Question			Expected Answer	Mark	Additional Guidance
1	(a)	(i)			**Mark the first suggestion on each line**
			1 _idea that_ (produces) large , yield / volume / amount, of milk ;		*1* **DO NOT CREDIT** milk yield unqualified
			2 _idea of_ long lactation period ;		*2*
			3 _idea of_ high milk quality ;		*3* **DO NOT CREDIT** milk quality unqualified or ref. meat
			4 large udders / correct udder shape (for milking machine) ;		*4*
			5 resistance to , (named) disease / mastitis / pathogens **or** effective immune system ;		*5* **DO NOT CREDIT** disease free
			6 _idea of_ calm temperament ;		*6* **CREDIT** docile / placid
			7 AVP ;		*7* eg ● walk / stand , comfortably without need for hoof-trimming ● _idea that_ converts food to milk efficiently
				3 max	
1	(a)	(ii)	normal shaped curve ; shifted to the right of original ;		Position of curve must meet the following conditions: ● **curve must end** to right of original end ● **must not start** to left of original ● **may start** at same point as original or to right of original
				2	

Question			Expected Answer	Mark	Additional Guidance
1	(a)	(iii)			**Mark the first suggestion on each line**
			1 artificial insemination / AI ; **2** in vitro fertilisation / IVF ; **3** *idea of* progeny testing ; **4** embryo transplantation / use of surrogate mother ; **5** cloning ; **6** genetic screening / use of gene probes ; **7** AVP ; **8** AVP ;		*1* **IGNORE** performance testing *2* *3* *4* **CREDIT** embryo splitting *5* *6* **ACCEPT** genetic engineering *7* eg ● sex selection technique / screening X and Y sperm *8* eg ● portmanteau animals
				2 max	
1	(b)	(i)	*idea of* change to , <u>DNA</u> / <u>base</u>(s) / <u>nucleotide</u>(s) ;	**1**	
1	(b)	(ii)	natural / directional , selection ;	**1**	**ACCEPT** evolution **DO NOT CREDIT** genetic drift

1	(c)	(i)	*regulatory*
			 idea that makes , repressor protein / transcription factor
			 or
			 idea that product switches (structural / another) gene ,
			                          on / off ;
			
			 structural
			 idea that makes , enzyme / polypeptide / protein ;
			
			 relationship between the 2
			 idea that regulatory <u>gene</u> , controls / affects ,
			                   the expression of structural <u>gene</u> ;
					ACCEPT 'makes regulatory protein'
					
					 ACCEPT 'switching on / off' for idea of control
					 IGNORE explanation involving repetition of word
					                                "regulates"

				2 max	

Question			Expected Answer	Mark	Additional Guidance

1	**(c)**	**(ii)**	lactose has been ,
			
			        removed / digested / respired /
			        broken down (by bacteria) **;**
			
			to **,** lactic acid / lactate / other sugars **;**
			
			yogurt still a good source of **,** calcium / vitamins **;**
				2 max	**DO NOT CREDIT** if context wrong (eg heat)
					
					eg ● glucose (and galactose)

1	**(d)**		**1** lactose binds to repressor protein **;**
			2 changes **,** shape / structure (of protein) **;**
			3 removes it from / stops it binding to **,** operator **;**
			
			4 RNA polymerase binds to promoter **;**
			
			5 *idea that* (so that Z and Y) are **,**
			          transcribed / <u>m</u>RNA made **;**
				3 max	*1* **DO NOT CREDIT** regulator substance
					2 **IGNORE** ref. to active site
					3
					
					4 **DO NOT CREDIT** DNA polymerase
					
					5 **CREDIT** lactose permease and β-galactosidase
					               for Z and Y
					IGNORE gene **,** switched on / expressed

			Total	**16**	

	Question		Expected Answers	Marks	Additional Guidance
2	(a)	(i)	red ; vermillion ; cinnabar ;	3	
2	(a)	(ii)	(recessive) epistasis / epistatic ;	1	**ACCEPT** complementary epistasis **DO NOT CREDIT** dominant epistasis

2	(a)	(iii)
		1
		2
		
		3
		
		4
		
		5
		
		6
			gene products are enzymes ;
			multi-enzyme / multi-step, pathway ;
			
			<u>3</u>, steps / enzymes, change tryptophan to red pigment ;
			
			product of one reaction / intermediate compound,
			                     is, substrate / starting point, for next ;
			
			dominant allele gives,
			               functional / wild-type / AW, enzyme ;
			recessive allele gives,
			             non-functional / different / AW, enzyme ;
				max 3	**2** needs to be a clear generalised statement
					                    (and not implied - e.g. by awarding mp 3)
					  IGNORE 'metabolic' pathway (as given in question)
					3 ACCEPT V, C <u>and</u> B are responsible for the change of
					                                tryptophan to red

