1 **(a)**	**1** **2** **3** **4** **5** **6** **7** **8**	cell wall **;** plasmid **;** flagella **;** capsule **;** loop of DNA / circular chromosome / no chromosome(s) **;** no nucleus **;** no, organelles / named organelle **;** AVP **;** e.g. smaller ribosomes	[max 2]	**R** size **A** fimbriae / pili **ignore** 'thread of DNA' unqualified *some of these structures are not in all bacteria, but are often shown in diagrams of bacteria*
(b) (i)	**A** – lag **;** **B** – exponential / log **;**		[2]	*please look carefully at spelling of lag and log*

	Answer		Marks	Guidance for Examiners
1 (ii)	1	**D** – 'birth' = death ;		**A** rate of growth / reproduction for birth
	2	**E** – death > 'birth' ;		
		*for either **D** or **E***		
	3	less / no, food / nutrients ;		
	4	less / no, oxygen ;		
	5	accumulation of, wastes / toxins ;		
	6	limiting factor(s) *used in appropriate context* ;		**A** limit / limits in context
	7	carrying capacity / described ;	[max 3]	
(c) (i)	jointed, legs / limbs / appendages ; exoskeleton ;		[max 1]	
(ii)	*either*			
	1	*idea that* bottom of sea, predators / prey, unable to see ;	1	bottom of the sea is covered in white, sand / rock ;
	2	camouflage not needed (ref to, avoiding predators /	2	dark coloured crabs, are conspicuous / easily seen, by predators / more likely to be predated ;
	3	(therefore) no need to make pigment ;	3	no need to make pigment ;
	4	less energy needed (to make pigment) ;	4	less energy needed (to make pigment) ;
	5	mutation / change in gene *or* DNA ;	5	mutation / change in gene / DNA ;
	6	so no pigment made (allow only if MP5 is given) ;	6	so no pigment made (allow only if MP5 is given) ;
	7	white crabs / albino crabs, survive and reproduce ;	7	white crabs / albino crabs, survive and reproduce ;
	8	pass on their, gene(s) / allele(s) (for no pigment) ;	8	pass on their, gene(s) / allele(s) (for no pigment) ;
	9	ref to (natural) selection in context ; **R** if artificial	9	ref to (natural) selection in context ; **R** if artificial [max 4]

Question	E answers	Mark	Additional Guidance
2 (a) (i) 1	kills, / destroys, (all) bacteria / microorganisms ; **A** viruses		**ignore** 'remove' / 'gets rid of' / 'eliminates'
	to prevent		**ignore** 'harmful'
2	contamination / remove contaminants (of the milk / yoghurt) ;		**ignore** impurities / make milk pure
3	competition with the two bacteria added ;		
4	disease / might be pathogens / any suitable e.g. (TB / food poisoning) ;		kills harmful bacteria = 1 mark kills bacteria that cause disease = 2 marks kills bacteria that might contaminate the milk = 2 marks
5	production of toxins ;		
6	alteration of the, flavour / taste ;		
7	AVP ;		
(ii) 1	best / optimum / ideal, temperature ;		
2	for bacterial, growth / division / reproduction ;		**R** 'speeds up the reaction' unqualified
	A bacteria grow quickly		
3	ref to enzymes ; **R** if enzymes are denatured at 45 ^{o}C		
4	ref to, kinetic energy / collisions ;		
5	produce most lactic acid in the shortest time ;		
	A 'lactic acid production takes too long at lower temperatures'		
6	ref to cost ;		
7	bacteria killed / enzymes denatured, at higher temperatures /		**A** enzymes are not denatured / bacteria are not killed, at this temperature
		[max 2]	

Question		E answers	Mark	Additional Guidance
2	(iii) 1	lag phase / numbers increase slowly / low rate of growth ; **ignore** 'numbers stay the same'		**accept** (cell) division / (binary) fission / reproduction for growth for **MP1** and **MP3**
	2	(while) bacteria, make proteins / increase in size ;		
	3	log phase / exponential phase / numbers increase quickly ; **A** rapid rate of growth / bacteria divide faster than die		
	4	plenty of, food / nutrients / oxygen ; **ignore** raw materials		**MP4 A** 'availability of food / AW'
	5	stationary phase / numbers stay constant ; **A** 'birth' rate = death rate		
	6	death phase / increase in death rate / decrease in numbers / bacteria be		
	7	(because of) lack of, food/nutrients/oxygen *or* decrease in pH / accumu		
	8	ref to limiting factors ;		
	9	AVP ; e.g. *Lactobacillus bulgaricus* increases first	[max 5]	
	(iv) 1	need different bacteria to, carry out different processes / produce		**A** both needed to make lactic acid **A** 'work differently'
	2	*idea that* each bacterium needs something produced by the other ;		
	3	*Streptococcus (thermophilus)* does not make lactic acid ;		
	4	*Lactobacillus (bulgaricus)* needs formic acid produced by		If **MP4** awarded then also award **MP2**
	5	each stage requires a different (specific) enzyme ; **A** enzymes work on different substrates		**A** *S. thermophilus* **A** *L. bulgaricus*
	6	*idea that* each bacterium cannot make all the enzymes needed ;		
	7	AVP ;	[max 2]	

