the effect of different sugars on the growth of bacteria.

The student found that the bacteria grew well when provided with glucose, sucrose and fructose, but did not grow well when provided with lactose.

Which statement, **A** to **D**, provides the best explanation for these results?

A lactose was too large to be absorbed
B the bacteria could respire only monosaccharides
C the bacteria did not possess the enzyme to digest lactose
D the bacteria were inhibited by lactose

Your answer ☐

[1]

8. The table shows the growth of a population of microorganisms.

Time (h)	Estimated population size (cells per mm^3)
0	1.0×10^3
4	4.0×10^3
8	9.0×10^3
12	1.8×10^4
16	3.1×10^4
20	5.8×10^4
24	1.4×10^5

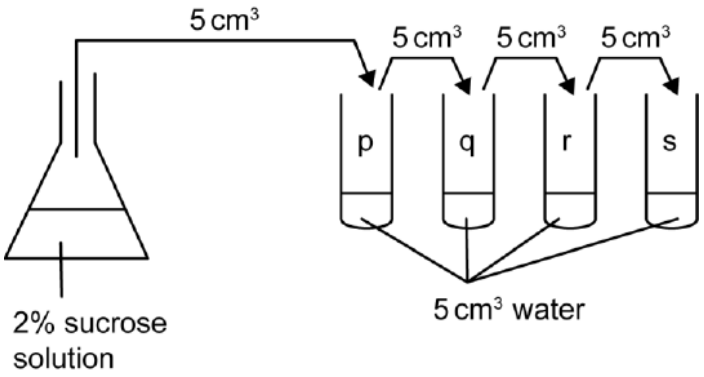
During which time period is the maximum (absolute) growth rate?

A 0 – 4 hours
B 8 – 12 hours
C 16 – 20 hours
D 20 – 24 hours

Your answer ☐

[1]

9. The diagram shows a serial dilution.



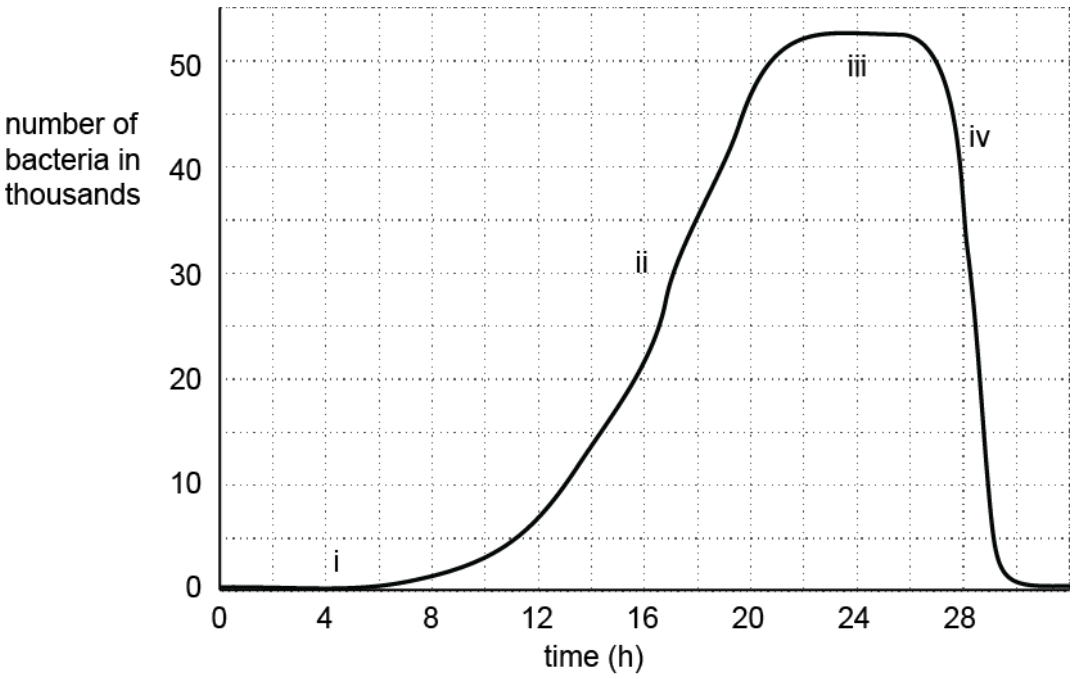
Which of the options, **A** to **D**, shows the correct concentrations of sucrose in tubes p – s?

