Question			Answer	Mark	Guid
1	(a)			max 2	**Mark the first 2 suggestions (see point 12 above)** For **each** mark point **CREDIT** *EITHER* a paired comparison referring to **both** cats and identifying which has which feature, e.g. "the wildcat has green eyes and the Persian has blue" but allow top / bottom, Fig. 1.1 / 1.2, first and second cat, etc, as identifiers, *OR* a reference to only one cat but using a **comparative** adjective ending in '-er' such as "shorter fur on wildcat", "second one looks **tamer**" or "second one is **more** tame", or, conversely, "wildcat looks **less** fierce". **IGNORE** use of the word different. e.g. "they have different coloured fur" if there is no further statement about how they differ. **IGNORE** answers that do not attempt to describe a difference at all, e.g. "fur length".
			*a **difference** is stated relating to* fur length **;** pattern / colour, of fur **;** eye colour **;** temperament / tameness **;** face shape **;**		 **IGNORE** albino

Question			Answer	Mark	Guid
(b)	(i)		selective breeding / artificial selection ;	1	**FA (see guidance on page 2)** **IGNORE** evolution **DO NOT CREDIT** natural selection or speciation
	(ii)		(named type of) mutation / production of new alleles ; sexual reproduction / meiosis / independent assortment / crossing-over ;	1	**FA** **ACCEPT** substitution / insertion / <u>base deletion</u> / gene mutation / random mutation as named types of mutation **DO NOT ACCEPT** chromosome mutation, discontinuous variation
(c)	(		(recessive) epistasis ;	1	**FA** **DO NOT ACCEPT** dominant epistasis or codominance
	(ii)		**BBDD ;** **BBDd ;** **BbDD ;** **BbDd ;**	4	**CREDIT** answers written in any order but look for and tick off answers in the order given
	(iii)		*homozygous* (individual / cat / genotype with) 2 identical, alleles / version of the gene / forms of the gene ; *gene locus* position / place / location**,** of, gene / allele, on chromosome ;	1 1	**ACCEPT** both, pair or idea of (same on) each for 2 idea **ACCEPT** same for identical and **CREDIT** description such as "both alleles either recessive or dominant" **DO NOT CREDIT** *genes* for alleles **DO NOT CREDIT** *similar* for identical or same **CREDIT** "where / whereabouts the gene is on the chromosome" **CREDIT** DNA molecule for chromosome and **ACCEPT** DNA strand

Question			Answers	Mark	Guidance
		(iv)	seal : blue : chocolate : lilac **;** 1 : 1 : 1 : 1 **;**	2	**IGNORE** absence of colons (:) **CREDIT** phenotypes all correct in any order **ACCEPT** dark brown for seal **ACCEPT** light brown for chocolate **ACCEPT** ratio of 1 : 1 : 1 : 1 as stand alone mark, even if only one, two or three colours stated for phenotypes **DO NOT CREDIT** fractions, percentages or decimals **CREDIT** ecf for ratio **only** if four colours stated e.g. "seal, lilac, chocolate, chocolate" (no mark) followed by ecf "1:1:2"
	(d)	(	*type of behaviour* innate / instinct(ive) / reflex **;** *characteristic* automatic **;** stereotyped / always performed in the same way **;** no previous experience necessary / not learned **;** genetic(ally programmed) / AW **;**	1 max 1	**FA for each prompt line** **IGNORE** maternal (as given in question) **IGNORE** instinctive in characteristic section **ACCEPT** same in all members of the species **ACCEPT** unlearned, not taught **ACCEPT** inherited

Question			Answer	Mark	Guidance
		(ii)			Markpoints 1–3 are linked within 4 possible contexts. ''t' refers to **good mothering behaviour** in the **domestic** environment (with people helping at the birth of kittens). Or candidates might say what would happen to the good behaviour patterns **in the wild**. Alternatively, the answer might focus on **bad mothering behaviour** (not licking the kittens), in either environment.

	domestic	in the wild
good mothering	**1** kittens do, survive / breed	**1** kittens do, survive / breed
	2 alleles not necessarily, passed on / kept	**2** alleles, increase / passed on / kept
	3 not selected for	**3** selected for
bad mothering	**1** kittens do, (still) survive / breed	**1** kittens do not, survive / breed
	2 alleles, increase / passed on / kept	**2** alleles, decrease **or** alleles not, passed on / kept
	3 not selected against	**3** selected against

1 whether kittens, survive / breed ;

2 whether <u>alleles</u>, change in frequency / passed on / kept ;

3 correct reference to selection / how selection acts ;

4 AVP ;

5 AVP ;

max 2

e.g. linkage (4) of poor mother, genes / alleles, with desirable alleles selected for in domestic cats (5)
OR
<u>genetic drift</u> (4) in small population (5)
OR
pleiotropic / multi-effect genes (4) with a desirable effect and this side effect (5)

