Cloning and Biotechnology (6.2.1): OCR A Level Biology Exam Questions

18 questions · 43 marks · about 52 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · A level Paper 3 · June 2024 · Q6(a) · 4 marks

6 Plants can be cloned and propagated in horticulture and agriculture.

(a) Describe how artificial clones of plants are produced using micropropagation.

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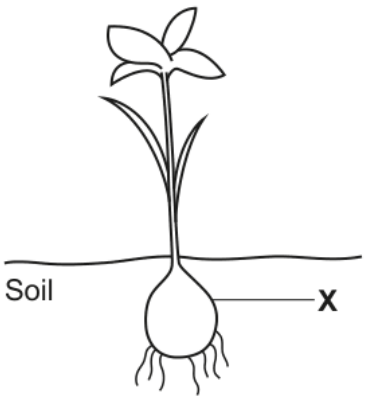
..... **[4]**

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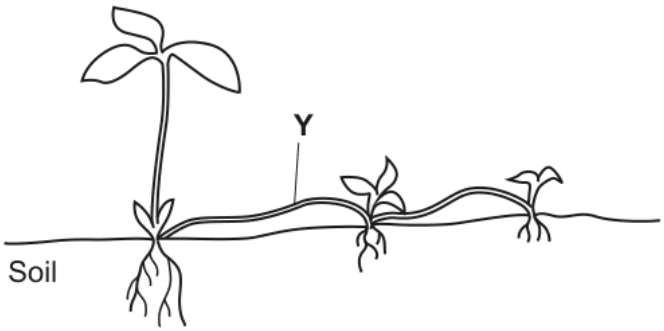
Question 2 · A level Paper 3 · June 2024 · Q6(c)(i) · 2 marks

(c) The diagram shows a lily plant and a peppermint plant.

Lily plant



Peppermint plant



(i) State the name of structure **X and** outline how a gardener could produce many cloned plants from structure **X**.

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

Question 3 · A level Paper 2 · June 2025 · Q17(c)(i) · 1 mark

(c) Animals can be cloned artificially using embryo splitting.

This is the procedure for cloning by embryo splitting:

1. An egg from a female is fertilised by sperm from a male.
2. The zygote divides to form an embryo.
3. After a few days, the developing embryo is split into several smaller embryos.
4. After a few days, each smaller embryo is implanted into a surrogate mother.
5. Each embryo grows into a fetus and is born normally.

(i) State the property of the cells in the embryo that allows cloning to be successful.

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

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Question 4 · A level Paper 3 · June 2024 · Q1(c) · 2 marks

(c) *E. coli* can be genetically modified to produce useful proteins.

State **two** other reasons why *E. coli* is a suitable microorganism to use in biotechnology.

1 .....

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2 .....

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[2]

Question 5 · A level Paper 2 · June 2022 · Q21(a) · 2 marks

21 Microorganisms can be used to produce a variety of food products.

(a) Microorganisms have simple nutrient requirements, which helps to reduce production costs.

List **two** other advantages of using microorganisms in food production.

1 .....

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2 .....

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[2]

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Question 6 · A level Paper 3 · June 2019 · Q6(a)(ii) · 3 marks

(ii) On an industrial scale, microorganisms can be cultured using either batch fermentation or continuous fermentation.

The table below lists statements about industrial culturing of microorganisms.

Place ticks (✓) in the table to indicate whether each statement applies to batch or continuous fermentation.

Statement	Batch	Continuous
Waste is removed during the fermentation process		
A fixed volume of nutrient medium is used		
Secondary metabolites are more likely to be produced		
The growth rate tends to be faster		
The culture is grown for a fixed period of time		

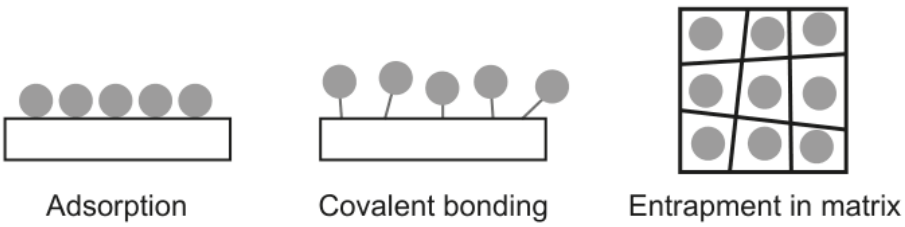
[3]

Question 7 · A level Paper 2 · June 2023 · Q18(a) · 1 mark

18 Immobilised enzymes are often used for industrial processes.

Fig. 18.1 shows three methods for immobilising enzymes.

Fig. 18.1



(a) State **one** other method for immobilising enzymes.

.....

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

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Question 8 · A level Paper 2 · June 2019 · Q20(a)(i) · 4 marks

20 Plant cloning is often used by farmers to produce new plants.

A plant that is often cloned by taking cuttings is lavender, *Lavandula angustifolia*.

(a) A farmer had two fertiliser solutions, solution **A** and solution **B**, and wanted to investigate which one to use on lavender plants. In order to ensure the investigation would be valid, two cuttings were needed from the same parent plant.

