Question			Answer	Marks	Guidance
1	(a)		sex linkage / sex linked **;**	1	**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** **ACCEPT** non-autosomal linkage
1	(b)	(i)	Z^BZ^b barred male **;** Z^BW barred female **;** Z^bW non-barred female **;**	3	If no gender given, **AWARD** one mark only if **all three** adult colours correct If no colours given, **AWARD** one mark only if **all three** genders correct **CREDIT AW** for 'barred' e.g. 'black (feathers) striped with white (bars)' **or** 'striped / stripey'. **CREDIT AW** for 'non-barred' e.g. (all) black / not striped.

Question			Answer	Marks	Guidance
1	(b)	(ii)	<table><tr><td>parent phenotypes:</td><td>barred female</td><td>non-barred male</td><td></td></tr><tr><td>parent genotypes:</td><td>Z^BW</td><td>Z^bZ^b</td><td>;</td></tr><tr><td>gametes:</td><td>Z^B and **W**</td><td>Z^b (and Z^b)</td><td>;</td></tr><tr><td>F1 genotypes:</td><td>Z^BZ^b</td><td>Z^bW</td><td>;</td></tr></table> *F1 day-old chick phenotypes* *male* black (body) with a white spot (on head) **;** *female* (all) black / black body and head / black with no white spot (on head) **;**	5	If symbols other than those given (B and b) are used (e.g. A and a), penalise once and then apply ECF. If X and Y are used instead of W and Z, penalise once and then apply ECF. If alleles put onto the W, penalise once and then apply ECF. **ACCEPT** W written before Z, or other order change eg Z^BZ^b as Z^bZ^B. Gametes must apply to candidate's stated parent genotypes – apply ECF. **IGNORE** genotype repeated (i.e. no space between the gametes). **CREDIT** F1 genotypes in any order **IGNORE** repetitions such as each genotype stated twice. Apply ECF if genotypes match gametes given. F1 genotypes and phenotypes should match, including repetitions if given. Apply ECF **DO NOT CREDIT** adult phenotypes
1	(c)	(i)	homozygous recessive **;**	1	**ACCEPT** reverse word order **IGNORE** double
1	(c)	(ii)	(all are) white **;**	1	**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**
			Total	**11**	

Question			Answer	Marks	Guidance
2	(a)		**1** geographical, isolation / separation / barrier **;** **2** *idea of* reproductive isolation **;** **3** different **,** selection pressures / adaptations (on different islands) **;** **4** small **,** populations / gene pools **;** **5** *idea of mp 4* resulting in founder effect **;** **6** *idea of mp 4* resulting in greater genetic drift **;**	2	**1** **IGNORE** allopatric speciation **2** e.g. no / less **,** interbreeding between different **,** populations (early) / species (late) **3** **IGNORE** different to mainland **ACCEPT** in different environments or conditions they evolve or adapt differently **4** **DO NOT CREDIT** small species **5** **ACCEPT** *idea of mp 4* resulting in greater impact of **,** mutation / input of alleles (migration) / loss of alleles (accidents etc.)
2	(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
2	(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) ● <u>*Scalesia*</u> tree (**mp4** deforestation, **mp10** competition from red quinine tree) ● (blue-footed) boobies (**mp11** predation by rats)

Question			Answer	Marks	Guidance
2	(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
3			**1 E ;** **2 C ;** **3 B ;** **4** given **5 F ;** **6 A ;** **7 G ;** **8 D ;**	7	**Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
			Total	**7**	