Question			Answer	Mark	Guid
1	(e)	(	**1** inbreeding **/** small or decreasing, gene pool **;**	max 2	**ACCEPT** decreasing genetic variation **IGNORE** interbreeding
			2 homozygous recessive (genotypes) **;**		
			3 gene / allele **,** for desired characteristic on same chromosome as problem, gene / allele **;**		**CREDIT** good and bad genes, linked / show linkage
			4 selecting for one trait (unintentionally) selects for another **;**		
			5 breeders select for looks not health **;**		
			6 weaker selection against less healthy animals (than in wild) **;**		
		(ii)		max 2	**Mark the first 2 answers**
			1 entrapment / alginate beads / cellulose network **;**		**ACCEPT** encapsulation, inclusion
			2 a**d**sorption / carrier bound **or** stuck to **,** porous carbon / clay / resin / glass **;**		**IGNORE** a**b**sorption
			3 covalent bonding **or** cross-linking enzymes to each other and to clay (using glutaraldehyde) **;**		
			4 membrane separation **or** enzyme and substrate either side of partially permeable membrane **;**		
			Total	**21**	

Question			Answer	Marks	Guidance
2	(a)	(i)	tyrosinase ;	1	**First Answer (**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)**.**
		(ii)	phenylketonuria / PKU ;	1	**Mark the First Answer**
	(b)		*both have an* amine / amino / NH_2 ; COOH / carboxyl / carboxylic ;	2	**DO NOT CREDIT** if formula given does not match name **DO NOT ACCEPT** ammonia, amide
	(c)		**1** low / less / no, thyroid hormones ; **2** less (aerobic) respiration ; **3** less, <u>ATP</u> produced / <u>energy</u> ; **4** slow(er) metabolism / low(er) (B)MR ; **5** low body temperature ; **6** AVP ;	3 max	**DO NOT CREDIT** no respiration / ATP eg sleep more, get tired quickly, poor muscle tone, mental retardation
	(d)	(i)	<u>homozyg</u>ous ;	1	**Mark the First Answer** **IGNORE** dominant / recessive
		(ii)	*genotype* combination of <u>alleles</u> ; possessed by organism ; *allele* alternative / mutant, form / version ; of, a gene ;	4	**ACCEPT** *idea of* **all** alleles or '**the**' alleles (suggesting all) **ACCEPT** *idea of* eg that a, person has / you have / of an individual / cell *'all my alleles'* = 2 marks **ACCEPT** altered, different (form / version) **CREDIT** DNA if qualified, eg at a locus / codes for X

Question			Answer	Marks	Guidance
	(e)		population, not large / (too) small **;** not randomly-mating / matings arranged **;**	2	
	(f)		natural / artificial / directional, <u>selec</u>tion **;** <u>genetic drift</u> **;** <u>mutation</u> **;** migration / AW **;**	2 max	**Mark the first two suggestions only** **ACCEPT** <u>selec</u>tion pressure, <u>select</u>ive breeding, <u>select</u>ive advantage
			Total	**16**	

Question			Answer	Marks	Guidance
3	(a)	(i)	artificial selection / selective breeding **;**	1	**First Answer**

		(ii)	*idea that* males can father many offspring / mate several females **;**
			 idea that females produce only a few offspring **;**
			
			 (so) more females (than males) needed to
			      maintain numbers (each generation) **;**
			
			 (20% females chosen as) inbreeding / genetic problems,
			      if breeding population is too small **;**
			
			 (5% males chosen as) selection pressure stronger
			      if fewer (tamest) are used **;**
				2 max	**IGNORE** artificial insemination
					 eg one litter at a time

	(b)		**1** (mostly) <u>genetic</u> **;** **2** as can be selected for / selective breeding increases frequency **;** **3** <u>allele</u>(s) for tameness **;** **4** (from) mutation **;** **5** query role of environment / learning **;** **6** ref. DRD4 / dopamine receptor **;**	3 max	**DO NOT CREDIT** if environment also given as cause **IGNORE** genetic drift **DO NOT CREDIT** if environment given as main cause **ACCEPT** query about experimental method, eg was environment controlled for?

Question			Answer	Marks	Guidance
	(c)		*linkage* tameness genes and genes for these traits <u>on same</u> <u>chromosome</u> ; (so) inherited together ; *epistasis* (product of) one gene affects expression of another ; via enzyme pathway ; *inbreeding* (hidden / masked) recessive alleles ; selected for, as well / unintentionally ; more chance homozygous as, small gene pool / parents related ; *genetic drift* random / chance (which alleles, present / passed on) ; (effect stronger because) small breeding population ;	2	**First Answer** Look for the two mark points relevant to the first word of the four on offer that the candidate has chosen. **ACCEPT** idea of (recessive)allele inherited from both parents because, they are closely-related / small gene pool / reduced genetic diversity
	(d)		**1** <u>geographic</u> ; **2** wolves avoid human settlements / dogs confined by humans ; **3** <u>behavioural</u> ; **4** detail / description ; **5** <u>mechanical</u> ; **6** idea of different size of wolves and some small dogs ; **7** gamete incompatibility ; **8** possibility of different chromosome numbers ; **9** <u>seasonal / temporal</u> ; **10** different breeding, seasons / times ;	3 max	**IGNORE** reproductive isolation **4** eg differences in, pheromones / courtship **6 ACCEPT** different genitalia **10 CREDIT** *the idea that* dogs breed all year round / wolves breed once a year

