Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1			D✓	1 (AO 1.2)	**Examiner's Comments** Many candidates appeared to confuse taking a cutting with micropropagation by tissue culture and hence less than a quarter scored a mark here.
			Total	**1**	
2			C✓	1 (AO 1.1)	**Examiner's Comments** Around half of responses were correct. Many candidates appeared to be conflating the use of microorganisms in food production with the use of microorganisms in biotechnology in general.
			Total	**1**	
3			A✓	1 (AO 1.2)	**Examiner's Comments** Most candidates got this right.
			Total	**1**	
4			D✓	1 (AO 1.2)	**Examiner's Comments** Fewer than half of candidates were able to correctly answer this question that tested detailed understanding of bacterial growth in a closed system.
			Total	**1**	
5	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 ✓	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

			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 ✓		**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 **Examiner's Comments** Generally, a well answered question, with many candidates scoring 4 marks for successfully describing the process of micropropagation. To improve their response, candidates could give details of why a specific nutrient is required or the purpose of the plant hormone applied. Some candidates were not credited the first mark point as they did not mention where the meristematic tissue was being removed from, e.g. Shoot tip. Some candidates incorrectly gave details of taking cuttings; however, many were still able to score one or two marks for using aseptic techniques and transferring the cutting to soil.
	b	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' **Examiner's Comments** Most candidates were able to label structure X as a bulb or tuber. They often did not get the second marking point as they did not mention dividing the bulb before replanting. They often replanted the whole bulb or described taking a cutting from the stem rather than the bulb. Some candidates, perhaps prompted by Question 6 (a), described using micropropagation techniques which would not be appropriate for a gardener to employ.
		ii	runner ✓ roots / shoots, form (away from parent plant) **or**	2	**ALLOW** stolon / horizontal stem / lateral stem **IGNORE** 'new plant grows away from parent plant' e.g. 'runners, detach / break down / breaks **IGNORE** 'by asexual reproduction /

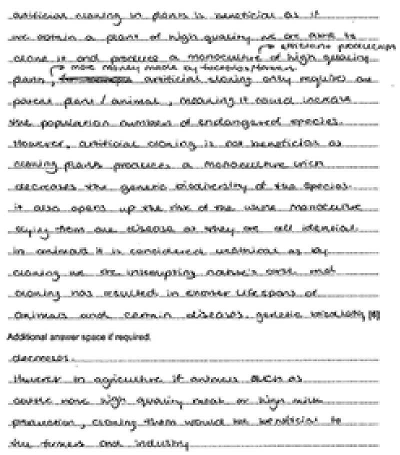
			runner between plant(let) dies / described ✓		vegetative propagation' (*as not a description*) **Examiner's Comments** Several candidates did know that structure Y was a horizontal stem or runner. However, they did not always get the second mark point as they did not mention that the runner grows away from the parent and then forms roots and shoots. Only a few candidates mentioned that the runner between plant dies or withers away.
			Total	**8**	
6	a	i	mix (each dilution) ✓ replace (micro)pipette tips between each transfer ✓ repeat the plating (at least three times) and calculate a mean ✓ take photo of final plate so colonies can be counted ✓ reduce the number of, dilutions / transfers (to reduce random error) ✓	2 max	**mark as prose** **ALLOW** stir / shake (test tube before plating) **ALLOW** replace pipettes between each transfer / sterilise pipette between dilutions **IGNORE** 'repeat the experiment' (*as this suggests starting with a new population so does not improve accuracy*) **IGNORE** repeat and take a mean (*as not indicated whether experiment or plates are being repeated*) **ALLOW** 'use more than one agar plate and calculate the mean' **IGNORE** 'average' **ALLOW** 'do fewer than 4 dilutions' **IGNORE** general ref to aseptic technique e.g. use sterile, water /agar **Examiner's Comments** Good answers tended to describe how the accuracy of the bacterial population estimate could be improved either by reducing the number of transfers (to limit error) or by repeating the plating. Some candidates, although a relatively low proportion, described the importance of mixing at each stage and replacing or sterilising the pipette (or pipette tips). The introduction to the question contained references to sterilisation and general aseptic technique, so these answers, if not specifically in the context of the pipettes, were ignored. Many candidates suggested the experiment should be repeated. This answer was not credited because of the ambiguity: repeating the