(i) Describe how to clone a plant by taking a cutting.

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Turn over

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Question 9 · A level Paper 2 · June 2019 · Q20(b) · 3 marks

(b) Cloning plants is also known as vegetative propagation.

Identify **three** advantages of vegetative propagation in agriculture.

1 .....

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2 .....

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3 .....

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[3]

Turn over

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(b) Both *A. aerophoba* and *S. fasciatum* reproduce sexually, but under particular conditions they are both able to reproduce asexually.

In asexual reproduction in *A. aerophoba*:
- clumps of diploid cells detach from the body of the sponge
- the cells reattach to a surface and grow into new, adult sponges.

In asexual reproduction in *S. fasciatum*:
- meiosis occurs in a female
- two of the haploid cells produced by meiosis fuse to form a diploid cell
- the diploid cell develops into a new shark.

A student stated, 'When they reproduce asexually, both animals produce clones of themselves.'.

Evaluate the student's statement.

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

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19 It is possible to clone animals using a technique called somatic cell nuclear transfer (SCNT).

The most well-known example of this was the cloning of Dolly the sheep in 1996.

(a) Thirty years before Dolly the sheep, successful cloning of an animal was carried out using a frog, *Xenopus laevis*.

Frogs lay eggs in water. These eggs then develop and hatch into swimming tadpoles. When the tadpoles grow to a certain size they develop into adult frogs.

The cloning process is outlined in Fig. 19.1.

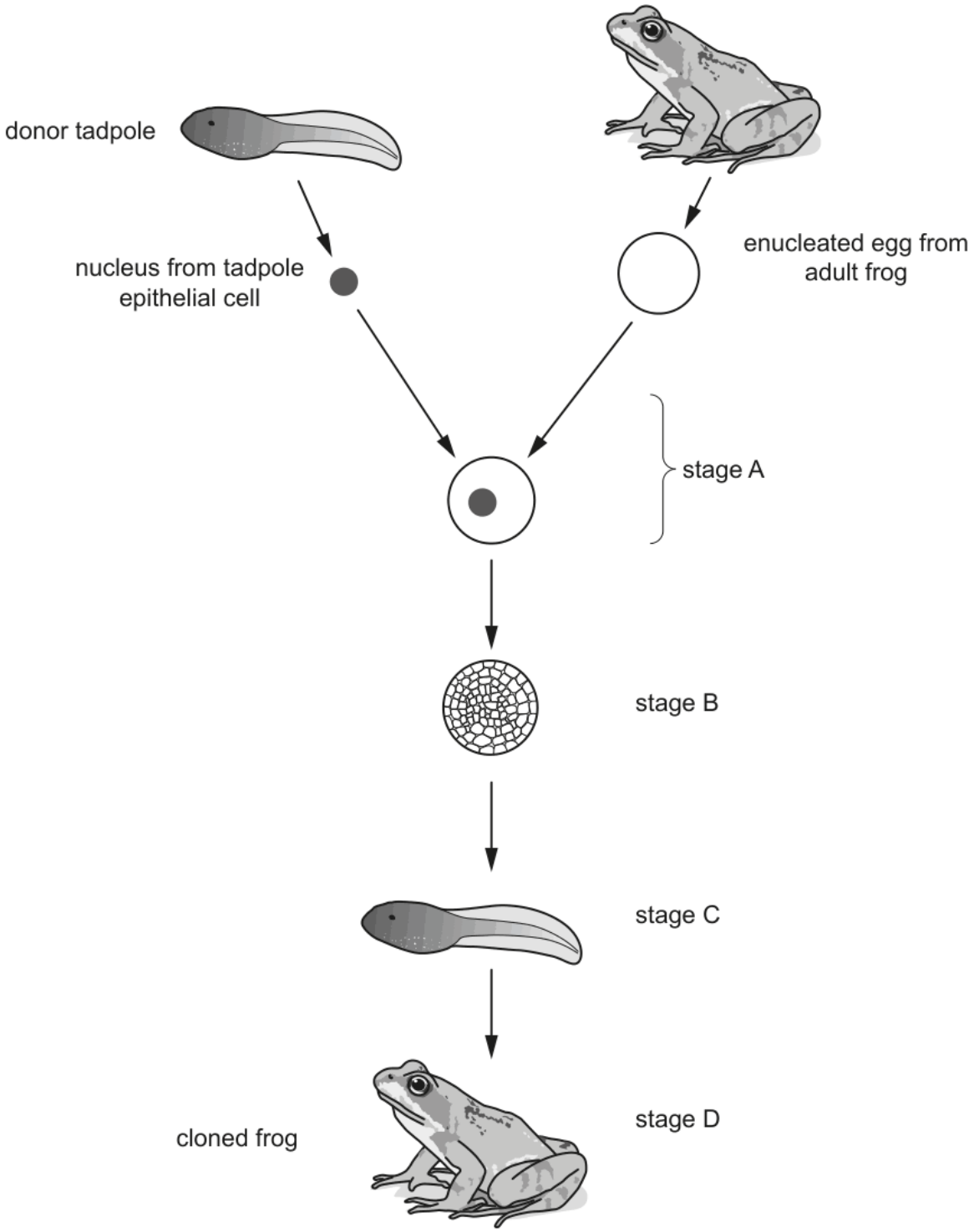


Fig. 19.1

(i) Describe what is happening at stage A **and** suggest a practical procedure that could allow this to occur.