Question			Answer	Marks	Guidance
4	(a)		**1** mutation **;** **2** meiosis **;** **3** cross(ing)-over **;** **4** between non-sister chromatids **;** **5** (in) prophase I **;** **6** independent / random , assortment / segregation **;** **7** (in) metaphase **;** **8** *idea of* random **,** fertilisation / fusion of gametes **;** **9** AVP **;**	5	**1** **CREDIT** in context of gene or chromosome mutation **ACCEPT** a suitable description e.g. change in DNA base sequence / non-disjunction **2** **DO NOT CREDIT** incorrect spelling of meiosis **3** **ACCEPT** formation of chiasmata **4** **DO NOT CREDIT** sister here (CON) but **IGNORE** sister for mp 3 and mp 5 **5** needs to be in context of 3 or 4 **6** **ACCEPT** description e.g. random alignment of bivalents **7** needs to be in context of 6 metaphase I (chromosomes) or I I (chromatids) **IGNORE** anaphase **8** **CREDIT** description relating to plant (as Q states rhubarb) e.g. any pollen grain could land on any stigma / any pollen grain could reach any ovule **9** ref. epigenetics

Question			Answer	Marks	Guidance
4	(b)	(i)	reproductive **;** cloning **;**	2	**ACCEPT** 'whole organism'
4	(b)	(ii)	(callus / plant) tissue culture / micropropagation **;**	1	**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** **ACCEPT** tissue culturing / micropropagating **IGNORE** cloning
4	(b)	(iii)	*they have different (qualitatively or quantitatively)* **1** genes / DNA / alleles / genotypes **;** **2** repressor proteins **;** **3** enzymes **;** **4** protein folding / tertiary structure / thermostability **;** **5** (plant) growth regulators / hormones **;**	2	**Mark the first 2 suggestions.** Must have 'different' idea at least ONCE e.g. higher / only one of them has x **3** **CREDIT** different enzymes or different amounts **4** **CREDIT** enzyme activity at different temperatures **5** **ACCEPT** PGRs / named hormones eg gibberellins
4	(c)	(i)	**1** (test) different varieties **;** **2** several plants or leaves (of each) / repeat readings **;** **3** same age **;** **4** same soil **,** type / mineral content / pH **;** **5** same light **,** exposure / conditions **;** **6** same **,** watering regime / temperature / CO_2 concentration **;**	5	**1** **ACCEPT** 'Timperley Early' and 'Victoria' **IGNORE** species **2** **ACCEPT** three or more **CREDIT** 'control / controlled' for 'same' in mps **3,4,5,6 & 7** **4** **IGNORE** soil nutrient level or content **5** **CREDIT** light intensity / wavelength / duration **IGNORE** amount of light *If none of mps 4-6 awarded*

Question	Answer	Marks	Guidance
			ACCEPT *'grown under same conditions' for 1 mark and dot for QWC if stated as controlled*
	7 same, preparation or testing procedure detail **;** (e.g. leaf mass / volume of solvent / soaking time / temperature)		**7** **IGNORE** amount (of solvent / water / ethanol / alcohol) or size (of leaf). Procedure can be liquidising/pestle and mortar, stated same for each.
	8 test / measure**,** (oxalic) acid concentration / acidity / pH / H^+ ion concentration **;**		**8** **IGNORE** amount / content / how much (of acid or H^+ ions) except for QWC
	9 detail of measuring method **;**		**9** e.g. pH probe universal indicator (not litmus) titration **IGNORE** colorimetry
	QWC ;	1	**Award if** variables correctly identified as <u>independent</u> (**1** only) **and** <u>control</u>led (any of **3/4/5/6/7**) **and** <u>dependent</u> (**8** only).