A p = 0.2% q = 0.02% r = 0.002% s = 0.0002%
B p = 1% q = 0.5% r = 0.2% s = 0.1%
C p = 1% q = 0.5% r = 0.25% s = 0.125%
D p = 0.2% q = 0.1% r = 0.05% s = 0.025%

Your answer ☐

[1]

10. The graph shows the growth of a population of bacteria in a closed culture.



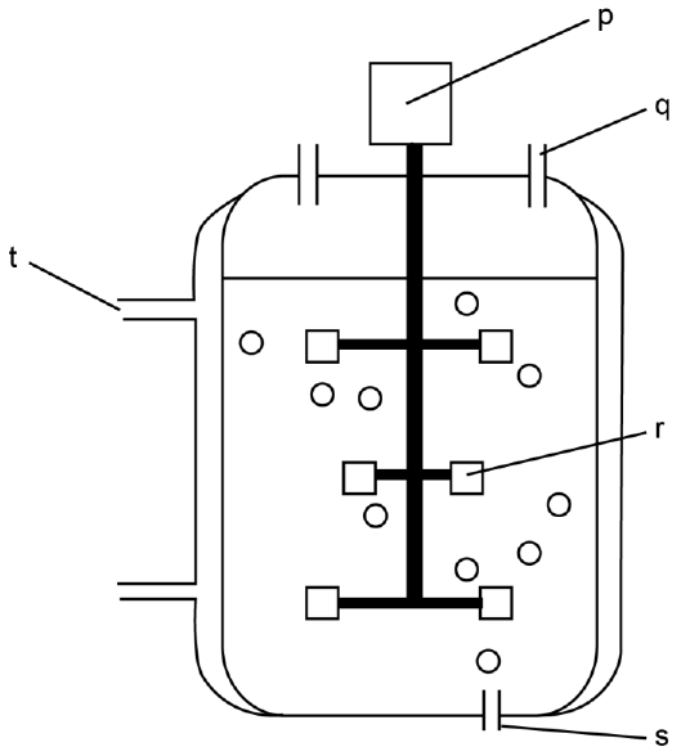
Which of the rows, **A** to **D**, correctly identifies the stages in the growth curve where primary and secondary metabolites are produced?

Row	No metabolites	Mainly primary metabolites	Mainly secondary metabolites
A	i	ii	iii & iv
B	-	i & ii	iii & iv
C	i & iv	ii	iii
D	iv	i & iii	ii

Your answer ☐

[1]

11. The diagram shows a simple fermenter.



Which row, **A** to **D**, correctly identifies the labelled components?

Row	P	q	r	s	t
A	motor	air inlet	stirring paddle	gas outlet	water outlet
B	stirring paddle	gas outlet	nutrient block	air inlet	water inlet
C	motor	gas outlet	stirring paddle	air inlet	water outlet
D	stirring paddle	gas outlet	nutrient block	gas outlet	water inlet

Your answer ☐

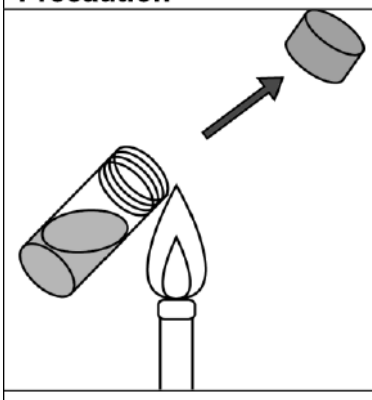
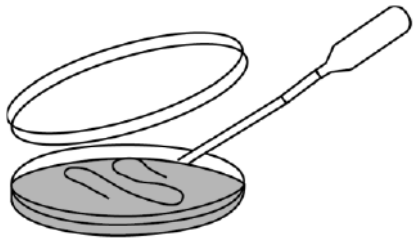
[1]

12(a). A student was asked to measure the population density of bacteria in a broth. The student was supplied with a broth culture of the bacterium *Bacillus subtilis.* The teacher suggested that the student should measure the population by transferring a sample of the broth to an agar plate then incubating the plate for 24 hours. The bacterial colonies could then be counted.

The student took certain precautions to avoid contaminating the cultures.

Explain how each precaution shown in the table below helped to avoid contamination.

Write your answers in the spaces provided on the table.

Precaution	Explanation
	
	

[2]

(b). After incubation for 24 hours, the student studied the agar plate. The plate was completely covered by a film of bacteria and it was not possible to count colonies.

Describe a modification to the procedure that would enable the student to estimate the population size.

[2]

(c). * Once the student had mastered the procedure to estimate population size, they decided to investigate the effect of temperature change on the rate of population growth.

The student used the following procedure:

- A broth culture was incubated at 20°C.
- Every four hours a pipette was used to transfer a sample of the culture to agar growth medium in a petri dish.
- The sample was spread over the surface of the agar by tilting and swirling the dish.
- The petri dish was incubated at 30°C for 24 hours.
- After 24 hours the petri dish was labelled and stored in a refrigerator until all results were complete.
- The procedure was repeated with broth cultures incubated at 10°C, 30°C and 40°C.
- Once all the agar plates had been collected the student removed them from the refrigerator and estimated population size by counting the visible colonies.
- Finally the student converted the data into a growth rate.

Describe and explain modifications that the student should make to improve the investigation and ensure the data collected are valid. (You may assume that full aseptic technique was used.)

[6]

(d). Microorganisms such as the single-cell fungus *Fusarium* can be cultured to grow food for the human population. In order to scale up cultures of microorganisms scientists use large fermenters. A study was carried out to determine which of two species of *Fusarium* would be better for production of fungal protein.

Fig. 18.1 shows the results of the study.

