Question			Expected Answer	Mark	Additional Guidance
1	(a)	(i)	*discontinuous* gender / male and female / eye colour **;** *continuous* size / length / mass **;**	2	**Mark the first answer on each prompt line.** If an additional answer is given that is incorrect or contradicts the correct answer, then **= 0 marks** **Note:** Suggestions must relate to **visible** characteristics of the **frogs**, **ACCEPT** sex **IGNORE** skin colour (as stated in Q) **CREDIT** example of a ***measurable*** characteristic (e.g. leg length, surface area, height, weight)
1	(a)	(ii)	*idea of* **1** no / little **,** environmental effect for **,** (named example of) discontinuous variation / example given for discontinuous variation in **(i)** as ecf **;** **2** some / large **,** environmental effect for **,** (named example of) continuous variation / example given for continuous variation in **(i)** as ecf **;** **3** gender may be affected by **,** temperature / atrazine exposure **;**	2	**IGNORE** examples of environmental factors **ACCEPT** discontinuous variation is ***only*** **,** genetic / due to alleles present **Note:** A comparative statement (e.g. ' environment has a great<u>er</u> effect on continuous variation') **= 2 marks** (mps 1 & 2) e.g ‘ no environment effect for discontinuous variation but it does affect continuous variation’ **= 2 marks** (mps1 &2)

<table>
<tr><th colspan="3">Question</th><th>Expected Answer</th><th>Mark</th><th>Additional Guidance</th></tr>
<tr><td>1</td><td>(a)</td><td>(iii)</td><td>1 idea that offspring visibly different from , A / egg donor ;

2 to show that the offspring produced were clones ;

3 to show / identify , (genetic) parents (of clone) / B and C ;</td><td>2 max</td><td>ACCEPT brown frog for A

2 ‘to show that cloning is successful’ is not enough

Note:
‘To show that the offspring were clones as they are not the same as A.’ = 2 marks (mps 1 & 2)</td></tr>
<tr><td>1</td><td>(b)</td><td>(i)</td><td><table><tr><th>Genetic fingerprint number</th><th>Letter of frog</th><th></th></tr><tr><td>1</td><td>D</td><td>;</td></tr><tr><td>2</td><td>A</td><td>;</td></tr><tr><td>3</td><td>B</td><td>;</td></tr></table></td><td>3</td><td>Mark the first answer in each box. If an additional answer is given that is incorrect or contradicts the correct answer, then = 0 marks

If no letters in the table <u>at all</u>, look at the diagram and award marks if the profiles are identified correctly.</td></tr>
<tr><td>1</td><td>(b)</td><td>(ii)</td><td>cytoplasm / mitochondria , came from A

or

mitochondria / (mitochondrial) DNA , in cytoplasm of A ;</td><td>1</td><td>If frog not identified correctly = 0 marks

Must refer specifically to frog A

Must refer specifically to frog A</td></tr>
</table>

Question			Expected Answer	Mark	Additional Guidance
1	(c)	(i)	*advantage* (genetically identical so) all react the same **or** genetic variable controlled **;** *disadvantage* expensive (to produce) **or** don't see varied response to drug like in real populations (of mice) **or** *idea that* clones (of mice) may have unknown health issue (which would affect responses) **;**	**2**	**Note that the question refers to the use of cloned or uncloned mice in testing – and NOT to humans.** **ACCEPT ora** throughout **IGNORE** large numbers of clones produced **IGNORE** ref to animal welfare / religious objections **IGNORE** ref to validity **ACCEPT** 'no genetic diversity to affect results' **ACCEPT** 'rare allergies / adverse reactions **,** won't be seen'

<table>
<tr><th colspan="3">Question</th><th>Expected Answer</th><th>Mark</th><th>Additional Guidance</th></tr>
<tr><td>1</td><td>(c)</td><td>(ii)</td><td>1 idea to produce , elite / best , animals ;