					experiment suggests restarting with a fresh bacterial population rather than carrying out more dilutions with the current culture. **OCR support** OCR's Language of measurement in context: Biology can be used with candidates to support their learning and use of language of measurement terms, such as accuracy.
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1.1 × 10^7 award three marks** (22 × 10^5 =) 2,200,000 ✓ × 5 (= 11,000,000) ✓ (standard form =) 1.1 × 10^7 ✓	3	*If answer is incorrect,* ***ALLOW ECF*** *within working for max 2 marks* ***If answer = 11,000,000 award 2 marks*** **ECF** from step 1 (e.g. 220,000 × 5 = 1,100,000) **ECF** from steps 1 and 2 (e.g. 1,100,000 in standard form = 1.1 × 10^6) (The third marking point is awarded for the correct use of standard form based on their calculation) **DO NOT ALLOW** incorrect use of standard form e.g. 11000000×10^1 **ALLOW** alternative calculation with same **ECF** from step1 or steps 1 and 2 (22 × 10^4 =) 220,000 ✓ × 50 (cm^3) (= 11,000,000) ✓ (standard form =) 1.1 ×1 10^7 ✓ **Examiner's Comments** It was encouraging to see that most candidates attempted the question with many giving the correct answer. Candidates should be encouraged to show their working as credit was available for stages within the calculation (multiply by x5 or x50) and the conversion of their calculated answer to standard form so many still gained 2 marks as ECF. Where candidates were unable to gain marks was for the original conversion being incorrect or the final answer not being given in standard form.

					OCR support Advice on how to make order of magnitude calculations (M1.8) and express results correctly in Standard Form for maths skill M0.2 can be found in the biology mathematical skills handbook.
	b		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 ✓	2 max	**Mark as prose** **ALLOW** reproduce / replicate / multiply, quickly / fast **ALLOW** many produced in a short period of time **IGNORE** short lifespan / reproduce easily **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 / cheap to maintain 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 **Examiner's Comments** This was generally well answered with most candidates identifying the short life cycle as one reason. Other popular answers were few ethical concerns and the low cost to feed, or the idea that it can be kept at low temperatures which is cheaper. Occasionally candidates did not gain marks with unqualified answers such as 'easy to grow', 'small' or 'cheap' as more supporting information was required.

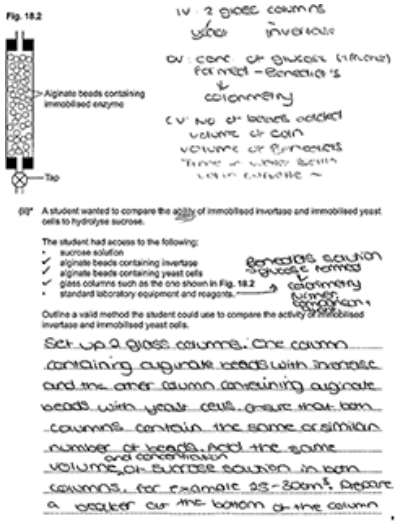
			Total	**7**	
7			**Level 3 (5–6 marks)** Describes arguments for **AND** against artificial cloning in animals **AND** plants There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated. **Level 2 (3–4 marks)** Describes arguments for **AND** against artificial cloning with some reference to animals or plants. There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence. **Level 1 (1–2 marks)** States some reasons for **AND** against artificial cloning. There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant. **0 mark** *No response or no response worthy of credit.*	6 (AO1.1)	**Indicative points may include** *Generic advantages* • rapid production of large numbers of individuals • propagation of individuals with desirable traits • numbers of rare species can be increased • production of large numbers of selectively bred or genetically-modified individuals *Animal-specific advantages* • use of animal example • key individuals, e.g. beloved pets, can be cloned *Plant-specific advantages* • propagation of seedless plants • propagation of plants that are difficult to grow from seed • quicker than growing from seed • growth of pathogen-free individuals • use of plant example *Generic disadvantages of cloning* • lack of genetic variation • population at greater risk of environmental change *Animal-specific disadvantages* • process (SCNT) is inefficient / expensive • high incidence of health issues • use of animal example *Against cloning in plants* • if source material is infected with microorganisms offspring will be • complex aseptic procedures • use of plant example **<u>Examiner's Comments</u>**