Question			Answer	Marks	Guidance
4	(c)	(ii)	**1** bacteria / fungi **;** **2** *idea of* external digestion **;** **3** by **,** enzymes / named enzymes **;** **4** absorption of breakdown products **;** **5** release of carbon dioxide and water **;** **6** (breakdown of protein) makes **,** ammonium **,** ions / compounds **or** NH_4^+ **;**	3	**1** **DO NOT CREDIT** wrong bacteria eg nitrogen fixing, nitrifying, denitrifying, *Rhizobium, Nitrosomonas, Nitrobacter* **2** **CREDIT** saprotrophic / saprophytic / saprobiotic **ACCEPT** **'**breaking down' for digestion **3** e.g. cellulase / lignase **6** **CREDIT** ammonification **IGNORE** ammonia / nitrates
4	(d)		auxin / IAA **;** not destroyed by light / more present in dark **;** moves down from shoot tip / uniformly distributed **;** (causes) <u>cell</u> elongation **;**	2	**IGNORE** gibberellins and references to phototropism and more light on one side
			Total	**21**	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>5</td><td>(a)</td><td></td><td>
<table>
<tr><th>control element</th><th>made of protein</th><th>binds to a protein</th><th>codes for protein</th><th></th></tr>
<tr><td>insulin</td><td>✓</td><td>✓</td><td>×</td><td>;</td></tr>
<tr><td>c AMP</td><td>×</td><td>✓</td><td>×</td><td>;</td></tr>
<tr><td>lac I (inhibitor) gene</td><td>×</td><td>✓</td><td>✓</td><td>;</td></tr>
<tr><td>lac O (operator) gene</td><td>×</td><td>✓</td><td>×</td><td>;</td></tr>
<tr><td>homeotic gene product</td><td>✓</td><td>×</td><td>×</td><td>;</td></tr>
</table>
</td><td>5</td><td>Award one mark for each correct row.
DO NOT CREDIT blank spaces, multiple answers or hybrid ticks (a tick that has been crossed through, so it cannot be judged if it is a tick or a cross.)</td></tr>
</table>

Question			Answer	Marks	Guidance
5	(b)		*RNA polymerase* **1** makes (m / messenger / t / transfer / r / ribosomal) RNA **;** **2** transcription **;** **3** one strand (DNA) used / short section used / one strand formed **;** *DNA polymerase* **4** DNA replication **;** **5** semi-conservative / both strands used / whole length used / 2 strands formed **;** **6** before **,** nuclear / cell **,** division **;**	4	**2** **CREDIT** transcribes / transcribed **3** Must be a clear statement **4** **CREDIT** replicates / replicated **5** Must be a clear statement **6** **CREDIT** before **,** mitosis / meiosis / cytokinesis **CREDIT** in S phase (of interphase) **IGNORE** interphase unqualified
5	(c)		**1** apoptosis **;** **2** cytoskeleton **;** **3** enzymes **;** **4** phagocytosis **;** **5** mitosis / mitotic cell division **;** **6** tumour **;**	6	**Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **1** **ACCEPT** 'apotosis' as phonetic **2** **ACCEPT** cell skeleton **3** **CREDIT** proteases / lysosomes **6** **ACCEPT** cancer / carcinoma
			Total	**15**	

Question			Answer	Marks	Guidance
6	(a)		**P** lag **;** **Q** log(arithmic) / exponential **;** **R** stationary **;**	3	**Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **IGNORE** plateau
6	(b)		(molecule made in or needed for cell's normal) survival / function / growth / development / reproduction **;** named example **;**	2	**IGNORE** metabolism (as stated in Q) / phase e.g. glucose / sucrose / (named) amino acid / CO_2 / ethanol / (named) nucleotide / named named respiratory intermediate / (named) protein / (named) enzyme **DO NOT CREDIT** antibiotics
6	(c)	(i)	**Q ;**	1	**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** **ACCEPT** log / exponential
6	(c)	(ii)	**R ;**	1	**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** **ACCEPT** stationary
6	(c)	(iii)	**R** / **S ;**	1	**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** **ACCEPT** stationary / decline / death (phase)

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>6</td><td>(d)</td><td>(i)</td><td>
<table>
<tr><th>factor (F)</th><th>change needed (C)</th></tr>
<tr><td>oxygen ;</td><td>increase it / more / high
or
stir / sparging ;</td></tr>
<tr><td>(named)
nutrient ;</td><td>increase it / more / high
or
stir ;</td></tr>
<tr><td>temperature ;</td><td>maintain at / control at /
change to , optimum
or
cool
or
ref. to using water jacket ;</td></tr>
<tr><td>pH ;</td><td>maintain at / control at /
change to, optimum
or
add, buffer / acid / alkali ;</td></tr>
<tr><td>(waste)
product / gas /
CO_2 ;</td><td>harvest / remove /
waste gas vent ;</td></tr>
<tr><td>other /
unwanted /
harmful /
competing ,
microbes ;</td><td>prevent entry / asepsis ;</td></tr>
</table>
</td><td>4</td><td>Mark the first suggestion on each prompt line. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks
C CREDIT idea of paddles distributing the available oxygen more evenly
C ACCEPT continuous, adding / supply, of oxygen
IGNORE aeration as named F but ACCEPT for C
C CREDIT idea of paddles distributing the available nutrients more evenly
C ACCEPT continuous, adding / supply, of nutrients
IGNORE food as named F but ACCEPT for C