2 idea to save / preserve , endangered animals ;

3 grow / produce (spare) , stem cells / tissues / organs ;

4 AVP ;</td><td>2</td><td>IGNORE ref research into disease (as given in Q)
IGNORE ref to cost

1 ACCEPT example / desirable characteristics

2 ACCEPT recreating extinct animals

3 ACCEPT ref to named example of , tissue / organ

4 e.g. pet cloning / cloning GM animals / animals for xenotransplantation</td></tr>
<tr><td>1</td><td>(d)</td><td></td><td><table>
<tr><th>Individuals</th><th>% of alleles shared</th><th></th></tr>
<tr><td>David and John</td><td>100</td><td>;</td></tr>
<tr><td>Anne and Lisa</td><td>50</td><td>;</td></tr>
<tr><td>Sarah and Lisa</td><td>50</td><td>;</td></tr>
</table></td><td>3</td><td>Mark the first answer in each box. If an additional answer is given that is incorrect or contradicts the correct answer, then = 0 marks</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>17</td><td></td></tr>
</table>

Question			Answer	Mark	Guidance
2	(a)		*a **difference** is stated relating to* fur length **;** pattern / colour, of fur **;** eye colour **;** temperament / tameness **;** face shape **;**	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". **IGNORE** albino

Question			Answer	Mark	Guidance
	(b)	(	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 / base deletion / 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

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td></td><td></td><td>(ii)</td><td>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 ;</td><td>max 2</td><td>Markpoints 1–3 are linked within 4 possible contexts.
‘It’ 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.

<table>
<tr><th></th><th>domestic</th><th>in the wild</th></tr>
<tr><td>good mothering</td><td>1 kittens do, survive / breed

2 alleles not necessarily, passed on / kept

3 not selected for</td><td>1 kittens do, survive / breed

2 alleles, increase / passed on / kept

3 selected for</td></tr>
<tr><td>bad mothering</td><td>1 kittens do, (still) survive / breed

2 alleles, increase / passed on / kept

3 not selected against</td><td>1 kittens do not, survive / breed

2 alleles, decrease or alleles not, passed on / kept

3 selected against</td></tr>
</table>
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)</td></tr>
</table>

Question			Answer	Mark	Guidance
	(e)	(	**1** inbreeding **/** small or decreasing, gene pool **;** **2** homozygous recessive (genotypes) **;** **3** gene / allele **,** for desired characteristic on same chromosome as problem, gene / allele **;** **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) **;**	max 2	**ACCEPT** decreasing genetic variation **IGNORE** interbreeding **CREDIT** good and bad genes, linked / show linkage
		(ii)	**1** entrapment / alginate beads / cellulose network **;** **2** a**d**sorption / carrier bound **or** stuck to **,** porous carbon / clay / resin / glass **;** **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 **;**	max 2	**Mark the first 2 answers** **ACCEPT** encapsulation, inclusion **IGNORE** a**b**sorption
			Total	**21**	

Question			Expected Answers	Marks	Additional Guidance
3	(a)		*somatic* changes / uses **,** body cells **;** change cannot be passed to offspring **;** cures / alleviates **,** genetic disease in one individual **;** short-lived / repeat treatments needed **;** *germ line* changes / uses **,** gametes / zygote / embryo / reproductive tissue **;** banned **;**	**2 max**	**ORA** germ line changes could be passed to offspring **ACCEPT** sperm / eggs
	(b)		*central* **CI** brain and spinal cord **;** **C2** intermediate neurones **;** **C3** has **,** coordinating role / many synapses **;** *peripheral* ***max 3*** **P1** <u>nerves</u> **,** from sense organs / to muscles / to glands **;** **P2** sensory **and** motor **,** neurones / nerve cells **;** **P3** role in **,** sensing stimuli / controlling effectors **or** conducting impulses, to / from **,** CNS / brain / spinal cord **;** **P4** includes **,** somatic / autonomic / sympathetic / parasympathetic **;**	**4 max**	**For full marks needs at least 1 C mark** **C2** **CREDIT** relay / internuncial / bipolar **C3** **IGNORE** processing **P1** **IGNORE** effectors **P2** **DO NOT CREDIT** if intermediate included **DO NOT CREDIT** nerves **P3** **IGNORE** messages / signals / information
	(c)		*prophase 1* <u>homologous</u> <u>chromosomes</u> pair up / <u>bivalents</u> form **;** <u>chiasmata</u> / crossing-over / recombination **;**	**2**	**CREDIT** reverse arguments for prophase 2 **ACCEPT** description e.g. <u>non-sister chromatids</u> exchange **,** (matching sections of) DNA / alleles / genetic material
				8	