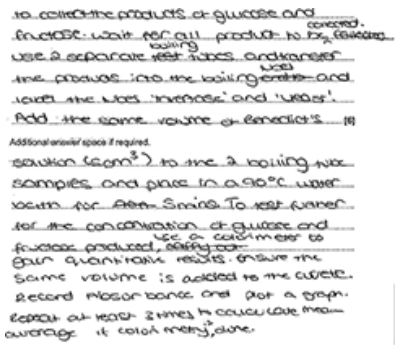
					Most candidates were able to write competent and coherent answers to this level of response question and most achieved at least Level 2. All of the indicative points on the mark scheme were seen and many candidates offered other suggestions of similar quality. For example, the use of cloned animals in medical research to control a key variable. Many advantages and disadvantages of cloning are generic, in that they can be applied to both plants and animals, e.g. lack of genetic variation and group susceptibility to a single disease. Such generic disadvantages were creditworthy and allowed candidates to access Level 1. If at least some kingdomspecific examples were included, a Level 2 was awarded. Level 3 required answers to include both positive and negative points that were specific to plants and others that were specific to animals. Most candidates discussed disease susceptibility as a problem with cloning. This was awarded only if it was clear that the entire clone would have the same susceptibility to disease. Many candidates thought that cloning necessarily increased susceptibility to disease in general, which was not credited. References to there being ethical issues with animal cloning were not credited without further high level qualification that was clearly related to cloning. Some candidates confused cloning with genetic engineering or/and selective breeding (or even with the production of mycoprotein). These points were not awarded and, if they made up a large proportion of the total answer, the upper 'communication' mark within a level was not awarded. The upper mark was also not awarded where there was ambiguity. For example, if it was not clear whether the candidate was discussing lack of genetic variation as a result of cloning or as a result of selective breeding. Descriptions of the processes involved in cloning were not awarded as they did not answer the question and, if they were lengthy, in some cases it resulted in loss of the communication mark.

					Exemplar 1  artificial cloning in plants is beneficial as if we obtain a plant of high quality we are able to clone it and produce a monoculture of high quality plants, → efficient production → more money made by farmers/farmers artificial cloning only requires one parent plant / animal, meaning it could increase the population numbers of endangered species. However, artificial cloning is not beneficial as cloning plants produces a monoculture which decreases the genetic biodiversity of the species. it also opens up the risk of the whole monoculture dying from one disease as they are all identical. In animals it is considered unethical as by cloning we are interrupting nature's order and cloning has resulted in shorter lifespans of animals and certain diseases. genetic variation [6] Additional answer space if required. decreases. However in agriculture if animals such as cattle have high quality meat or high milk production, cloning them would be beneficial to the farmers and industry This is a typical Level 2 response. While discussing plants, the candidate has mentioned some advantages of cloning (propagation of organisms with beneficial features and increasing the population of an endangered species) and has clearly addressed the problem of reduced genetic diversity and potential susceptibility to a single disease. However, all of these points could also apply to cloned animals, so the response did not achieve Level 3 as it did not include any plant-specific points. Towards the end of the main answer space, it mentions an animal-specific negative of cloning (potentially shortened lifespan). It also includes an animal-specific example of a beneficial feature (milk production) in the additional space.
			Total	**6**	
8	a		membrane separation / encapsulation / microcapsule ✓	1 (AO1.2)	**ALLOW** contained by a partially-permeable membrane **<u>Examiner's Comments</u>** Around a third of candidates answered this question well, stating either membrane separation, encapsulation or a microcapsule. A number of candidates made slight adaptations to the list above, for instance, entrapment in beads and 'Ionic bonding' was seen frequently.
	b		covalent bonding / matrix / carrier , might affect shape of	2 (AO2.5)	**ALLOW** carrier restricts induced fit

			active site ✓ active site might be (partly) hidden (when bonded to the carrier) ✓ substrate must move through a matrix ✓		**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 **Examiner's Comments** This question was low scoring but discriminated well. Candidates were asked to refer to Figure 18.1 and answers that were credited focused on reasons resulting from the processes of immobilisation illustrated in Fig. 18.1, not just the fact that the enzymes could not move. All marking points were seen but many responses were unable to gain credit for marking point 1 because they stated that the 'enzyme shape' or 'tertiary structure' would be changed, without mentioning the active site. Similarly, merely stating that enzyme surface area would be reduced, without reference to the active site, was not enough to be given marking point 2.
	c	i	idea that yeast needs resources to stay alive ✓	1 (AO2.7)	**ALLOW** waste products need to be removed **Examiner's Comments** Around a quarter of candidates achieved this mark. Most incorrect answers referred to yeast being larger or difficult to immobilise. A few suggested that yeast was expensive because there was demand for it in the brewing and baking industries.
		ii	**Level 3 (5–6 marks)** Outlines a valid investigation that explains how the independent variable should be changed **AND** how the dependent variable should be measured **AND** mentions controlling other variables. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)**	6 (AO3.3)	**Indicative points may include** *Independent variable* • set up two columns • one with invertase beads and one with yeast beads • use of control column *Dependent variable* • measure product for reducing sugar • using Benedict's test • quantity can be estimated by ○ colour chart or testing strips