Question	E answers	Mark	Additional Guidance	
2 (b)	preservative / acidity regulator / pH regulator ; antioxidant ; colouring / food dye ; flavouring ; emulsifier ; sweetener ; thickener ; stabiliser ;	[max 3]	**ignore** names and/or (E) numbers of additives e.g. MSG, tartrazin sunset yellow, etc.	**Reject** fruit chocolate nutrients any named nutrient, e.g. food starch / corn starch (named) vitamin(s) (named) mineral(s) salt calcium supplement

3 **(a)**	pinna / external ear ; fur ; mammary glands / secretes milk ; sweat glands ; endothermic / homoeothermic / AW ; **A** – warm blooded different types of teeth ; 3 middle ear bones ;	[max 3]
(b)	**MP1** redirects blood away from skin to (internal / vital) organs ; **MP2** vasoconstriction ; **MP3** fat under the skin ; **MP4** fur / hair ; **MP5** traps air ; **MP6** fat / air, poor conductors of heat / insulators ; **MP7** reduces heat loss ; **MP8** by, conduction / convection ; **MP9** generate heat, by metabolism / shivering ; **A** – endothermic **MP10** small surface area to volume ratio / large size ;	[max 5]
(c)	group of organisms of one species ; live in the same place, at the same time / together ;	[2]
(d)	different species have different, genes / DNA ;	[1]
(e)	any two suitable suggestions, e.g. maintaining, genetic diversity ; important in food web ; possible medical application / useful genes ;	[max 2]
		[Total: 13]

Question	E Answers	Marks	Additional Guidance
4 (a)	jointed / articulated, legs ; exoskeleton / described ;	[max 2]	**R** antennae / wings **R** many legs **R** segmentation body
(b)	*6/7 RIGHT = 4* *5 RIGHT = 3* *3/4 RIGHT = 2* *1/2 RIGHT =1* *0 RIGHT = 0*	[4]	

go to 2	
go to 7	
Schistocerca gregaria	**A**
go to 3	
go to 4	
Drosophila melanogaster	**B**
go to 5	
go to 6	
Ephestia cautella	**G**
Batrachedra amydraula	**E**
Rhynchophorus ferrugineus	**F**
Oryctes agamemnon	**D**
Microcerotermes diversus	**C**
Oligonychus afrasiaticus	**H**

(c)	**1** kills, harmless / other / non-pest, insects / animals / fish ; **2** ref to, predators / parasites, of pests ; **3** idea that pesticides are concentrated in food chains ; **4** any effect on animals higher up food chain ; e.g. extinction **5** any further detail, e.g. kills birds of prey / egg shell thinning ; **6** pollutes / poisons, streams / rivers / lakes / sea ; **7** AVP ;	[max 4]	**MP5 A** any consequence for food chain/web/ecosystem

(d)	as a control ;	[1]	**A** *idea that* it is used as a reference to see the effect of the pesticide
(e) (i)	*pesticide*		
1	numbers decreased, immediately (after spraying) / on day 4 ;		
2	then increased ;		
3	use of figures – reference to day and density ;		
	fungal spores		
4	numbers did not decrease immediately / decreased after day 7 ;		
5	decreased, slowly ;		
6	did not increase ;		
7	use of figures – reference to day and density ;		
8	any comparison to the control ;	[max 5]	
(ii)	*pesticide*		
1	kills nearly all grasshoppers / kills instantly ;		
2	on contact / or immediately after ingesting it ;		
3	some resistant / some tolerant / some not hit by spray / some not eaten pesticide / some survive ;		
4	pesticide decays / removed / not effective for long ;		
5	more grasshoppers migrate from neighbouring areas ;		
6	more grasshoppers, hatching / AW ;		
7	eggs not killed ;		
	fungal spores		
8	did not kill on contact / did not kill immediately ;		
9	spores need to, germinate / grow ;		
10	takes several days (must be linked to MP9) ;		
11	fungus (produces spores) that infect other grasshoppers ;		
12	ref to transmission of fungus ;		
13	any grasshoppers that migrate into area are infected (and killed) ;	[max 4]	
		[Total: 20]	