Question			Expected Answer	Mark	Additional Guidance
4	(a)		young / elderly / HIV infected / malnourished / post-operative / on immunosuppressants / leukaemia / undergoing cancer treatment / anorexics **;** immature / compromised / weak / AW, immune system **;**	2	**IGNORE** prompt lines and mark the answer as a whole **ACCEPT** AW for young / elderly etc **IGNORE** 'ill' or 'unfit' **IGNORE** any reference to populations e.g. those living in vicinity of outbreak **ACCEPT** description **ACCEPT** no immunity
	(b)	(i)			**DO NOT CREDIT** 'mould' – penalise once only
		1	bacteria / (bacterial) cells, divide / increase in number / multiply / reproduce / proliferate / replicate **;**		*1* **IGNORE** 'growth' **DO NOT CREDIT** 'mitosis'
		2	(secrete) enzymes / named enzyme **;**		*2* **DO NOT CREDIT** excrete Answer should **not** imply intracellular enzymes
		3	food, digested / broken down **;**		
		4a	protein / named protein / polypeptides → peptides / amino acids **OR**		
		4b	fat / triglycerides → fatty acids **OR**		*4b* **IGNORE** cholesterol
		4c	starch / amylose / glycogen → glucose / sugar **;**		*4c* **ACCEPT** other correct carbohydrate breakdown
		5	production / release / excretion / secretion, of, toxins / named toxin / waste products **;**		
		6	(causes) change in, appearance / smell / texture / taste **;**	3 max	*6* **CREDIT** suitable example e.g. 'goes mushy'

Question			Expected Answer	Mark	Additional Guidance
	(b)	(ii)			Idea of 'more' is needed for all marking points but it can be stated once and linked to more than one point. • e.g. 'more bacteria secreting enzymes' = mp 2 and 4 **ACCEPT** converse argument throughout **ACCEPT** 'fungi' / 'mould' in place of bacteria as question stem does not specify
		1	bacteria, reproduce / AW, more rapidly / faster **;**		*1* **IGNORE** 'grow' **IGNORE** 'more easily' or 'effectively' **DO NOT CREDIT** if the candidate thinks there is no reproduction at 5°C
		2	(so) more bacteria present **;**		
		3	more, toxins / waste, produced / released / AW **;**		
		4	more enzymes, secreted / AW **;**		*4* **DO NOT CREDIT** excreted
		5	enzyme, action faster / works better / more effective, at higher temperatures **;**		*5* **IGNORE** optimum
		6	(substrate and enzymes have) more <u>kinetic</u> energy **;**		
		7	more, enzyme-substrate complexes / ESC / (successful) collisions between substrate and active site **;**	**3 max**	