			Outlines a valid investigation that mentions the independent variable **AND** the dependent variable **AND** control variables. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence* **Level 1 (1–2 marks)** Attempts to outline a valid investigation but does not discuss one of the variables. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant* **0 mark** *No response or no response worthy of credit.*		○ colorimeter *Control variables* • number or volume of beads in each column • concentration of substrate solution added to columns • volume of substrate added to columns • substrate exposed to columns for same time • temperature • pH • identical procedure for measuring product • zero colorimeter **Examiner's Comments** This level of response question differentiated well and responses at all three levels were regularly seen. The command word was 'outline' so a good answer needed only the main steps of a method that was valid. The comparison was between the activity of immobilised invertase and immobilised yeast cells. To access Level 3, a candidate needed to outline how they would change this independent variable, measure the dependent variable and keep control variables constant. Most candidates identified that the independent variable would require the setting up of two columns, each containing the different beads. Some candidates also had a third column with inert beads as a control. Fewer candidates were able to provide enough detail about measuring the dependent variable. Vague comments like 'measure the volume of product' or 'test the solution for sucrose', were common and not credited. Use Benedict's reagent was the most common creditworthy way to measure the end products. However, some candidates said that this would test for non-reducing sugar or that glucose and fructose were nonreducing sugars. Some candidates also correctly noted that a colorimeter would be the instrument to use but some candidates called it 'calorimeter' instead. When candidates opted to use a glucose test strip, they often did not add any further detail, thus limiting the level

					they could be given. The majority of candidates were able to name several variables that should be controlled by keeping them constant. Some chose a suitable quantity for the variable and kept it the same for both tests. It was common to see the concentration and volume of sucrose being controlled or the number of beads added to each column. Common errors included controlling the enzyme concentration (as this was the independent variable) or using the ambiguous term 'amount' (as opposed to 'concentration' or 'volume'). Many candidates did not follow the command word, 'outline', and went into great detail about, e.g. what colour of filter to use in the colorimeter or what axes to use on the calibration curve, which took more time than was needed and often meant they could not be given the upper 'communication' mark within a given level. Some candidates added extra detail about, for example, statistical tests, which was not required under the directed focus of validity. **Assessment for learning** The use of the term 'amount' is ambiguous and it should be avoided especially when used to describe experimental designs. A more appropriate word should be 'concentration' or 'volume'. Exemplar 2  Fig. 18.2 Alginate beads containing immobilised enzyme Tap IV: 2 glass columns one with invertase DV: conc of glucose (mmol/l) formed - benedict's + colorimetry CV: no of beads added volume of conc volume of buffer (0)* A student wanted to compare the activity of immobilised invertase and immobilised yeast cells to hydrolyse sucrose. The student had access to the following: ✓ sucrose solution ✓ alginate beads containing invertase ✓ alginate beads containing yeast cells ✓ glass columns such as the one shown in Fig. 18.2 • standard laboratory equipment and reagents Benedicts solution → glucose formed → colorimetry → time taken Outline a valid method the student could use to compare the activity of immobilised invertase and immobilised yeast cells. Set up 2 glass columns. One column containing alginate beads with invertase and the other column containing alginate beads with yeast cells. Ensure that both columns contain the same or similar number of beads. Add the same volume and concentration of sucrose solution in both columns, for example 25-30cm³. Prepare a beaker at the bottom of the column

					 This response begins by concisely stating how to manipulate the independent variable. It then lists tree variables that need to be controlled. Enough detail about how to measure the dependent variable (Benedict's test and colorimeter) are included on the second page for it to achieve Level 3. Although there was some detail on the second page that went beyond what was required for an 'outline', and so was deemed 'irrelevant, the communication mark was awarded because the extra detail did not make up a disproportionately large part of the answer.
			Total	**10**	
9			B ✓	1 (AO2.4)	**Examiner's Comments** This challenging question tested understanding of the logarithmic scale and the term 'rate'. Many candidates chose options **C** or **D**, presumably because they are in the death *phase.* The *incidence* of death (deaths as a proportion of bacterial population) would certainly be higher than at option **B**. However, 'death rate' implies 'deaths per minute/hour', which is higher at B because the population at B (which can be read from the y-axis) is about 12 times bigger than the population at C and around 500 times bigger than the population at D. **OCR support** Help with logarithms and other mathematical skills can be found in the OCR Biology Maths Skills Handbook Maths for Biology resources can also be