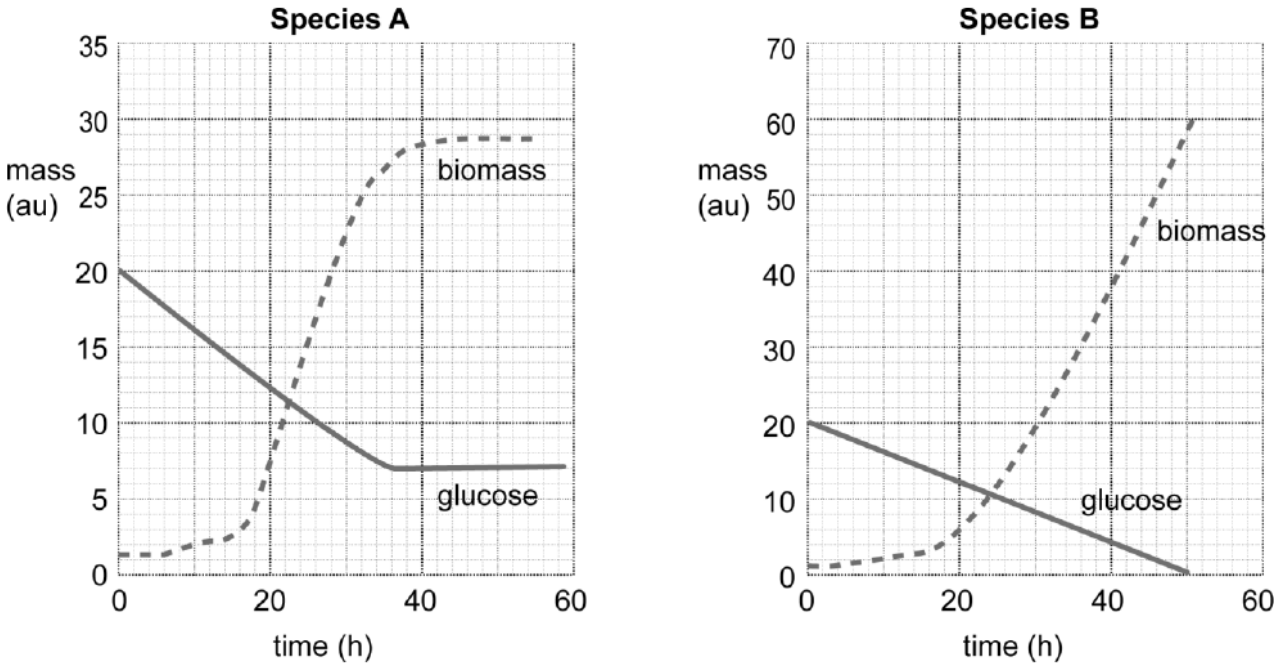


Fig. 18.1

(i) Calculate the percentage of glucose used by species **A**.

Answer = _____ % **[2]**

(ii) Using the information in Fig. 18.1 suggest which species would be better for use in production of fungal protein for human consumption.

Explain your choice.

_____

_____

_____

_____ **[2]**

(e). Table 18.1 compares burgers made from fungal protein with burgers made from beef.

Protein source	Total fat (%)	Saturated fat (%)	Cholesterol (%)	Essential amino acids (%)	Energy (kJ $100g^{-1}$)
Fungus	4.8	0.5	0.000	4.98	611
Beef	24.7	10.7	0.076	7.92	1218

Table 18.1

Some people think that we should produce fungal protein rather than beef for human consumption. Use Table 18.1 and your own knowledge to discuss this claim.

---

[4]

13. One way that humans try to maximise food production is to manipulate the transfer of energy through ecosystems.

A number of methods can be used to increase energy transfer through agricultural ecosystems and other food production systems.

These methods include:

A	artificial selection
B	recombinant DNA technology
C	growing microorganisms in a fermenter
D	use of immobilised enzymes
E	control of plant physiology with synthetic plant hormones
F	manipulation of the nitrogen cycle.

Using the letters **A** – **F**, select the **most suitable** method that could be used to achieve each of the aims shown in the table below.

You may select each letter more than once.

Aim	**Letter**
improving soil that is low in nutrients for the growing of wheat	
preventing the spoilage of fruits after picking	
reducing the impact of a fungal disease on yields from cucumber plants	
producing strawberry plants that grow quicker and fruit earlier	
making sugar syrup from waste starch	
producing large amounts of a fungus for food	

[6]

14(a). In the 1970s, the technique used to clone the frogs was successfully adapted to clone mice from embryos. Cloned mice are used to investigate factors affecting the development and treatment of disease.

(i) State **one advantage** and **one disadvantage** of using clones to test a treatment for a disease.

advantage

---

disadvantage

---**[2]**

(ii) In the 1990s, there were further developments in cloning technology when it became possible to make a clone of an adult mammal. The first clone produced from an adult cell nucleus was Dolly the sheep.

Adult cell cloning can be used to investigate the development and treatment of disease.

Outline **two other** potential applications of adult cell cloning.

1

2

---**[2]**

(b). Identical twins in humans are natural clones. They form when a fertilised egg cell divides by mitosis into two entirely separate groups of cells. Each group of cells develops into a baby.