21

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Question 12 · information from earlier in the question

(d) Animals can be cloned artificially using a technique called somatic cell nuclear transfer (SCNT).

SCNT can be used to increase the population of an endangered species.

Przewalski's horse, *Equus przewalskii*, is a species of horse related to the domestic horse, *Equus caballus*. The common ancestor of both horse species is thought to have lived 45 000 years ago.

Przewalski's horse became extinct in the wild in the 1960s. Captive breeding from 12 individuals has increased the population and some have since been reintroduced to the wild.

The genetic diversity of all modern Przewalski's horses is very low.

In 2020 and 2022, SCNT using frozen cells from an individual that died 42 years previously has led to the birth of two cloned Przewalski's horses which appear to be free of health problems.

(i) Outline how genetic diversity in a species such as Przewalski's horse can be measured.

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

Question 12 · A level Paper 2 · June 2025 · Q17(d)(iii) · 1 mark

(iii) Suggest **one** reason why the health of the cloned Przewalski's horses is better than that of Dolly the sheep, the first mammal to be cloned by SCNT.

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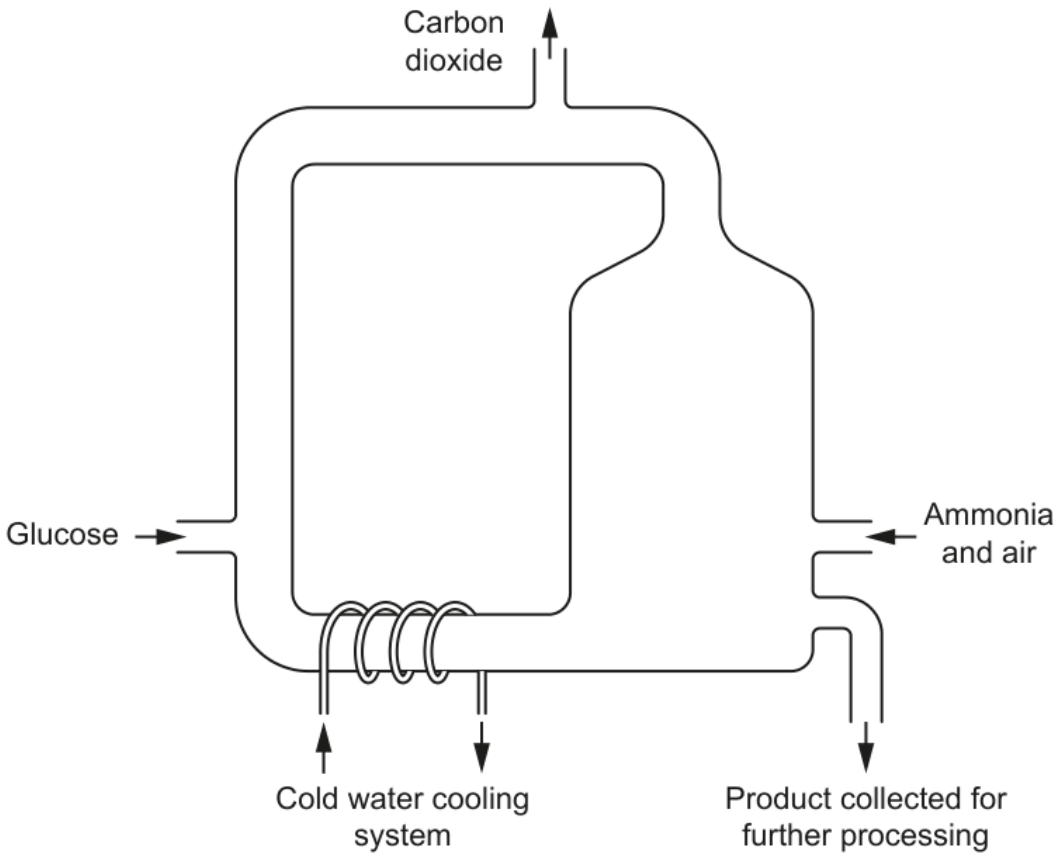
..... **[1]**

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Question 13 · information from earlier in the question

(c) The microorganism that is used to produce mycoprotein is a fungus.

The diagram is of a fermenter used for mycoprotein production.



(i) Use the diagram to name the type of fermentation process used for mycoprotein production.

Justify your answer.

Name .....

Justification .....

.....

[1]

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Question 13 · A level Paper 2 · June 2022 · Q21(c)(ii) · 2 marks

(ii) Suggest and explain why a cooling system is necessary.