					useful to support students with mathematical skills via tutorials and quizzes.
			Total	**1**	
10	a	i	continuous **AND** there is an outlet for (continuous) collection of product ✓	1(AO3.1)	**ALLOW** (named) raw materials can be constantly added **Examiner's Comments** The vast majority correctly chose 'continuous' and all but a few of these supported this with a creditworthy explanation. Some chose batch but almost as many wrote 'aerobic' or 'alcohol' (fermentation).
		ii	temperature affects , rate of growth / enzyme activity ✓ (fungal) metabolic reactions generate heat ✓ to inhibit growth of pathogenic bacteria ✓	2 max(AO2.5)	**ALLOW** proteins could denature (at higher temperatures) **ALLOW** respiration is exothermic **Examiner's Comments** Most candidates achieved 1 mark here, usually for a version of the extra guidance for the first marking point. All three marking points were seen but rarely more than one in a single answer. Often candidates stated that heat was being produced but many such responses were vague about the source of this extra heat.
		iii	source of , nitrogen / N / amine / NH2 ✓ for (producing) amino acids / polypeptides / proteins ✓	2(AO2.5)	**IGNORE** nitrate / NH_3 **ALLOW** for (named) nucleic acids **Examiner's Comments** A little under half of candidates seemed to understand what was happening here but those who did usually achieved both marks. A significant minority of responses discussed the role of nitrates in the nitrogen cycle. Many responses vaguely suggested that ammonia might be used as a substrate for something, usually respiration. Some thought it killed unwanted microbes.
	b		1 no , welfare / ethical , issues ✓ 2 can be genetically modified (relatively easily) ✓	2 max(AO1.2)	*Mark the first two answers*. **1 ALLOW** e.g., 'acceptable to vegetarians' **3 ALLOW** rapid reproduction **IGNORE** nutrient requirements

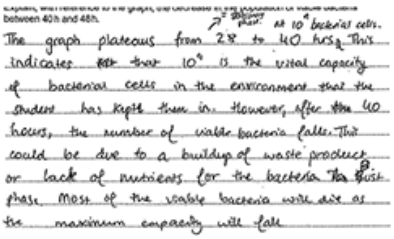
			3 rapid growth / production can be easily changed to meet demand ✓ 4 non-seasonal / year-round production ✓ 5 take up little space ✓ 6 low costs because work at low temperatures ✓		**Examiner's Comments** Most responses achieved at least 1 mark in this question and correct versions of the first five marking points were common – the last marking point was rarer. The most common uncredited responses discussed being grown on waste materials, being readily available, or producing healthy protein. Responses that just said 'quick' or 'cheap' were not given marks without further qualification.
	c	i	pH below <u>optimum</u> ✓ (for) bacterial enzymes ✓	2(AO2.5)	**ALLOW** low(er) pH denatures (enzymes) **ALLOW** enzymes in (named) microorganisms **Examiner's Comments** Most candidates struggled to produce a creditworthy response to this with many answers merely stating that the lactic acid prevented microbial growth. Around a fifth of candidates gained at least 1 mark, most commonly for a version of the extra guidance for the first point; the second marking point was more rarely given marks and usually only in those responses that had already been given the first. A significant minority of responses suggested that the acidic conditions would promote the growth of bacteria and some suggested that the bacteria could metabolise the lactic acid in preference to lactose. A few responses discussed the *lac* operon.
		ii	*Product* amino acid(s) ✓ *Reaction* hydrolysis ✓	2(AO1.2)	**ALLOW** water added **Examiner's Comments** The vast majority of candidates gained both marks here. Of those that didn't, the reaction was more often correct than the product, for which 'whey' and even 'casein' itself were sometimes suggested.
			Total	**11**	
11	a	i	prevent contamination (by unwanted microorganisms) ✓ to prevent , entry / growth , of unwanted microorganisms ✓	1 max(AO1.2)	**IGNORE** kill **Examiner's Comments** The vast majority of candidates achieved this mark. Most understood the need to prevent contamination and for those who did not use

					the term contamination, they accessed the mark by stating that the entry or growth of microbes would be prevented.
		ii	use , sterile / autoclaved , flask / pipette / equipment / broth ✓ stopper flask (to prevent contamination) ✓ disinfect / sterilise , surfaces ✓ (nearby) Bunsen flame (to create upward air flow)✓	2 max(AO1.2)(AO3.3)	*Mark first two answers only or first answer on each prompt line, which ever gives the candidate most benefit*. **ALLOW 'pasteurise' as AW for 'autoclave'** **DO NOT CREDIT** if airtight seal is implied **ALLOW** flame neck (of flask) / remove stopper for minimal time / do not put stopper on bench **ALLOW** wash hands / wear gloves **Examiner's Comments** Almost half of candidates achieved both marks here. In the information given in the question, they were told that there was a large flask of bacterial culture, which was divided into a number of smaller flasks. Candidates who took on board this information recognised that the flasks and broth would need to be sterilised (by autoclaving) and that the flasks should have a stopper or that the neck of the flask would need to be flamed before the culture was transferred. The most likely piece of equipment to transfer the culture would be a pipette so that would need to be sterilised too. Versions of the 2nd and 4th marking points were also frequently seen. A significant minority of candidates did not relate their answer to the question and discussed streaking an agar plate with a wire loop–responses that were clearly in this incorrect context were not given marks. There was also the misconception that the Bunsen burner flame was used to kill all microbes rather than to create the upward air movement directing them away from the work area.
	b	i	*idea of* so bacterial cells are evenly distributed ✓	1(AO3.4)	**Examiner's Comments** About half of the responses achieved this mark. It was often stated the sample was needed to be mixed, or because bacteria will have settled to the bottom, but many