Two brothers, who were identical twins, married two sisters, who were also identical twins. Each couple had one child.

Fig. 1.3 shows the relationships between these six people.

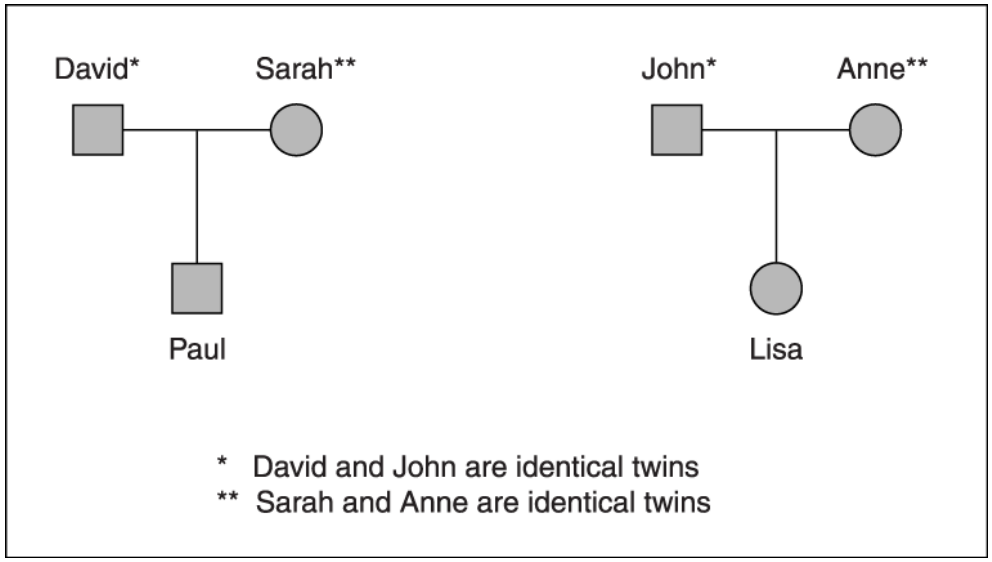


Fig. 1.3

Using your knowledge of mitosis and meiosis, estimate the percentage of alleles shared by the individuals listed in the table below.

Individuals	% of alleles shared
David and John	
Anne and Lisa	
Sarah and Lisa	

[3]

15(a). A batch fermenter is used during the production of beer.