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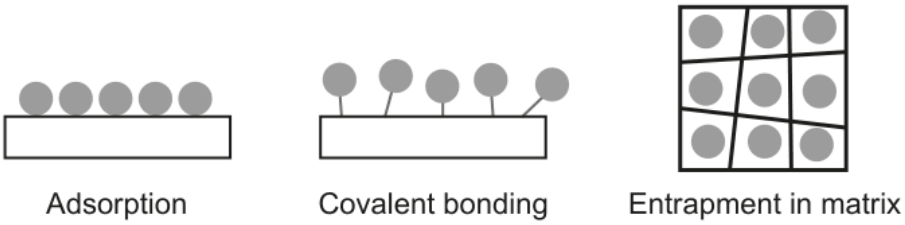
..... **[2]**

Question 14 · information from earlier in the question

18 Immobilised enzymes are often used for industrial processes.

Fig. 18.1 shows three methods for immobilising enzymes.

Fig. 18.1



(a) State **one** other method for immobilising enzymes.

.....

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

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Question 14 · A level Paper 2 · June 2023 · Q18(b) · 2 marks

(b) One advantage of using immobilised enzymes is that the enzyme can be reused many times. However, the process of immobilisation can reduce the activity of enzymes.

With reference to **Fig. 18.1**, explain why the activity of immobilised enzymes might be lower than that of enzymes that are free in solution.

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

Question 15 · A level Paper 3 · June 2017 · Q2(b)(ii) · 2 marks

(ii) Describe **two** practical considerations to ensure the *S. cerevisiae* population grows successfully when the initial culture is established.

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

Turn over

Questions, mark schemes and examiners' report extracts © OCR.

Question 16 · information from earlier in the question

17 Some students investigated the effect of time on the growth of bacterial populations.

The students prepared a large flask of bacterial culture.

They divided this large culture into a number of smaller flasks each containing 50 cm^3 of bacterial culture.

They then incubated the smaller flasks at 20 °C for up to 48 h.

Every 4 h the students removed one of the flasks and counted the bacteria.

The students recorded the total number of bacteria and the number of viable bacteria in each flask.

(a) When growing bacteria in culture, it is important that aseptic techniques are used.

(i) State why it is important that the technique used for culturing microorganisms be aseptic.

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

(b) When counting the number of bacteria, the students performed serial dilutions on samples removed from each small flask. In each serial dilution, the students removed 0.1 cm^3 and added it to 9.9 cm^3 of water.

To estimate the total number of bacteria, the students used a light microscope to count the number of bacterial cells in a 0.01 cm^3 sample of the final serial dilution.

To estimate the number of viable bacteria, the students spread 0.1 cm^3 of the final serial dilution on an agar plate and counted the number of colonies that had grown after 24 h.

(i) The students shook each flask before they removed the samples for counting.

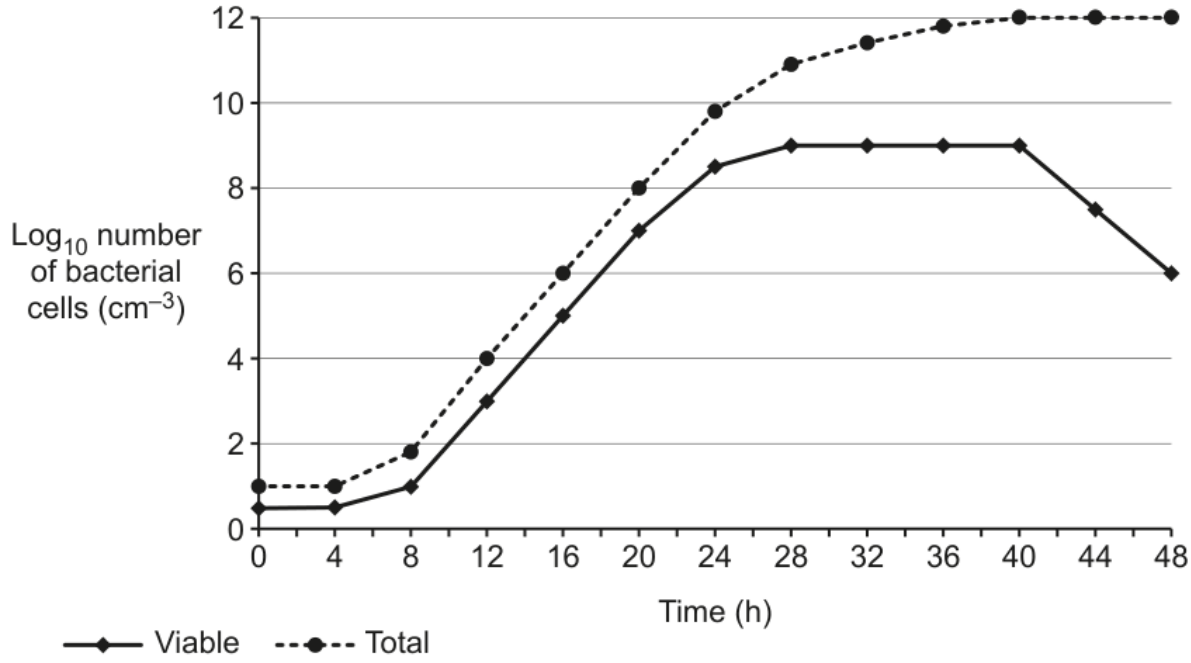
Suggest why the students shook the flasks.