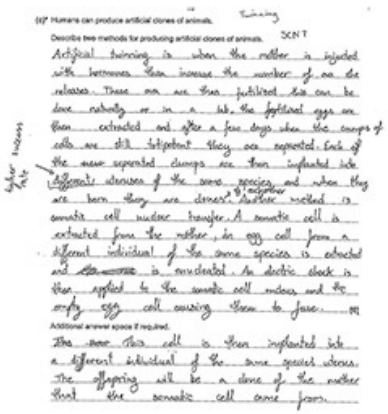
					responses omitted the explanation that an even distribution of bacteria was required. As in part (i), responses that discussed colonies or spreading bacteria on agar were not given marks.
		ii	small(er size)✓	1(AO3.4)	**ALLOW** size similar to wavelength of (visible) light **IGNORE** reference to resolution of microscope **Examiner's Comments** This synoptic question tested candidates' knowledge about relative cell size of eukaryotic (human) and prokaryotic (bacterial) cells in the context of using a light microscope to count them. Most responses gained this mark. A significant minority discussed microscope resolution without mentioning size and received no marks while others cited the absence of a nucleus to take up stain. A few candidates mistakenly thought that the bacterial cells would be moving due to flagella, or that they would be dividing rapidly, so would be difficult to count.
		iii	*Calculate the number in 10 cm*^{3} **1** multiply , 52 / number of bacteria in sample , by 1000 ✓ *Correct treatment of serial dilutions* **2** multiply by , 100^n (where n is the number of serial dilutions) ✓ *Calculate the total in 50 cm*^{3} **3** multiply (answer to **1**) by 5 ✓	3(AO2.8)	*Credit steps in any order* **1 ALLOW** if 52 000 seen as part of a calculation **1 ALLOW** 52 x 100 if working out number in 1cm^3 **3** 52 × 5 000 = 2 marks (**1** and **3**) *If mp1 has not been awarded* **ALLOW** 1 mark for 260 000 **ALLOW** answer written as single formula, e.g., • 52 × 1000 × 100^n × 5 = 3 marks • 52 000 × 100^n × 5 = 3 marks • 52 × 100 × 100^n × 50 = 3 marks (if working out no. in 1cm^3 first) • 100^n × 260 000 = 2 marks (steps not clearly described) **Examiner's Comments** Candidates found this unfamiliar style of question challenging. Although most gained at least 1 mark, it was rare to award all 3

					marks. The most common mark given was for multiplying by a correct number to get the number of bacteria in 10 cm^3 or 1 cm^3. Some then went on to multiply this by the appropriate number, 5 or 50, to get the number in 50 cm^3. Very few candidates were able to clearly demonstrate how to deal with the number of serial dilutions, hence, the 2nd marking point was achieved only by the strongest candidates and this was normally written out rather than expressed as a formula. Some candidates did not attempt to describe the steps as the question asked but treated it as a calculation with a correct answer. This approach meant they could not access the 2nd marking point, as the number of serial dilutions was not stated in the question.
	c	i	*idea that* differences in numbers would be too big to represent on paper ✓ two figures quoted in support ✓	2(AO2.8)	**ALLOW** so the scale can fit on the paper **ALLOW** e.g. total count at 0 h is 10 but at 40 h is 1×10^{12} **Examiner's Comments** The concept of logarithms proved difficult and many candidates could not explain why a log scale would be used. Many candidates were able to identify that the numbers would be large but large numbers can be plotted easily; the key idea that the numbers change quickly from very small to very large was missed by most candidates. The majority of candidates did not include any data in their answer despite the question asking to refer to the graph. Many offered the circular explanation that logarithms are necessary because growth is exponential. Some candidates thought that a number with fewer zeroes would make the *y*-axis labels easier to read.
		ii	**FIRST CHECK ON ANSWER LINE** **If answer = 99.9 award 3 marks** *Reading from graph* log 9 = 1×10^9 and log 6 = 1×10^6 ✓ *Calculating percentage* $\frac{1 \times 10^9 - 1 \times 10^6}{1 \times 10^9} \times 100$ ✓	3(AO2.8)	*If the answer is not 99.9…* **ALLOW** −99.9 for 3 marks **ALLOW** numbers not in standard form / 10^9/ 10^6 **ALLOW** substitution of incorrect numbers into the formula $\frac{\text{difference}}{\text{original}} \times 100$ **and** answer given to 3 s. f. (with correct sign) for **1** mark **AWARD** 2 marks for 0.999