2	(b)	(i)
		1
		
		2
		
		3
			if (red-eyed parent) was heterozygous
			there would be no difference between,
			                  sexes / males and females ;
			red-eyed males **and** white-eyed females would occur ;
			
			1:1:1:1 ratio
			or
			1:1 ratio in both sexes ;
				max 2	**IGNORE** ref to sex linkage
					
					2 ACCEPT "because there are no red-eyed males
					                   and white-eyed females (in results)"
					        "*all* 4 phenotypes would, occur / be represented"
					  DO NOT infer phenotype(s) from genotype(s)
					
					3 If 4 phenotypes stated / listed *together with the ratio*,
					                    then award mp 2 as well

Question			Expected Answers	Marks	Additional Guidance

2	(b)	(ii)	parental genotypes **XrXr** **XRY-** ;
			
			gametes **Xr** **XR and Y-** ;
			
			F1 genotypes **XRXr** **XrY-** ;
				3	**ACCEPT** alternative letters **only if a KEY is given**. Must have capital letter for dominant allele and small (same) letter for recessive allele.
					
					CREDIT GAMETES **either** on the correct line
					          or in correct place on Punnett square, whichever is correct.
					         They do not need to be in circles.
					
					ACCEPT ecf once only if Y wrongly shown as carrying 'r' allele
					
					ACCEPT ecf once only if X and Y missing
					
					DO NOT CREDIT F1 genotypes written in blank space if F1 phenotypes put on bottom lines instead

2	(b)	(iii)	<table><tr><td>phenotype of fly</td><td>O</td><td>E</td><td>O - E</td><td>(O – E)²</td><td>(O – E)²/E</td><td></td></tr><tr><td>red-eyed female</td><td>27</td><td>2</td><td>2</td><td>4</td><td>0.16</td><td>;</td></tr><tr><td>white-eyed male</td><td>23</td><td>2</td><td>-</td><td>4</td><td>0.16</td><td>;</td></tr></table> $\chi^2 = 0.32$; no significant difference (at 95% confidence level) ;	4	**One mark per row** **ACCEPT** fractions in last column (4/25) **ACCEPT** not significant **IGNORE** ref to happening by chance **ACCEPT** ecf for last two points **IGNORE** arguments referring to null hypothesis
			Total	16	

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	Question		Answer	Marks	Guidance
3	**(a)**		**1** <u>geographic</u>al, isolation / separation / barrier **;**	2	**1** **IGNORE** allopatric speciation
			2 *idea of* reproductive isolation **;**		**2** e.g. no / less **,** interbreeding between different **,** populations (early) / species (late)
			3 different **,** <u>selection</u> pressures / adaptations (on different islands) **;**		**3** **IGNOR** different to mainland **ACCEPT** in different environments or conditions they evolve or adapt differently
			4 small **,** populations / gene pools **;**		**4** **DO NOT CREDIT** small species
			5 *idea of mp 4* resulting in founder effect **;**		**5** **ACC PT** *idea of mp 4* resulting in greater impact of **,** mutation / input of alleles (migration) / loss of alleles (accidents etc.)
			6 *idea of mp 4* resulting in greater genetic <u>drift</u> **;**		
3	**(b)**	**(i)**	681 **; ;**	2	**Correct answer = 2 marks** even if no working shown *Expected working* *125 000 – 16 000 = 109 000* *(109 000 ÷ 16 000) x 100 = 681 (%)* If answer not rounded or rounded incorrectly **ACCEPT** e.g. 682 **or** 681.3 **or** 681.25 for **1 mark** If the final answer is incorrect **and** no mark was awarded for a figure close to correct value, **ACCEPT** the figure 109 000 in the working **or** 125 000 – 16 000 for **1 mark**.