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

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(c) The graph shows the students' results.



(i) Explain, with reference to the graph, why the students used a logarithmic scale on the *y*-axis.

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

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Question 16 · A level Paper 2 · June 2022 · Q17(d) · 4 marks

(d) Explain, with reference to the graph, the decrease in the population of viable bacteria between 40 h and 48 h.

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Turn over

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(d) Scientists recorded the population growth of bacteria in a closed culture. The scientists added various nutrients to the culture, including nitrate (NO_3^-).

Fig. 2.3 shows the growth curve of the bacterial population.

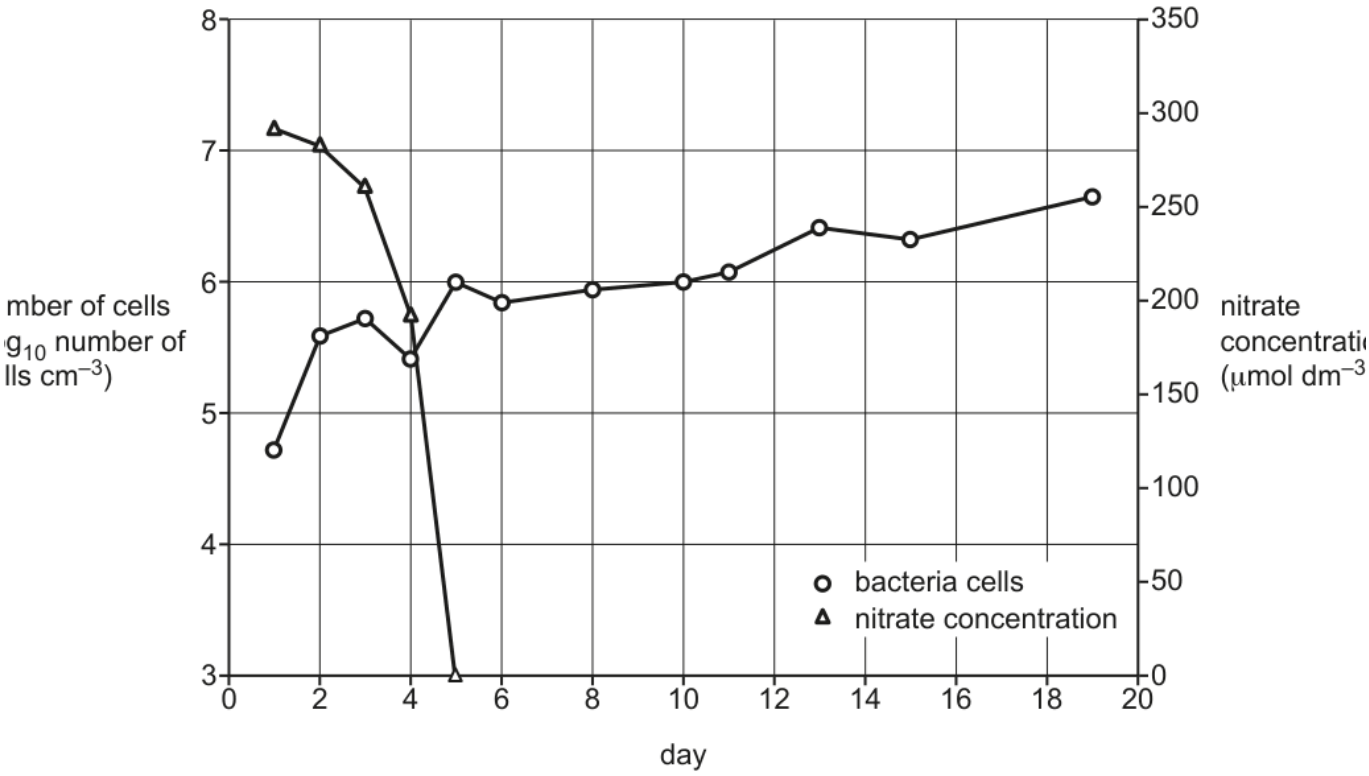


Fig. 2.3

(i) A student looked at **Fig. 2.3** and made the following statement:

'The bacterial growth curve in **Fig. 2.3** looks very different from a standard growth curve for bacterial populations.'

Use evidence from **Fig. 2.3** to evaluate the student's statement.

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

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Question 17 · A level Paper 3 · November 2021 · Q2(d)(ii) · 3 marks

(ii) Calculate the total number of bacterial cells that would have been present in a 50 cm^3 container on day 1.

Write your answer in standard form.

Number of bacterial cells = ... **[3]**

Question 18 · information from earlier in the question

19 Two students investigated the growth of bacteria at different temperatures.

Three flasks containing identical solutions of nutrient broth were used.