			Correct processing correct answer to 3 s. f. ✓		**Examiner's Comments** This question differentiated well between candidates with a little under a fifth of answers scoring full marks. However, many candidates struggled to interpret the logarithmic numbers and could not translate, e.g. $\log_{10}6$ into 1 000 000. Around half of responses scored 1 mark for knowing know to calculate a percentage change despite beginning with the wrong numbers, as long as working was shown. **OCR support** Help with logarithms and other mathematical skills can be found in the OCR Biology Maths Skills Handbook: AS and A Level Biology A Biology B (Advancing Biology) Mathematical Skills Handbook (ocr.org.uk) There is also a useful blog about serial dilutions and logarithms: https:/www.ocr.org.uk/blog/challenging-maths-skills-alevel-biology/ The Maths for Biology website is a further resource: https:/www.ocr.org.uk/subjects/science/maths-for-biology/index.aspx?id=biology-a-h020-h420-from-2015
	d		**1** reproduction rate lower than death rate ✓ **2** total count / dead bacteria , much / AW , higher than viable bacteria ✓ **3** use of figures <u>with units</u> (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	4max(AO1.2)(AO2.8)	**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 **Examiner's Comments** This question differentiated well between candidates. This question directed the candidates to a specific part of the graph and

			area for access to nutrients / oxygen ✓		asked for an explanation. Many correctly identified the stage as the death, or decline, phase. Often, responses described this phase in terms of reproduction rate being lower than death rate; however, references to bacteria having a 'birth rate' were not given marks. Many candidates explained that there would be a lack of nutrients and a build-up of waste products. Where competition was mentioned, it was only given marks when couched in terms of an increase. Few candidates appreciated the significance of the high total count indicating that the culture was full of dead cells and hence rarely offered a creditworthy figures quote. Many quoted figures for the viable population but these were not given marks because describing a decrease does not really offer any support to an explanation for that decrease. A lot of candidates spent unnecessary time explaining all the events leading up to 40h (i.e., lag, log and stationary phases) instead of discussing the specific timeframe that was the focus of the question. Some candidates did not seem to understand the distinction between 'viable' and 'total' with many writing responses implying that they thought there were two different species of bacteria competing with one another. **Exemplar 2**  between 40h and 48h. The graph plateaus from 28 to 40 hrs. This indicates that over 10^9 is the total capacity of bacterial cells in the environment that the student has kept them in. However, after the 40 hours, the number of viable bacteria falls. This could be due to a buildup of waste products or lack of nutrients for the bacteria. The last phase. Most of the viable bacteria will die as the maximum capacity will fall This response gets 2 marks but the first part of this response discusses the time between 28 h and 40 h, which does not respond to the question. The response to the question begins on line 4, gaining the 4th marking point on line 6 and the 5th on line 7.
			Total	**17**	
12	a		*idea that* sponges produce, genetically identical offspring / clones ✓	max 3(AO3.2)	e.g. offspring of sponges share same, DNA / genome / genetic material **IGNORE** 'similar DNA'

			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 ✓		‘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’ **Examiner’s Comments** Strong responses provided an evaluation of the student statement that both animals produce clones of themselves by naming each animal in turn and discussing whether the claim was justified. Candidates with a sound understanding of mitosis and meiosis responded correctly that *A. aerophoba* (the sponge) produces clones but that *S. fasciatum* (the zebra shark) does not. For *S. fasciatum* strong responses explained that new allele combinations form due to crossing over or independent assortment in meiosis. Many candidates realised that production of gametes involved meiosis but did not gain marks by not linking it to crossing over or independent assortment or just saying that it produced variation rather than genetic variation.  **Misconception** Less successful responses stated that meiosis generates genetic variation by mutation. Most mutation occurs in DNA replication during S phase of the cell cycle and the mutation rate will be the same preceding mitosis or meiosis. The processes that ‘reshuffle’ pre-existing alleles to give new genetic combinations in meiosis are a different source of genetic variation to the mutation events that change the DNA sequence to give brand new alleles.
	b		***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*	6(AO1.2)	**Indicative scientific points may include (but are not limited to):** *Embryo splitting / artificial twinning / embryo twinning* • Sperm taken from a male (with desired traits) • Artificial insemination or IVF • Embryo splitting