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

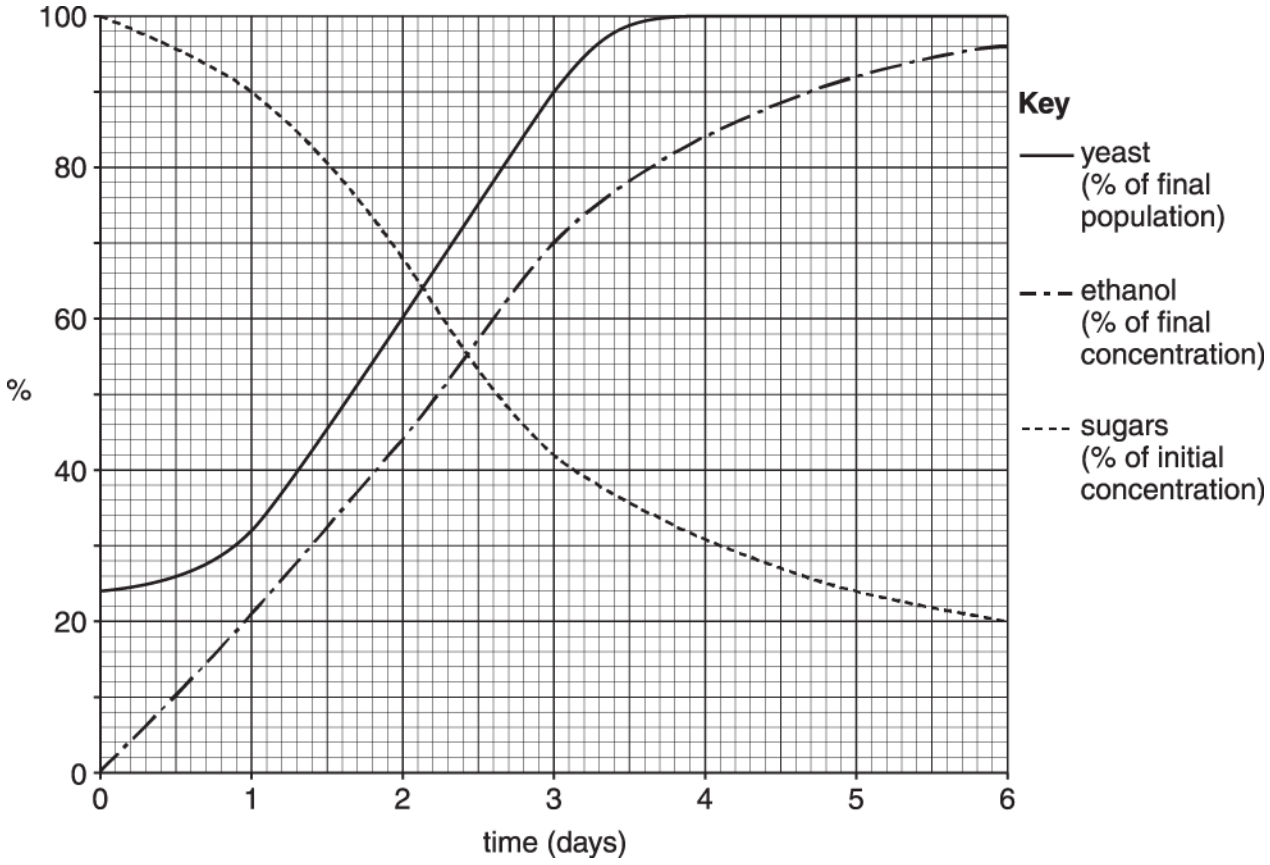


Fig. 5.1(a)

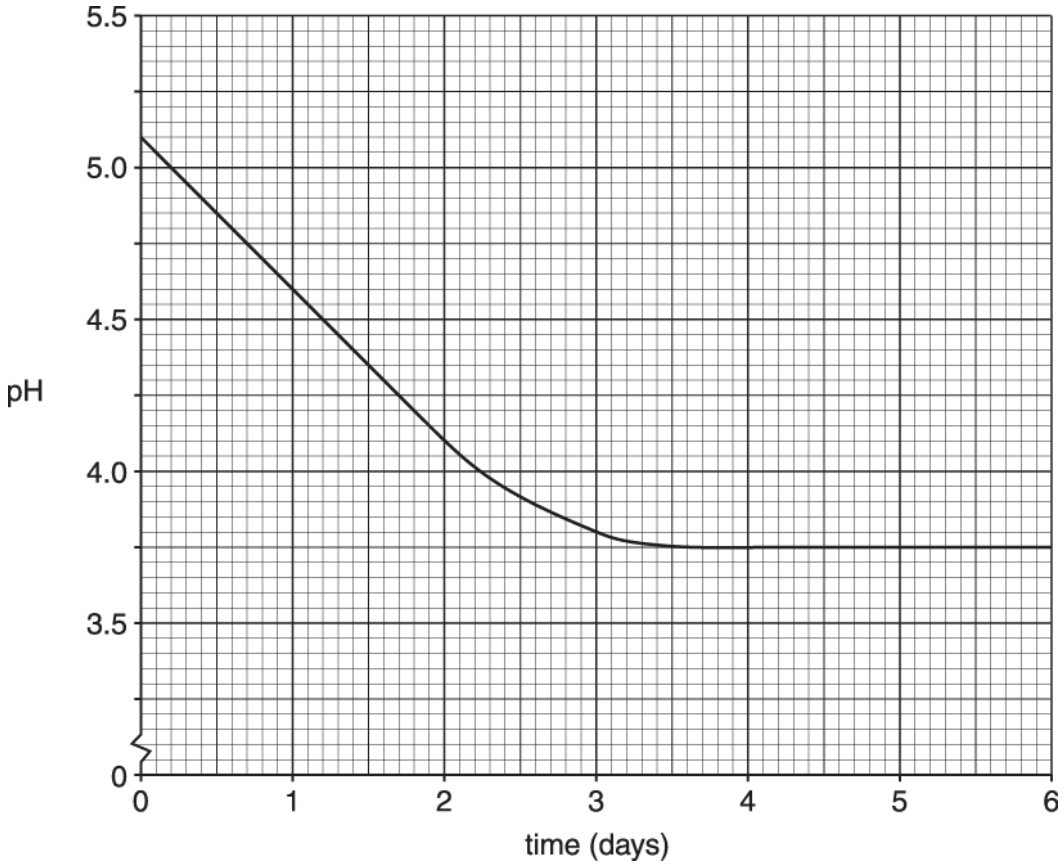


Fig. 5.1(b)

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

---

[4]

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

Explain this relationship.

---

[3]

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

---

[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

2

---

[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.

---

[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.

[6]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1			D	1	
			Total	**1**	
2			D	1	
			Total	**1**	
3			D	1	
			Total	**1**	
4			*two from* (enzymes) re-used so less, **money** / **cost** (for new ones) (1) downstream processing / purifying, **cost / expense**, reduced (1) (higher temperature allows) more **profit** from faster yield (1)	2	**Mark the first answer on each prompt line.** If the prompt numbers are ignored, mark the **first two answers** as prose. Answers **must** refer to reduced cost / losses / expense, or increased profit. **ALLOW** ORA for any point if clearly stated **IGNORE** 'more economic' in general e.g. 'Continuous processing is more economic'. Look for the details listed.
			Total	**2**	
5			*two from* work in an inoculating cabinet / maintain minimum plate-opening time (1) flame inoculating loop / use sterile, pipette tip / implement of transfer (1) seal the plates for incubation (1)	2	**IGNORE** refs to safety – question is about sterile practice. **IGNORE** autoclave, irradiation etc., as done before technician gets sample.
			Total	**2**	
6			*two from* cutting needs less / micropropagation needs more, (expensive) equipment (1) cutting needs less / micropropagation needs more, (expensive) skills / staff / AW (1) cutting produces less / micropropagation produces more, clone offspring (1) AVP (1)	1	Answers must be **comparative** Look for two separate ideas **IGNORE** refs to time, one or other method may be quicker. e.g. cutting needs less / micropropagation needs more aseptic discipline.
			Total	**2**	
7			C	1	
			Total	**1**	
8			D	1	
			Total	**1**	