C ACCEPT ‘suitable’ for ‘optimum’ temperature
ACCEPT prevent overheating / enzymes denaturing

C ACCEPT ‘suitable’ for ‘optimum’ pH
ACCEPT prevent enzymes denaturing

C CREDIT reduce pressure (for waste gases)

F CREDIT named microbes e.g. bacteria / fungi / pathogens
C CREDIT idea of use of filters or aseptic techniques</td></tr>
</table>

Question			Answer	Marks	Guidance
6	(d)	(ii)	**1** (child's) cells / DNA / genes / alleles **,** not changed **;** **2** vector not used (in child) **;** **3** child / cells **,** not producing **,** HGH / hormone **;** **4** HGH / drug / injection **,** has to be given repeatedly / is a short term solution / not a cure **;**	3	**ACCEPT** reverse reasoning throughout e.g. **1** in gene therapy **,** the person's cells are altered / a functional allele is introduced. **1** **DO NOT ACCEPT** gene replacement **ACCEPT** genotype **2** **CREDIT** named vector **3** **CREDIT** (the) protein / polypeptide
			Total	**15**	

Question			Answer	Marks	Guidance
7	(a)		**C ;** **D ;** **B ;** **A ;**	4	**Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
7	(b)		goal **D ;** **A ;** **B ;** **C ;** **E ;**	5	**Mark the first answer in each box.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
			Total	**9**	

Question			Answer	Marks	Guidance
8	(a)		*producer* (leaves / plants) fix carbon / photosynthesise / make food / autotroph(ic) / convert light energy to chemical energy / convert inorganic, C / CO_2, to organic molecules **;** *consumer* (bird) eat / derives energy from / feeds on **,** other organisms **or** heterotroph(ic) **;** *trophic level* stage / position / place / level **,** in a food **,** chain / web **;**	3	**IGNORE** 'first level in a food chain' **DO NOT CREDIT** 'produces energy' **IGNORE** 'consumes' **IGNORE** named levels / organisms e.g. eats producers **ACCEPT** animals, and / or, plants **IGNORE** step, feeding level
8	(b)	(i)	number of quadrats (per area) **;** method of placing quadrats (randomly) **;** time waiting **,** after solution added / for worms to rise **;** <u>volume</u> of solution **;** <u>concentration</u> of solution **;** AVP **;**	2	**CREDIT** any two correct answers **IGNORE** ref to quadrats being the same size (as given in Q) **IGNORE** amount e.g. method of applying solution length of time spent counting time of day / light intensity soil moisture / rainfall / humidity method to ensure no double counting

Question			Answer	Marks	Guidance
8	(b)	(ii)	means different / mean less in soil with plants removed **;** (but) error bars overlap **;** (could have) mean trend reversed / equal numbers in some pairs of results **;** difference**,** not / less **,** valid **;**	2	**DO NOT CREDIT** if difference in mean stated to be valid **IGNORE** average **ACCEPT** cross (over) e.g. in any pair of results you could find that the number of earthworms in the cleared soil could be higher than in the uncleared soil **ACCEPT** introductory statement ' No it is not'.
8	(b)	(iii)	number / abundance **,** of earthworms varies **,** from year to year / from 2004 to 2006 / over the two years / over time **;** number / abundance **,** of earthworms varies , before and after plant clearance / as vegetation changes / during succession **;**	2	**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** **ACCEPT** change described e.g. more worms in 2006 than 2004 If neither mark point awarded **ACCEPT** numbers of earthworms constantly **,** changing / fluctuating for **1 mark**
			Total	**9**	