Question			Expected Answer	Mark	Additional Guidance
	(b)	(iii)	max 2 for 2 distinct methods max 2 for 2 **correctly linked** explanations Only credit the explanation mark if the method mark has been awarded.		Where more than one method is given, mark first on line and assume explanation linked with that **DO NOT CREDIT** chilling or freezing (as in question)
		M1 **E1**	salting **;** lack of water due to, osmosis / low water potential (outside cell) **;**		***M1*** **IGNORE** drying ***E1*** **ALLOW** low Ψ / high solute potential
		M2 **E2**	sugar **;** lack of water due to, osmosis / low water potential (outside cell) **;**		***M2*** **IGNORE** drying ***E2*** **ALLOW** low Ψ / high solute potential
		M3 **E3**	(air / freeze) drying **;** *idea that* enzymes cannot mobilise / intracellular transport impaired / reactions have no medium in which to occur / (microbes) cannot move **;**		
		M4 **E4**	pickling / (use of) vinegar **;** (low pH) denatures / changes tertiary structure of / changes 3D shape of, enzymes / proteins **OR** substrate no longer fits active site / active site shape changes / prevents ESC **;**		***E4*** **DO NOT CREDIT** high pH
		M5 **E5**	heat treatment / cooking **;** denatures / changes tertiary structure of / changes 3D shape of, enzymes / proteins **OR** substrate no longer fits active site / active site shape changes / prevents ESC **;**		***M5*** **ACCEPT** pasteurising **IGNORE** canning for this mp ***E5, E 6 & E7*** **ACCEPT** 'kills bacteria' or 'kills microbes' as a reason supporting heat treatment, irradiation or smoking **only once**
		M6 **E6**	irradiation / UV / gamma rays / X-rays / ionising radiation **;** destroys / damages / changes / mutates, DNA / genes / genetic material **;**		***M6*** **CREDIT** radiation if correctly qualified in explanation
		M7 **E7**	smoking **;** (so exposed to) antibacterial / named antibacterial, chemical(s) **;**		***M7*** **CREDIT** addition of, sulphites / sodium benzoate / alcohol
		M8 **E8**	vacuum packing / canning / bottling **;** microorganisms cannot respire aerobically **;**	**4**	***E8*** **IGNORE** 'denaturing' as a consequence of canning / bottling

Question			Expected Answer	Mark	Additional Guidance
	(c)		**This is a QWC question** **Ignore sections and mark as continuous prose**		Assume candidate is talking about mycoprotein unless otherwise stated. **CREDIT** ora for beef throughout. **IGNORE** use of figures alone when awarding mps **1, 3, 6, 7, 9** – look for **descriptive statement**, e.g. • '12 g of protein' = no mark • 'only 12 g protein' = 1 mark (mp 9)
		1 **2**	low(er) / less, energy (than beef) **;** useful for, slimming / weight control / AW **;**		*2* **ACCEPT** preventing obesity **ACCEPT** 'less energy to burn off *during exercise*' **DO NOT CREDIT** 'burn off' unqualified
		3 **4** **5**	low(er) / less, (total) fat **;** (very) low / (much) less, saturated fat **;** lower, cholesterol **OR** lower risk of, (coronary) heart disease / CHD / cardio-vascular diseases / heart attack / cardiac arrest / myocardial infarction / MI / angina / atherosclerosis / atheroma **/** stroke / hypertension **;**		
		6	contains carbohydrate / AW **;**		*6* **ACCEPT** 'more carbohydrate than beef' **IGNORE** 'carbs'
		7 **8**	low(er) / less, iron content **;** (increased risk of) anaemia / fewer RBCs / less haemoglobin / reduced oxygen carrying capacity of blood **;**		*8* **IGNORE** answers phrased in terms of role of iron alone e.g. 'haemoglobin contains iron' = 0 Answers must show consequence of deficiency e.g. 'less haemoglobin' = 1
		9	low(er) / less, protein **;**		
		10 **11**	(mycoprotein provides) more balanced diet **;** need larger intake to meet requirements / AW **;**	**7 max**	
			QWC – award for 2 clear references to the table **;**	**1**	Award for 2 sets of comparative figures (stated or calculated) with units – 'content per 100g' not needed **IGNORE** vague terms like 'about' as long as figs are correct
			Total	**20**	