- Flask 1: inoculated with 1 cm^3 of broth containing the bacterium *Bacillus subtilis* and incubated at 20 °C.
- Flask 2: inoculated with 1 cm^3 of broth containing *B. subtilis* and incubated at 30 °C.
- Flask 3: inoculated with 1 cm^3 of broth containing no bacteria and incubated at 30 °C.

Aseptic techniques were used throughout.

At set times over the next 3 days the students removed samples from each flask and measured the number of viable bacteria present.

(a) State one further variable the students should have controlled in their investigation in order to produce **valid** results.

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

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(b) The students used the following procedure to determine the number of viable bacteria in each flask at a given time.

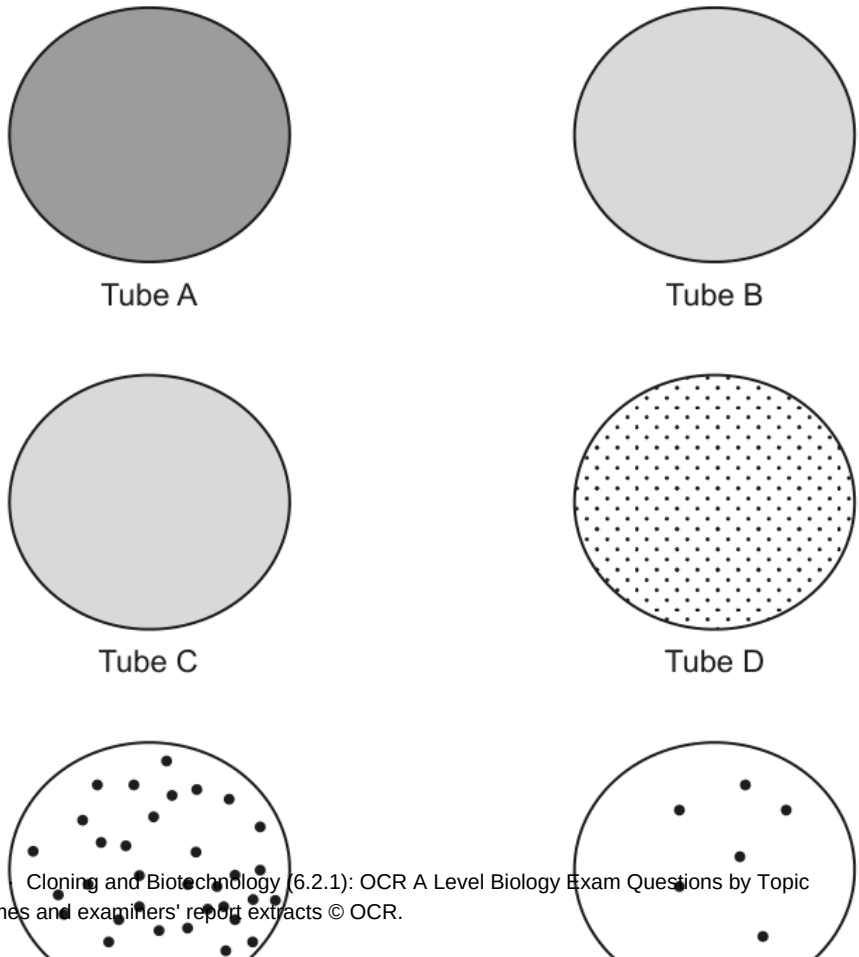
From each flask, 0.1 cm^3 was removed and mixed with 9.9 cm^3 of sterile water in a test tube. This was labelled **Tube A**. A serial dilution then proceeded, as shown in Table 19.1.

Tube	Contents	
B	1 cm^3 of Tube A mixture	9 cm^3 of sterile water
C	1 cm^3 of Tube B mixture	9 cm^3 of sterile water
D	1 cm^3 of Tube C mixture	9 cm^3 of sterile water
E	1 cm^3 of Tube D mixture	9 cm^3 of sterile water
F	1 cm^3 of Tube E mixture	9 cm^3 of sterile water

Table 19.1

From each tube, A–F, 0.1 cm^3 of mixture was cultured on nutrient agar for 24 hours at 30 °C.

The results from Flask 2 after 7 hours of incubation are shown in Fig. 19.