Question			Answer/Indicative content	Marks	Guidance
9			C	1	
			Total	**1**	
10			B	1	
			Total	**1**	
11			C	1	
			Total	**1**	

Question			Answer/Indicative content	Marks	Guidance
12	a		*flaming the tube* causes air to expand and pushes bacteria away so less likely to settle into tube (1) kills bacteria on neck of tube (1) *holding lid of petri dish over agar plate* avoids infection / inoculation with bacteria in the air (1)	2	
	b		dilute the sample taken from the colony (1) multiply result from agar plate by dilution factor (1)	2	**ALLOW** for serial dilution, choose the correct plate (highest number of colonies without colonies merging)
	c		***Please refer to the marking instruction point 10 for guidance on how to mark this question.*** ***In summary:*** *Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.) Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors,* ***Level 1, Level 2*** *or* ***Level 3****, best describes the overall quality of the answer.* *Then, award the higher or lower mark within the level, according to the* ***Communication Statement*** *(shown in italics):* • *award the higher mark where the Communication Statement has been met.* • *award the lower mark where aspects of the Communication Statement have been missed.* • ***The science content determines the level.*** • ***The Communication Statement determines the mark within a level.***		

Question			Answer/Indicative content	Marks	Guidance
			Level 3 (5–6 marks) A good range of correct modifications are provided. Each modification is explained. Comments both on improvement to the investigation **and** on validity are included. *The explanations are clearly linked to the modifications with a well-reasoned explanation of how the modification will work.* **Level 2 (3–4 marks)** Some correct modifications are provided. Each modification is explained. Comments on improvement to the investigation and / or on validity are included. *The explanations are clearly linked to the improvements but it may not be clear how the modifications will work to improve the investigation or make the results more valid.* **Level 1 (1–2 marks)** Limited correct modifications are provided. There are no clear explanations of how the modifications will improve the investigation or validity of the results. OR Only one correct modification is described with a clear explanation of how it will improve the investigation or validity. *There is a logical structure to the answer. The explanation, though basic and not linked to the modification, is clear.* **0 marks** No response or no response worthy of credit.	6	**Indicative scientific points may include:** **Modifications:** 1 Take samples more frequently than every four hours 2 Use a spreader to spread the bacteria on the agar 3 Label petri dish as soon as inoculated 4 Place petri dishes upside down 5 Use a wider range of temperatures / use more intermediate temperatures **Explanations:** 1 Bacteria can reproduce (very) quickly and a big change could occur in four hours so detail of growth may be missed 2 Tilting / swirling the plate may not spread the bacteria evenly and this would make counting the colonies more difficult and cause the result to be invalid 3 The dishes could easily be confused or mixed up so that the results are invalid 4 Prevents the agar drying out which would reduce bacterial growth and make the results invalid 5 Provides more information about the effect of temperature
	d	i	65 (1)(1)	2	Correct response = two marks. If incorrect response allow one mark for working: $\frac{(20-7)}{20} \times 100$

Question			Answer/Indicative content	Marks	Guidance
		ii	*Species B* [no mark] produces more biomass (1) continues to produce biomass at low glucose concentration (1)	2	
	e		*Any four from:* microorganisms grow more quickly and can produce more protein per, hour / day / week (1) microorganisms can be grown on waste material from other processes (1) beef has five times the total fat content of protein produced by microorganisms ORA (1) beef has 20 times the saturated fat content and is more likely to contribute to atherosclerosis / heart disease ORA (1) fungal protein has no cholesterol and is less likely to contribute to, atherosclerosis / heart disease (1) people on a weight reduction diet prefer fungal protein as it has half the energy content of beef (1) AVP (1)	4	**ACCEPT** reverse argument **ACCEPT** reverse argument **IGNORE** 'more' or 'less' **ACCEPT** reverse argument **IGNORE** 'more' or 'less' e.g. rearing beef takes up a lot more land
			Total	**18**	

Question			Answer/Indicative content	Marks	Guidance
13			<table><tr><th>Goal</th><th>Letter</th></tr><tr><td>improving soil that is low in nutrients for the growing of wheat</td><td>F ;</td></tr><tr><td>preventing the spoilage of fruits after picking</td><td>E ;</td></tr><tr><td>reducing the impact of a fungal disease on yields from cucumber plants</td><td>A / B ;</td></tr><tr><td>producing strawberry plants that grow quicker and fruit earlier</td><td>A / B ;</td></tr><tr><td>making sugar syrup from waste starch</td><td>D ;</td></tr><tr><td>producing large amounts of a fungus for food</td><td>C ;</td></tr></table>	6	**Mark the first answer in each box**. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **ACCEPT** A / B **ACCEPT** C **Examiner's Comments** A Generally well answered question, with the majority of candidates gaining full marks. Producing strawberry plants which grow quicker was the most common point to get wrong, with the choice of E given. Some candidates put multiple letters in the boxes, which examiners allowed, if all letters given were present as options in the mark scheme.
			Total	**6**	

