

Question number	Answer	Marks	Guidance
1 (a)	Herbicide, is selective agent / exerts selective pressure; natural selection; resistants have, selective advantage / AW; e.g. competitive advantage resistants survive / susceptibles die; (more) resistants (reproduce and) pass, mutation / allele / trait, to offspring; increasing frequency of, mutation / allele (in population); R gene (common weed so) sprayed in many different places / AW; (common weed so) large number of seeds / rapid spread / many generations in a year; (weed so likely to have) good dispersal mechanism / described; ref to, large number of loops of DNA in chloroplasts / large number of chloroplasts, so greater chance of, replication error / mutation;	5	
1 (b) (i)	Substitution; no missing base pair / $88 + 35 = 123\text{bp}$ / $88 + 35 + 154 = 123 + 154\text{ bp}$ (277bp);	2 max	
1 (b) (ii)	(mutation) removes / no, target site; for the restriction enzyme; so 123 bp fragment is not cut in two (88 + 35);	2 max	
1 (b) (iii)	Mutation A <i>ecf</i> from (i)  ref to (mutation) altering DNA triplet code; (so) codes for different amino acid; (so) primary / tertiary, structure of protein different; or codes for premature stop triplet; incomplete / no, protein produced; AVP;  <i>effect in terms of gene product / protein / enzyme / transcription factor / AW</i> (altered) protein no longer, binds / inactivated by, triazine / AW; A fits (altered) protein no longer allows triazine through membrane; (altered) protein inactivates triazine; (altered) enzyme breaks down triazine; A denatures AVP; e.g. ref to different metabolic pathway (so triazine not effective)		
2 (a)	<i>Autosomal / not sex-linked, because</i> approximately equal numbers of male (5) and female (4) sufferers; appears in every generation / no alternate generation pattern; male passes trait to son; <i>Dominant / cannot be recessive, because</i>	3 max	

	only inherited from sufferer; ORA approximately equal numbers of sufferers and non-sufferers in each generation/ora expect smaller numbers if recessive; e.g. 2 sufferers and 2 non-sufferers in offspring of sufferers in generation 2 ; e.g. 3 sufferers and 2 non-sufferers in offspring of sufferers in generation 3 ;		
2 (b) (i)	cuts DNA into, pieces / fragments / AW; at specific sites; close to, but not in stutter; detail of site; e.g. 4-6 base pairs, palindromic	3	
2 (b) (ii)	negatively charged; detail; e.g. phosphate groups attracted to anode; smaller fragments travel further (towards anode) / ORA; smaller fragments have less impedance / AW / ORA;	5	
2 (c) (i)	inherited from three different individuals/ each parent (unaffected parents of A, B and C);	1	
2 (c) (ii)	length of stutter increases in each generation/ C longer than A/different sizes of stutter;	1	
3 (a)	homeotic / regulatory, (gene); contains, 180 bp / homeobox, sequence; that codes for homeodomain (on protein); (gene product) binds to DNA; initiates transcription / switch genes, on / off; control of, development / body plan;	2 max	IGNORE hox CREDIT controls gene expression, ref. transcription factor(s) ACCEPT description, eg polarity, segmentation, position of limbs
3 (b)	these genes very important; mutation would, have big effects / alter body plan; many other genes would be affected / knock-on effects; mutation likely to be, lethal / selected against;	2 max	ACCEPT example, eg no arms CREDIT selected against in context of survival, not reproduction DO NOT CREDIT ora, not beneficial so not selected for
3 (c)	protein synthesis / transcription and translation; respiration; DNA replication; mitosis; cytokinesis; apoptosis; differentiation / gene switching;	2 max	IGNORE growth ACCEPT programmed cell death
3 (d)	fungi / plants;	1	
4 (a)	Increase expression of gene; bind transcription factors / aid binding of RNA polymerase to promotor;	2	
4 (b)	Section of non-coding DNA.	1	
4 (c)	Change in single, base / nucleotide; e.g. substitution;	2	
4 (d)	Regulatory gene; involved in body development; hedgehog is a mammal;	2 max	
4 (e)	<i>Idea that</i> rate of transcription determines enzyme production; enzymes required for protein synthesis; enzymes required for respiration; energy / proteins, required for growth;	3 max	