Question			Answer	Marks	Guidance
3	(b)	(ii)	**1** <u>habitat</u> / <u>ecosystem</u> **,** disturbance / destruction **;**	6	
			2 (land used for) (named) building / roads **;**		**2** e.g. houses, schools, factories **ACCEPT** urbanisation and development for tourism
			3 (land used for) agriculture / farming **;**		
			4 deforestation **;**		**4** **ACCEPT** description e.g. cutting down trees / logging
			5 effect of (tourist) **,** boats / divers, described **;**		
			6 more / increased **,** <u>pollution</u> **;**		
			7 sewage / eutrophication **,** in sea / water **;**		
			8 oil / fuel **,** spill in sea **;**		
			9 (humans) hunting / collecting / (over-) fishing **;**		**9** **CREDIT** poaching / green sea turtles caught in fish nets
			10 competition from introduced species **;**		**10** **CREDIT** nest / egg **,** trampling by introduced species
			11 predation / overgrazing **,** by introduced species **;**		
			12 **(**new / named) **,** diseases / pathogens, introduced **;**		**12** **CREDIT** West Nile virus / avian malaria / bird flu
			QWC – linking **TWO** ecological pressures above to **TWO** examples of affected species **;**	1	**Two** Galapagos animals or plants named in context. e.g. ● (marine / land) iguana, (lava) lizard, (ground) finch (**mp11** predation by cats) ● rock purslane (**mp11** overgrazing by goats) ● (giant) tortoise (**mp9** hunting, **mp10** competition from goats) ● whale / seal / named fish / sea cucumber (**mp9** hunting) ● _Scalesia_ tree (**mp4** deforestation, **mp10** competition from red quinine tree) ● (blue-footed) boobies (**mp11** predation by rats)

Question			Answer	Marks	Guidance

3	**(c)**		*economic*
			fewer jobs / smaller profits / business closure /
			        reduced tourism / less income / less revenue **;**
			
			ethical
			question of **,** humane killing / animal suffering
			or
			people suffer through losing their **,**
			        homes / friends / jobs **;**
				2	**IGNORE** economic loss
					
					IGNORE right to life arguments

			Total	**13**	

Question				Answer	Marks	Guidance
4	(a)	(	1	<u>artificial selection</u> / <u>selective breed</u>ing ;	3 max	
			2	select (male and female) sheep that are, larger / woollier / meatier/ have desired characteristics ;		**2 ACCEPT** 'large / woolly / meaty, male and female that can produce healthy offspring' ; **2** 'sheep' can be inferred from 'individuals' as it is in the stem of the question
			3	crossbreed / breed (together) / mate (together) / interbreed ;		**3 ACCEPT** 'reproduce'
			4	select , best / AW, offspring ;		
			5	*idea of* breeding (and selecting) for , many / several , generations ;		**5 IGNORE** traits passed on through generations, answers must imply breeding and selection
		(ii)			1 max	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
				(use of) (named) antibiotics ; (use of) (named) pesticides / insecticides / fungicides ;		**IGNORE** refs to 'fertiliser' etc., as 'sheep' is in question stem **IGNORE** refs to diet
				cloning / genetic modification / AW ; artificial insemination / AI / IVF / marker-assisted selection ; hormones ; vaccinations ;		**ACCEPT** 'steroids' / 'growth supplements' **IGNORE** 'better veterinary care'

Question				Answer	Marks	Guidance
4	(b)	(	**1**	broken down by, decomposers / bacteria / fungi **;**	**3 max**	
			2	add (named) mineral(s) <u>to soil</u> **;**		**2 IGNORE** nutrients **ACCEPT** ions
			3	nitrate and phosphate and potassium / NPK **;**		**3 ACCEPT** nitrogen **,** $NO_3^{(-)}$, $PO_4^{(3-)}$, $K^{(+)}$ NH_3, $NH_4^{(+)}$, ammonium, ammonia **3 IGNORE** phosphorous, P , N_2
			4	specific use of (any) named mineral **;**		**4** eg nitrate or nitrogen for protein, magnesium for chlorophyll, etc. **4 DO NOT CREDIT** vague uses like 'nitrate for growth'
			5	lack of (named) , mineral(s) / nutrient(s) / ion(s), is <u>limiting factor</u> (for growth) **;**		
			6	*example of* way in which soil quality is improved **;**		**6 ACCEPT** for example change in pH / crumb size / air content / moisture content / less leaching of minerals / increased humus / presence of (named) detritivores / less risk of soil erosion