Question			Answer/Indicative content	Marks	Guidance
14	a	i	*advantage* (genetically identical so) all react the same **or** genetic variable controlled; *disadvantage* expensive (to produce) **or** don't see varied response to drug like in real populations (of mice) **or** *idea that* clones (of mice) may have unknown health issue (which would affect responses);	2	**Note that the question refers to the use of cloned or uncloned mice in testing – and NOT to humans.** **ACCEPT ora** throughout **IGNORE** large numbers of clones produced **IGNORE** ref to animal welfare / religious objections **IGNORE** ref to validity **ACCEPT** 'no genetic diversity to affect results' **ACCEPT** 'rare allergies / adverse reactions, won't be seen' **Examiner's Comments** Whilst many recognised that benefit was due to clones being genetically identical and therefore all responding in the same way, fewer candidates could describe a disadvantage correctly. Many invoked ethical issues, and a few introduced the idea that the clones would be expensive to produce, or that the cloned mice would not show the range of responses to be expected of the general (mouse) population.

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td></td><td>ii</td><td>1 idea to produce, elite / best, animals;

2 idea to save / preserve, endangered animals;

3 grow / produce (spare), stem cells / tissues / organs;

4 AVP;</td><td>2</td><td>IGNORE ref research into disease (as given in Q)
IGNORE ref to cost

1 ACCEPT example / desirable characteristics

2 ACCEPT recreating extinct animals

3 ACCEPT ref to named example of, tissue / organ

4 e.g. pet cloning / cloning GM animals / animals for xenotransplantation

Examiner's Comments

Generally well answered with most candidates gaining 2 marks.</td></tr>
<tr><td></td><td>b</td><td></td><td><table><tr><th>Individuals</th><th>% of alleles shared</th></tr><tr><td>David and John</td><td>100</td><td>;</td></tr><tr><td>Anne and Lisa</td><td>50</td><td>;</td></tr><tr><td>Sarah and Lisa</td><td>50</td><td>;</td></tr></table></td><td>3</td><td>Mark the first answer in each box. If an additional answer is given that is incorrect or contradicts the correct answer, then = 0 marks

Examiner's Comments

Most candidates got full marks for this question. However, some answers had values such as 99% or 49%, indicating that the idea of inheriting half of each parent's alleles had not been applied correctly.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>7</td><td></td></tr>
</table>

Question			Answer/Indicative content	Marks	Guidance
15	a	i	**1** lag phase / slow increase (in, population / number / percentage), at start / initially / day 0 - 1 / during day 1; **2** log phase / exponential increase / rapid increase, day 1 - 3; **3** <u>rate of increase</u>, slows / less steep, days 3 - 4 / during day 3; **4** stationary phase / population levels off / population stays at 100%, at end / finally / remaining days / days 4 - 6; **5** comparative figures quoted with 2 x-y readings;	4 max	**IGNORE** explanations **ACCEPT** 'the population grows' or 'it grows' (rather than increase) **DO NOT CREDIT** 'yeast grow(s)' **1 ACCEPT** days 0 – 0.9 **ACCEPT** lasts 1 day **2 ACCEPT** days 0.9 – 3.5 **3 ACCEPT** days 3.3 – 3.6 **4 ACCEPT** after day 3.5 – 4 **5** Each unit must be quoted at least once **Take care to distinguish between an increase in percentage (by either quoting the figures for the days or by calculating the difference) and a *percentage increase*.** **Examiner's Comments** This question was generally done very well with candidates often gaining 3 out of the 4 available marks. Most candidates knew the terms lag and log phase and could describe the growth occurring there. However many could not accurately quote the days at the beginning and end of each phase. Many also read the values wrongly from the graph or failed to express it correctly i.e. 2 x-y readings, and so failed to gain mp5. Only a very few candidates

Time (days)	Yeast (% final population)
0	24
1	32
3	90
3.5 - 6	100

Question			Answer/Indicative content	Marks	Guidance
					gave a comment that the rate of increase slowed down during day 3. A significant number also described the pH, sugar and ethanol changes shown by the graphs, or explained reasons why the growth rate was slow or fast, which gained no credit.
		ii	**1** sugar converted to ethanol; **2** in anaerobic respiration; **3** sugar, undergoes glycolysis / converted to pyruvate; **4** pyruvate, loses carbon dioxide / decarboxylated / forms ethanal; **5** reduced NAD giving hydrogen to ethanal; **6** *idea of* NAD being, regenerated / recycled, (so) glycolysis continues; **7** correct ref to, pyruvate decarboxylase / ethanol dehydrogenase;	3 max	**CREDIT** glucose / maltose / maltotriose for 'sugar' **2 IGNORE** fermentation **5 CREDIT** $NADH_2$ / NADH ($+H^+$) / red NAD **Examiner's Comments** It was pleasing to see that the majority of candidates could relate the decrease in sugar concentration to the fact that the yeast is converting it to ethanol in anaerobic respiration. Good responses went on to describe the steps involved in the conversion of sugar to ethanol to gain full marks.
		iii	*ethanol is* produced in, **all** yeast growth phases / **all** of the time **or** production of ethanol increases as yeast population increases **or** *idea that* ethanol is a normal (metabolic waste) product (of yeast);	1	**IGNORE** ref to ethanol not being a secondary product **CREDIT** 'produced during normal growth' **CREDIT** follows growth curve for yeast **IGNORE** waste unqualified **Examiner's Comments** Many candidates successfully gained a mark for stating that ethanol was produced as a normal product of metabolism or that it followed the growth curve of yeast. A common error was to say that ethanol was produced during a specific phase rather than in all growth phases, or that ethanol is needed for growth.

