Question			Answer	Marks	Guidance
1	(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** **CREDI** 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** **ACC PT** formation of chiasmata **4** **DO NOT CREDI** sister here (CON) but **IGNORE** sister for mp 3 and mp 5 **5** needs to be in context of 3 or 4 **6** **ACC PT** 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** **CREDI** 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
	(b)	(i)	reproductive ; cloning ;	2	**ACCEPT** 'whole organism'
	(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
	(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
	(c)	(iv)	**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 independent (**1** only) **and** controlled (any of **3/4/5/6/7**) **and** dependent (**8** only).

Question			Answer	Marks	Guidance
	(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
	(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**	

Question			Expected Answers	Marks	Additional Guidance
2	(a)		124 (%) / 123.7 (%) **; ;**	**2**	• Correct answer = 2 marks (208 – 93) **÷** 93 x 100 • **ACCEPT** 55 (%) / 55.3 (%) for 2 marks (208 – 93) **÷** 208 x 100 • Correct numerical answer but inappropriate units (eg 124 μm) = 1 mark • If answer not rounded correctly (to nearest whole number or to 1 dp) or if answer incorrect**,** then allow 1 mark for seeing **either** 115 **or** (208 – 93)

Question			Expected Answers		Marks	Additional Guidance	
	(b)					**Read through complete answer.** **Award 2 marks if a benefit and explanation <u>are</u> correctly linked.** **If benefit and explanation <u>are not</u> correctly linked:** **Award Max 1 for <u>either</u> a benefit <u>or</u> an explanation.**	
				benefit			
			1a	allows entry of **more** CO_2 **;**		***1a***	Must indicate the idea of ***more*** *and* ***imply going in*** eg 'allows more gas exchange so that there is more CO_2 for photosynthesis' the mention of gas exchange implies that the CO_2 must be going in
				explanation			
			2a	(CO_2) for **,** light-independent reaction / Calvin cycle		***2a***	**DO NOT CREDIT** 'CO_2 fixed' without further qualification (eg ref to Rubisco / GP formation)
				or			
			2b	light-dependent reaction is taking place quickly / reduced NADP building up / ATP building up		***2b***	
				or			
			2c	CO_2 not as limiting (than when there are fewer stomata)		***2c***	**CREDIT** with fewer stomata CO_2 is limiting
				or			
			2d	*idea that* increases access to air spaces for distribution of CO_2 **;**		***2d***	
				OR			
				benefit			
			1b	reduces transpiration **;**		***1b***	**DO NOT CREDIT** description of transpiration **ACCEPT** 'plant less likely to wilt'
				explanation			
			2e	*idea of* stomata sheltered from **,** air currents / heat (when on lower surface)		***2e***	
				or			
			2f	*idea that* diffusion shells maintained **;**	**2**	***2f***	

Question			Expected Answers		Marks	Additional Guidance	
	(c)					**DO NOT CREDIT** refs to controlling temperature **or** light **or** wind **or** time	
			1	equal sample size for sun and shade leaves / increase sample size of shade leaves / greater numbers of sun and shade leaves ;		***1***	
			2	measure thickness of cuticle / make cuticle observations quantitative ;		***2***	
			3	record range / calculate SD / calculate SE / (named) statistical analysis ;		***3***	
			4	record data on leaf, length / width / area / colour / chlorophyll content ;		***4***	
			5	record data on , size of stomata / stomatal count on upper surface ;		***5***	
			6	define what is a sun or shade leaf / measure light levels to classify type of leaf ;		***6***	
			7	repeat / replicate , the (whole) experiment / using other plants of the same species ;		***7***	**IGNORE** ref to other species **DO NOT CREDIT** 'repeats' unqualified or implying the same individual plant
					2 max		
				TOTAL	**6**		

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>3</td><td>(a)</td><td>(i)</td><td>
<table>
<tr><th></th><th>Discontinuous</th><th>Continuous</th></tr>
<tr><td>Species identified by letter</td><td>S and T ;</td><td>R ;</td></tr>
</table>
</td><td>2</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>statement 1 in S and T only ;
statement 8 in S and T only ;

statements 2 and 3 in R only ;
statement 5 in R only ;

statements 4 and 7 in T only ;
statement 6 in S only ;</td><td>6</td><td>
<table>
<tr><th>Species</th><th>Statement number(s)</th></tr>
<tr><td>R</td><td>2 3 5</td></tr>
<tr><td>S</td><td>1 6 8</td></tr>
<tr><td>T</td><td>1 4 7 8</td></tr>
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Question			Answer	Marks	Guidance
	(b)		*collection* **1.** named equipment for collecting from, dogs / fields **;** **2.** get**,** large number / over 100 (fleas) **;** **3.** use several, dogs / fields **;** **4.** *idea of* random sampling (dogs / field) **;** *testing* **5.** (named) container **;** **6.** correct dose / range (of concentrations)**,** tested **;** **7.** control without flea killer **;** **8.** delivery method described **;** *processing* **9.** leave for set time **;** **10.** count number of, dead / live**,** fleas (after testing) **;** **11.** calculate percentage (frequency) of**,** alive / dead / resistant / non-resistant **;**	6	**1 CREDIT** pooter, forceps, tweezers, pipette, (flea) comb, sweep net, sticky traps, light traps (in correct context) **5 CREDIT** tank, jam jar, boiling tube, petri dish. **6 ACCEPT** 'dose according to manufacturer's instructions' **IGNORE** same, volume / concentration **8** e.g. flea-killer sprayed / left to evaporate from cotton wool / fed in blood or food **9 ACCEPT** leave for same amount of time **10 IGNORE** how many were left, how many were resistant **IGNORE** identify – must be counting number
			QWC ;	1	Award if the **first mark point awarded in each section** is ***<u>in the correct section order</u>***: collection **1 to 4** **then** testing **5 to 8** **then** obtaining and processing results **9 to 11** *e.g. if the first mark of each section is awarded in the wrong order (such as mp 1, then mp 10, with nothing from the testing section inbetween)* ***then do not award QWC***
			Total	**15**	