14

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Question			Answer	Marks	Guidance
	(e)		*biological species concept*	4 max	
			1 (members of same species) need can interbreed to produce fertile offspring **;**		
			2 not all dog breeds can do this therefore not same species **;**		
			3 dog and wolf can so they should be same species **;**		
			phylogenetic species concept		
			4 *idea that* dogs and wolves monophyletic group / tip of phylogeny **;**		**4 ACCEPT** share a common ancestor
			5 genetic differences, between dogs and wolves small **;**		**5 CREDIT** question of how much DNA difference needed to classify as separate species
			6 gene flow between wolves → big dogs → little dogs / analagous to ring species **;**		
			7 (PSC) one species (with a lot of phenotypic variation) **;**		
				Total	**15**	

	Question		Expected Answers	Marks	Additional Guidance
4	(a)	(i)	**1** sweep netting / sweep vegetation with a net ; **2** beating / beat trees and bushes ; **3** pooter / pooting / described ;	1 max	**2** **ACCEPT** fogging **3** **ACCEPT** pitfall traps / described

	(a)	(ii)	*idea of* ladybirds not evenly distributed /
			      some parts of hill different /
			      more representative ;
			
			 lets <u>reliability</u> be assessed / anomalies identified ;
				1 max	**ACCEPT** description
					      e.g. could be more ladybirds one side than another
					
					 ACCEPT increases reliability
					 IGNORE accuracy / precision / removes anomalies

	(b)	(i)	**M1** (calculate) % / proportion / ratio ; **E1** as different total numbers at each site ; **or** **M2** (draw) bar chart / kite diagram ; **E2** pictorial data easier to understand ;	2 max	**M1** **IGNORE** χ^2 **M2** **IGNORE** histogram / line graph

	Question		Expected Answers	Marks	Additional Guidance
4	(b)	(ii)			**If candidates argues 'yes' exclusively, can only be awarded mps 1-3** **If candidate answers 'no' exclusively, can only be awarded mps 4 & 5**
			yes (for first statement) **1** first statement true / correlation exists **;** **2** number of black ladybirds increase **,** from 100m to 300m / until 300m **;** **3** 400m number decrease **but** % black increases **;**		*Note percentage of black ladybirds increases as you go up the hill* = 2 marks (mps 2 & 3)

			no (for second statement)
			4 correlation not proof of causation /
			         no proof of causal link /
			         second statement not (necessarily) true **;**
			5 another (named) factor could be involved **;**
					5 **CREDIT** could be due to distance from town /
					                  more **or** less predation high up /
					                  camouflage / warning colours

				3 max	
	(c)	(i)			**DO NOT CREDIT gene** **IGNORE letters / genotypes**

			only expressed , when homozygous /
			               in absence of dominant (allele) **;**
			not expressed when heterozygous /
			             expression masked by dominant (allele) **;**
				1 max	**ACCEPT only seen in phenotype when it is present in**
					                              'double dose'

Question			Expected Answers	Marks	Additional Guidance
4	(c)	(ii)	1 $\underline{q^2}$ = 296 / 346 or 0.85 / 0.855 / 0.86 ; 2 q = √previous answer or 0.92 / 0.93 ; 3 p = 1 – previous answer or 0.08 / 0.07 ;		1 **DO NOT CREDIT** calculation or figure unless it has been indicated as q^2 2 **ACCEPT ecf** 3 **ACCEPT ecf** *Note* **If both p and q are correct = 3 marks** *If p and q not given to 2 decimal places* then penalise 1 mark and then apply ecf • If the 2 final answers add up to 1 give mp 3, then look for evidence of mps 1 or 2 in the working • If the 2 final answers do not add up to 1, look for evidence of mps 1, 2 & 3 in the working • Award the working mark(s) if method correct, even if subsequent calculation incorrect (e.g. *1 – 0.54 = 0.56* could get mp 3 for '1 – previous answer' even though 0.56 is the incorrect answer for the calculation) *e.g. if black allele wrongly assumed to be recessive* *q = 0.38* or *q = √0.1445* give mp 2 as ecf *p = 0.62* or *p = 1 – 0.38* give mp 3 as ecf *e.g. if answer given as* *q = 0.85 and p = 0.15* give mp 3 They will not get mp 1 as they think that 296/346 = q (rather
				3	than q^2) and so will not square root it so they won't get mp 2
				11	