Question			Answer/Indicative content	Marks	Guidance
		iv	**1** sugar concentration falls **too** low; **2** pH falls **too** low / conditions become **too** acidic / decrease in pH causes enzymes to denature; **3** high ethanol concentration, damages / poisons / inhibits, yeast;	2 max	**1 ACCEPT** very low sugar concentration / sugar concentration decreases as used up **2 ACCEPT** very low pH / very acidic **DO NOT CREDIT** 'falls and rises' **3 ACCEPT** high ethanol concentration kills yeast **Examiner's Comments** It was surprising that more candidates did not score 2 marks on this question. Many referred to pH but did not discuss it being too low or refer to denaturing of enzymes, and some thought it would go too high. A number of candidates incorrectly referred to the presence of ethanol as being responsible for pH changes. Only a few referred to sugar concentration going too low, and many just used the term sugar alone or just said it would decrease. The term 'amount' was often used instead of the required more precise term 'concentration'.

Question			Answer/Indicative content	Marks	Guidance
	b		**1** glucose can, be used / enters glycolysis, directly / without being broken down (first); **2** maltose, must, be hydrolysed / have glycosidic bonds broken; **3** enzyme / maltase, only made when, needed / maltose present / glucose running out; **4** enzyme induced / gene(s) switched on; **5** transcription and translation / protein synthesis, takes time; **6** maltotriose requires, more (2) hydrolysis (reactions) / breaking of more (2) glycosidic bonds **or** enzyme to break down maltotriose made last;	3 max	**ACCEPT** 'monosaccharide' for glucose and 'disaccharide' for maltose and 'trisaccharide' for maltotriose throughout **1 IGNORE** ref to glucose being used first / at start / immediately (as stated in Q) **Examiner's Comments** This was a challenging question, which few candidates grasped, often simply reciting the information given in the stem of the question. Many thought that glucose needed to be broken down before it could be used. There was a lot of reference to breaking the disaccharide or trisaccharide down before use, but many answers were vague and did not mention hydrolysis or glycosidic bonds, gaining no credit. Only a few candidates realised that enzymes would need to be produced to carry out the hydrolysis and that this would involve enzyme induction and protein synthesis.

Question			Answer/Indicative content	Marks	Guidance
	c			5 max	**CREDIT** statements relating to yeast method only **IGNORE** statements relating to chemical method **IGNORE** ref to cost
			advantages of using yeast **A1** less energy required; **A2** does not need, high temperature / 300°C / high pressure; **A3** can use waste material (as a substrate); **A4** substrate is, sustainable / grown each year; **A5** process does not use up, oil reserves / fossil fuels; **A6** product is carbon neutral / no carbon footprint; **A7** AVP;		**A2 ACCEPT** works well at low, temperatures / pressures **A3 CREDIT** example e.g. sugar cane waste **A6 IGNORE** ref to global warming / greenhouse gases **A7** e.g. yeast is readily available / easily accessible / yeast is in plentiful supply / yeast has simple growth requirements / process is less hazardous
			disadvantages of using yeast **D1** time consuming / takes several days; **D2** needs, downstream processing / purification of product; **D3** is killed by product; **D4** can (only) use batch method; **D5** aseptic / sterile, conditions required; **D6** AVP;		**D1 ACCEPT** slower rate of reaction **D2 ACCEPT** need to separate ethanol from yeast **D3 ACCEPT** is inhibited by product **D5 ACCEPT** more likely to become contaminated **D6** e.g. concentration of ethanol produced is limited
			QWC;	1	**Award** if 2 **A** marks **and** 2 **D** marks have been awarded **Place a tick or a cross alongside the pencil icon to indicate whether or not the QWC mark has been awarded.**

Question			Answer/Indicative content	Marks	Guidance
					Examiner's Comments This question worked well as a discriminator, generating a full range of marks. The weaker candidates often wrote about the chemical method rather than the advantages or disadvantages of using yeast. Good answers often referred to the advantage of using lower temperatures and less energy, but only a few mentioned the idea that the process did not use fossil fuels and left no carbon footprint. The disadvantages were more clearly understood, with many knowing it was a time consuming process with a higher risk of contamination and the need for purification of the product. Some candidates thought it was a continuous process and that it produced a more natural form of ethanol.
			Total	**19**	