			*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)*: • o award the higher mark where the Communication Statement has been met. o 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.*** **Level 3 (5–6 marks)** Detailed descriptions of both embryo splitting **and** somatic cell nuclear transfer. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated*. **Level 2 (3–4 marks)** A detailed description of one method **and** an outline of the other method. *There is a line of reasoning with some structure. The information presented is relevant and supported by*		• Incubation in a lab • Implantation into a surrogate • Offspring are clones of each other *Somatic cell nuclear transfer* • Nucleus removed from a somatic cell • Enucleation of an egg • Electrofusion • Embryo is transferred into a surrogate • Offspring are clones of the original somatic cell **Examiner's Comments** This 6 mark levels of response question required candidates to describe two methods for producing artificial clones of animals. Many candidates gave detailed descriptions of embryo splitting and somatic cell nuclear transfer. Strong responses showed care in their use of terminology. In embryo splitting a multicellular embryo containing totipotent cells is divided into groups of cells. Poor descriptions referred to splitting the single-celled zygote or fertilised egg or splitting the cells of the embryo. Most candidates described SCNT in textbook fashion but answers that showed awareness that in fact a donor somatic cell is used rather than a separated somatic nucleus gained marks. Some less successful responses confused the cloning process with genetic engineering. Exemplar 3  (d)* Humans can produce artificial clones of animals. Describe two methods for producing artificial clones of animals. Twinning SCNT Artificial twinning is when the mother is injected with hormones that increase the number of ova she releases. These ova are then fertilised that can be done naturally or in a lab, the fertilised eggs are then extracted and after a few days when the ovums of cells are still totipotent they are separated. Each of the ovum separated clumps are then implanted into different uterines of the same species and when they are born they are clones of the mother. father / mother Somatic cell nuclear transfer. A somatic cell is extracted from the mother, an egg cell from a different individual of the same species is extracted and the nucleus is enucleated. An electric shock is then applied to the somatic cell nucleus and the empty egg cell causing them to fuse. Additional answer space if required. The new fuse cell is then implanted into a different individual of the same species uterus. The offspring will be a clone of the mother that the somatic cell came from. This response contains a detailed description of firstly artificial twinning and secondly somatic cell nuclear transfer. Both

			some evidence. **Level 1 (1–2 marks)** A detailed description of either embryo splitting **or** somatic cell nuclear transfer **OR** outlines of both methods *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear*. **0 marks** No response or no response worthy of credit.		descriptions cover most of the points seen in the indicative scientific points listed in the mark scheme. Terminology used is accurate and the information presented is relevant and substantiated. The response is clear and logically structured and so meets the criteria for Level 3 – 6 marks.
			Total	**9**	
1 3			D: select stem with no flowers / remove flowers from stem ✓ E: *idea of* encourage root growth / reduce water loss ✓ D: remove most leaves / reduce leaves to 1–4 / cover with a plastic bag ✓ E: *idea of* reduce, water loss / transpiration ✓ D: (use) aseptic techniques / sterilise equipment / sterilise stem ✓ E: idea of stop, infection / contamination ✓ D: use propagator / propagation box / greenhouse ✓ E: *idea of* control, (optimum) temperature / humidity / moisture ✓ D: do not overwater compost ✓ E: *idea of* to allow air, to	3 max(AO3.3)	**Explanations (E) can be awarded only with a correct Description (D) mark.** **Max 2 for descriptions alone** e.g. more energy for roots to grow **DO NOT ALLOW** 'stops water loss' **<u>Examiner's Comments</u>** The topic focus of Question 3 was 5.1.5 Plant and Animal Responses, learning outcomes a-f. Few candidates scored 3 marks for this section. Where marks were gained, most candidates were able to describe one or two improvements with many identifying the need for aseptic technique, reducing the leaf number to between 1–4 or removal of flowers. Explanations of improvements as instructed by the second command term in the question stem were less frequent. Specific levels of detail were missed out in numerous responses, such as quoting 'some flowers should be removed' or 'all the leaves should be removed'. Another frequent error seen where few/no marks were given was candidates repeating the procedure given in the question stem in more detail without

			reach roots / for root respiration ✓		making any specific changes or qualifying improvements, e.g., how to preserve the meristem while making a cut or the use of rooting powder or a slant cut to the stem - both of which were mentioned in the question. Some candidates misinterpreted this question and described alternative techniques such as using tissue culture or growing in agar jelly.
			Total	**3**	
14			C ✓	1(AO1.2)	**Examiner's Comments** Approximately 2 out of 3 answers were correct. D and B were the most common incorrect responses.
			Total	**1**	