Question				Answer	Marks	Guidance
4	(b)	(i	1	(fertiliser) promotes <u>growth</u> of, one / few, (plant) species ;	2 max	**1 ACCEPT** 'once species might grow more than another' **1 IGNORE** 'yield'
			2	other (plant) species , out-competed / AW (as a result of competition from crop species) ;		**2 IGNORE** fertilisers / eutrophication , killing other plants **2 ACCEPT** 'other plants die' in the context of their being out-competed by the crop plant
			3	*idea of* disruption of food chains ;		**3 DO NOT CREDIT** in the context of biomagnification / eutrophication
			4	*idea of* reduction in , soil quality / humus , over time so plants cannot grow ;		**4 ACCEPT** 'might change soil pH so some plants can't grow'
		(iii)			3 max	**IGNORE** answers in the context of genetic variation **within the domestic population**. For example,' if one plant is susceptible to a disease then they might not all die'.
			1	loss of <u>genet</u>ic , diversity / variation (in wild population) ;		**1 ACCEPT** small / reduced , gene pool
			2	environment / agricultural requirements, may change (in future) ;		
			3	(lost) genes / alleles , may have been useful ;		**3 ACCEPT** 'potential genetic resource may have been lost'
			4	e.g. of gene useful to agriculture ;		**4** *e.g., gene for* pest resistance / disease resistance / heat tolerance / drought tolerance ; **4 DO NOT CREDIT** immunity to diseases
			5	fewer pollinators ;		
			6	loss of (pest) predators ;		
				Total	12	

Question			Expected Answers	Marks	Additional Guidance
5	(a)	(i) 1 2	similar / same, cells / metabolism ; similar / same / share, <u>genes</u> **or** have <u>genes</u> in common ;		*1* **ACCEPT** they are all eukaryotic cells
		3 4	similar / same, (embryonic) development ; shared, ancestry / ancestor **or** all related by evolution ;	max 2	*4* **CREDIT** due to phylogeny **ACCEPT** all same <u>kingdom</u> **IGNORE** 'they are all animals'
5	(a)	(ii) 1 2	small ; short life cycle ;		**Mark the FIRST answer on each numbered line** *2* **ACCEPT** fast development / mature quickly / fast reproductive rate / short generation time
		3 4 5 6 7	easy to, keep / breed / AW ; cheap (to buy / keep) ; readily available / common / not rare ; large cells ; previously well-studied / many known mutants ;	max 2	*3* **ACCEPT** produce many offspring *7* **ACCEPT** genome has been, mapped / sequenced
5	(b)	(i)	scanning ; electron (microscope) ;	2	**CREDIT** SEM = 2 marks **ACCEPT** transmission electron / TEM = 1 mark **IGNORE** micrograph
5	(b)	(ii)	description of legs in place of antennae in, mutant / 3.2 / AW ;	1	**ACCEPT** projections on head / antennae / feelers, <u>longer</u> (in Fig. 3.2) **DO NOT CREDIT** antennae / projections vs. none **DO NOT CREDIT** mandibles / fangs **DO NOT CREDIT** incorrect statement e.g. legs on mouth
5	(b)	(iii)	homeotic / homeobox / hox ;	1	

Question			Expected Answers	Marks	Additional Guidance
5	(c)	1	*synthesis*		**MAX 6** marks for synthesis
		2	DNA, copied into / →, <u>m</u>RNA **or** described **;**		**MAX 6** marks for roles
		3	<u>transcription</u> / <u>transcribe</u>d **;**		
			one strand copied **;**		*1* **DO NOT CREDIT** descriptions that contain errors
		4			
		5	complementary base-pairing **;**		*3* **ACCEPT** coding / sense / non-sense / template, strand
		6	triplet code / code read in threes / codon is 3 bases **;**		(implying one only)
		7	base sequence determines amino acid sequence **;**		*4* **CREDIT** description of base pairing as correct to context
		8	<u>translation</u> **;**		
		9	<u>ribosome</u>s **;**		
			role of tRNA described **;** **(max 6)**		
					9 e.g. "tRNA brings amino acid"
					or "tRNA anticodon binds to mRNA codon"
		10	*roles of polypeptides*		
		11	(named) structural protein **;**		*10* e.g. actin / myosin / collagen / keratin
			enzymes / catalyse reactions / control metabolism **;**		
		12			
		13	hormones / growth factors **;**		
		14	receptor proteins **;**		*12* **CREDIT** growth hormone / GH / somatotrophin / FSH
			adenyl cyclase / cAMP **;**		
		15			*14* most likely to be expressed in context of mp 12
			idea of switching genes, on / off **;**		
		16			*15* **CREDIT** transcription factors / regulatory proteins /
			homeotic / homeobox, genes		repressor proteins
		17	**or** homeodomain proteins **;**		
			idea of master switch gene /		
			one gene turns on/off whole set of other genes /		
			cascades of gene switching **;**		
		18			
			apoptosis **;** **(max 6)**		
				7 max	
			QWC – balanced account ;	**1**	At least 2 marks from points 1 - 9
					<u>**and**</u> at least 2 marks from points 10 – 18
			Total	**16**	