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Mark schemes

Question 1 · A level Paper 3 · June 2024 · Q6(a) · 4 marks

6	(a)	1. remove meristem tissue from, shoot (tip) / root (tip) / leaf / (apical / axial) bud ✓ 2.use aseptic techniques / described ✓ 3.place (explant) in culture medium / described ✓ 4.*ref to* use of **named** nutrient in culture medium ✓ 5.to allow cells to divide / to form a callus ✓ 6.divide (callus) into smaller clumps (of cells) ✓ 7. ref.(named) hormones / plant growth substances, to encourage differentiation / (shoot / root) growth / AW ✓ 8.transfer (plantlet) to, soil / compost ✓
Question		**Answer**

4 max	e.g. disinfect surfaces / work near Bunsen flame / use sterile scalpel / sterilise with, ethanol / sodium dichloroisocyanurate / bleach / sodium hypochlorite e.g. 'place on agar gel' *example* 'place on sterile nutrient medium' = mp2 and 3 e.g. amino acids for protein synthesis / phosphates for DNA or ATP / glucose or sucrose for respiration **ALLOW** 'allow cells to undergo mitosis' e.g. auxins / cytokinins, for specialisation **IGNORE** ref to hormones for mp7 if they are added before the callus forms
Mark	**Guidance**

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Question 2 · A level Paper 3 · June 2024 · Q6(c)(i) · 2 marks

6	(c)	(i)	bulb ✓ split / divide / cut, (bulb / corm / tuber) **and**, plant / repot / AW ✓

2	**ALLOW** corm / tuber (*as not familiar with lily plant)* **IGNORE** rhizomes **ALLOW** 'remove bulb scale' for 'split bulb'

Question 3 · A level Paper 2 · June 2025 · Q17(c)(i) · 1 mark

17	(c)	(i)	(cells are) totipotent / able to differentiate into any cell <u>type</u> ✓	1	1.1

IGNORE cells are undifferentiated

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Question 4 · A level Paper 3 · June 2024 · Q1(c) · 2 marks

1	(c)		1.short life cycle / fast growth rate ✓ 2.simple nutrient requirements ✓ 3.can be maintained at (relatively) low temperatures ✓ 4.few ethical concerns ✓ 5.qualified reason why it is costs less ✓

Question	Answer
2 max	**Mark as prose** **ALLOW** reproduce / replicate / multiply, quickly / fast **ALLOW** many produced in a short period of time **ALLOW** divides rapidly **IGNORE** short lifespan **ALLOW** 'does not require many nutrients' **IGNORE** simple / few, requirements for growth **ALLOW** 'does not require high temperatures' (for growth) **ALLOW** no, (animal) welfare issues / ethical concerns **e.g.** does not take up much space / uses cheaper substrates / uses wastes as substrates / uses cheap food example 'can be kept at low temperatures which is cheaper' = mp 3 and 5 'does not use many nutrients so it reduces cost' = mp 2 and 5
Mark	**Guidance**

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Question 5 · A level Paper 2 · June 2022 · Q21(a) · 2 marks

21	**(a)**	**1** no , welfare / ethical , issues ✓ **2** can be genetically modified (relatively easily) ✓ **3** rapid growth / production can be easily changed to meet demand ✓ **4** non-seasonal / year-round production ✓ **5** take up little space ✓ **6** low costs because work at low temperatures ✓

2 max	1.2	*Mark the first two answers.* **1 ALLOW** e.g., 'acceptable to vegetarians' **3 ALLOW** rapid reproduction **IGNORE** nutrient requirements

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Question 6 · A level Paper 3 · June 2019 · Q6(a)(ii) · 3 marks

a	ii		

Statement	Batch	Continuous
Waste is removed during the fermentation process		✓
A fixed volume of nutrient medium is used	✓	
Secondary metabolites are more likely to be produced	✓	
The growth rate tends to be higher		✓
The culture is grown for a fixed period of time	✓	

✓✓✓

3	All 5 correct = ✓✓✓ 4 correct = ✓✓ 3 correct = ✓

Question 7 · A level Paper 2 · June 2023 · Q18(a) · 1 mark

18	(a)	membrane separation / encapsulation / microcapsule ✓	1

1.2	**ALLOW** contained by a partially-permeable membrane

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Question 8 · A level Paper 2 · June 2019 · Q20(a)(i) · 4 marks

20	**(a)**	**(i)**	**1**	use a healthy shoot / cut shoot from healthy plant ✓
			2	cut (stem) at a slant ✓
			3	between nodes ✓
			4	(dip in) rooting powder / plant hormone / auxin ✓
			5	place in , soil / compost , and add water ✓
			6	(to reduce transpiration) cover with plastic bag / remove some leaves ✓

4 max	**4 IGNORE** add rooting hormone to , soil / agar **5 ALLOW** place in moist soil

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Question 9 · A level Paper 2 · June 2019 · Q20(b) · 3 marks

(b)	1	some crop plants cannot reproduce , sexually / from seed ✓
	2	young seedlings , less likely to survive / AW ✓
	3	quicker than , growing from seed / sexual reproduction ✓
	4	uniform / predictable , shape / size / quality / yield ✓
	5	*idea of* easier to harvest ✓
	6	(propagation) can be done , at any season / time of year ✓
		Total

3 max	**Mark as prose** **1 ALLOW** seedless / hard to germinate , plants can be grown **4 ALLOW** always get a good yield **4 IGNORE** many copies
13	

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Question 10 · A level Paper 3 · June 2022 · Q4(b) · 3 marks

4	(b)	*idea that* sponges produce, genetically identical offspring / clones ✓ *idea that* shark offspring will not be, genetically identical / clones ✓ shark offspring have alleles from only, the mother / one parent ✓ (but) crossing over / independent assortment, (in meiosis) creates, new allele combinations / genetic variation ✓	**max 3**	3.2	

e.g. offspring of sponges share same, DNA / genome / genetic material
IGNORE 'similar DNA'

'only sponges, produce clones of themselves / share same DNA' = 2 marks

ALLOW 'shark offspring have, DNA / genetic material, only from the mother'

IGNORE 'changes the DNA'

Question 11 · A level Paper 2 · June 2019 · Q19(a)(i) · 2 marks

19	(a)	(i)	nucleus from , tadpole / donor cell , fuses with / enters / AW , (enucleated) egg ✓ using , needle / micropipette / electric pulse / electrofusion ✓	**2**

ALLOW electric , current / shock
IGNORE injection / electroporation / electricity (unqualified)

Question 12 · A level Paper 2 · June 2025 · Q17(d)(iii) · 1 mark

Question			Answer	Mark	AO	Guidance
17	(d)	(iii)	*idea of* developments in , science / technology / understanding / knowledge ✓	1	2.5	**ALLOW** reference to possibility of DNA originating from younger cell, e.g. younger when nucleus taken **IGNORE** a better understanding of genetic engineering

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Question 13 · A level Paper 2 · June 2022 · Q21(c)(ii) · 2 marks

(ii)	temperature affects , rate of growth / enzyme activity ✓ (fungal) metabolic reactions generate heat ✓ to inhibit growth of pathogenic bacteria ✓	

2 max	2.5	**ALLOW** proteins could denature (at higher temperatures) **ALLOW** respiration is exothermic

Question 14 · A level Paper 2 · June 2023 · Q18(b) · 2 marks

(b)	covalent bonding / matrix / carrier , might affect shape of active site ✓ active site might be (partly) hidden (when bonded to the carrier) ✓ substrate must move through a matrix ✓	**2**	2.5

ALLOW carrier restricts induced fit

ALLOW fewer active sites accessible
IGNORE fewer active sites

ALLOW enzymes and substrates can't freely mix
IGNORE enzymes are unable to move
IGNORE leakage

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Question 15 · A level Paper 3 · June 2017 · Q2(b)(ii) · 2 marks

ii	(use) aseptic techniques / avoid contamination ✓ provide (sources of) nutrients / respiratory substrates ✓ (incubate at) suitable temperature ✓ use (pH) buffer ✓ agitation / stirring / shaking ✓

2 max	**Mark first two suggestions given** **ACCEPT** a description of an aseptic technique **ACCEPT** sterile techniques **ACCEPT** a specific example of a nutrient **ACCEPT** optimum temperature / right temperature /a specific, appropriate temperature (15- 35°C) **IGNORE** keep temperature constant / low temperature/ monitor temperature / control temperature **ACCEPT** maintain optimum pH / right pH /a specific, appropriate pH (4-7) **IGNORE** keep pH constant / monitor pH / control pH **ACCEPT** mixing **IGNORE** ref to aeration / oxygen supply / sparging

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Question 16 · A level Paper 2 · June 2022 · Q17(d) · 4 marks

(d)		**1** reproduction rate lower than death rate ✓ **2** total count / dead bacteria , much / AW , higher than viable bacteria ✓ **3** use of figures with units (to support **2**) ✓ **4** increased / high level of , (named) waste products ✓ **5** less oxygen / fewer (named) nutrients ✓ **6** increased (intraspecific) competition ✓ **7** dead cells / turbidity / lack of space , reduces surface area for access to nutrients / oxygen ✓

4 max	1.2 2.8	**1 ALLOW** death / decline , stage / phase **2 ALLOW** total count is *very* high **3 ALLOW** e.g log12 cells per cm^3 / difference at 48h is 999 999 000 000 cells **4 ALLOW** fall in pH **4 IGNORE** secondary metabolites **5 ALLOW** oxygen / nutrients , limiting / low **5 IGNORE** food

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Question 17 · A level Paper 3 · November 2021 · Q2(d)(ii) · 3 marks

ii	**FIRST CHECK ON ANSWER LINE** **If answer = 2.5 x 10^6 award 3 marks** $10^{4.7}$ = 50,118.72336 ✓ x 50 (= 2,505,936.168) ✓ standard form = 2.5 x 10^6 ✓	3	2.4

ALLOW any value between $10^{4.5}$ and $10^{4.8}$
i.e. 1.6 - 3.2 x 10^6 award 3 marks
ALLOW 31,622.7766 – 63,095.73445
ALLOW any correct rounded value

This mark should be awarded to 'x50' seen anywhere in the working, regardless of the value being multiplied
This mark should be awarded for correctly converting to standard form, regardless of the value being converted as **ECF**
MAX 2 for correct answer not converted to standard form

Question 18 · A level Paper 2 · June 2018 · Q19(b)(i) · 2 marks

(b)	**(i)**	6.0 / 6 , x 10^7 ✓✓	**2**	*Max 1 if answer not given as standard form* **ALLOW** 1 mark for 6 x 10^6 / 6 x 10^8

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