	Question		Answer	Marks	Guidance
1	(a)		AAA TCT GGT ;	1	
1	(b)	(i)	the correct bases inserted in **all** 3 rows before box ; correctly identifying the last base in each sequence as the labelled base ; 5 **T** **T** **T** 6 **T** **T** **T** **C** 7 **T** **T** **T** **C** **C**	2	

1	(b)	(ii)	electrophoresis ;
			
			(negatively-charged DNA) moves towards ,
			                       positive electrode / anode ;
			
			smallest/smaller (fragments) move, fastest / faster ; **ora**
			
			resolution on gel sufficient to register 1, nucleotide **/**
			                                            base;
				3 max	**ACCEPT** positive, end /terminal
					
					IGNORE ref to distance
					ACCEPT lightest / shortest
					
					ACCEPT description ' machine detects fragments to one base in length'
					IGNORE pair

1	(c)	(i)	<u>contrac</u>tion of smooth muscle ; circular (muscle) ; extra mucus production ; inflammation ;	2 max	**ACCEPT** involuntary muscle / non-striated muscle **ACCEPT** blocked by mucus / build-up of mucus **ACCEPT** swelling / oedema **IGNORE** scarring

Question			Answer	Marks	Guidance
1	(c)	(ii)	(reduced diameter means) increased , resistance to air flow / friction ; *idea that* exhalation is passive / no (muscular) force behind exhalation / requires additional, force / pressure, to exhale; **1 max**		**ACCEPT** 'breathes harder'
1	(d)		(mutation) change in (DNA) nucleotide/ base, sequence ; (mutation causes) change in, amino acid sequence / primary structure (of protein) ; change in , tertiary structure/ 3D shape / binding site , of <u>receptor</u> ; salmeterol unable to bind ; *idea that* no response triggered in cell / no second messenger system activated ; **3 max**		**IGNORE** triplet/codon/gene / frameshift **DO NOT CREDIT** active site **ACCEPT** salmetorol not complementary shape to <u>receptor</u> **ACCEPT** salmeterol cannot bind as easily e.g. adenyl cyclase not activated **IGNORE** 'has no effect'
1	(e)	(i)	(mutation resulted in) <u>receptor</u> having complementary shape to montelukast ; montelukast able to bind ; (whereas) salmeterol cannot ; montelukast may have a different <u>receptor</u> ; **2 max**		**DO NOT CREDIT** active site **IGNORE** fit **ACCEPT** attach **ACCEPT** cannot bind as easily **ACCEPT** montelukast receptors not damaged
1	(e)	(ii)	not reliable because, sample size **too** small / **only** 62 children in study; **or** could be reliable because 31 is quite a large sample ; **1**		<u>**Note**</u> *31 is a suitable number for a phase 1 trial*
1	(e)	(iii)	(epithelial) cells lining cheek ; **1**		**ACCEPT** (named) white blood cells in saliva / salivary gland cells
			Total	**16**	

Question			Answer	Marks	Guidance
2	(a)	(i)	*idea of* tentative / uncertain / developing / advancing / improving / dynamic ;	1	**IGNORE** change(s), changing, changeable (as given in question)
		(ii)	1 conservation / keep rare plants / save endangered plants ; 2 <u>gene bank</u> **OR** genetic resource / store of alleles ; 3 teaching / education ; 4 leisure / amenity / visitor attraction / aesthetic value ;	2	**Read as prose.** 1 **ACCEPT** prevent extinction / maintain biodiversity 3 **IGNORE** 'research' (as given in question)
	(b)	(i)	to**,** amplify / make (many) copies of**,** <u>DNA</u> ; (range of) different lengths ;	2	**IGNORE** refs. to single stranded / coding strand / template strand **CREDIT** idea of, chain terminating / dideoxy, nucleotides attaching at different points along sequence
		(ii)	to put DNA pieces in size order ; to read, base sequence / order of bases ;	2	**IGNORE** speed or rate of movement, look for distance or position or pattern, e.g. shortest / lightest / smallest**,** lengths first or lighter move further and heavier move less far **DO NOT CREDIT** 'put genome back in order'
		(iii)	to cut (genome DNA) into, small(er) / 750 bp, fragments ; to cut, vectors / BACs / plasmids, (for gene library) ;	2	**ACCEPT** fragment size in range 500-1000 base pairs

Question			Answer	Marks	Guidance
(c)			genome, too big / very large **;**	2	**ACCEPT ORA** only**,** small sections / 750bp, can be sequenced (at a time)
			accuracy better / fewer errors (with small fragments) **;**		**CREDIT ORA** large sections sequenced less accurately
			divide job over, time / different labs **;**		**ACCEPT** otherwise would take <u>too</u> long / be unmanageable / be impractical **IGNORE** ref to efficiency
(d)	**(i)**		1 160 000 **; ;**	2	**Correct answer = 2 marks (no units)** **CREDIT** 1.16 <u>million</u> **or** 1.16 x 10^6 If answer incorrect, **award 1 mark** for 870 (million) ÷ 750 **AWARD** 1 max correct answer has inappropriate units (e.g. 1 160 000 Mbp = 1 mark)
	(ii)		(monkey flower) has, small<u>er</u> genome / few<u>er</u> Mbp DNA **;**	2	**Read as prose.** **ACCEPT ORA** but must be comparative **IGNORE** refs to chromosome number
			fewer lab hours / fewer staff needed / quicker / cheaper **;**		**ACCEPT ORA** but must be comparative
	(iii)		larger (in size) **;**	1	**ACCEPT** bigger **/** plumper / juicier

Question		Answer	Marks	Guidance
	(e)	*phylogenetic approach*	2	
		no need to test for interbreeding **;**		**ORA** for biological species concept – (importance of members of same species) (inter)breeding to give fertile offspring
		ref. common ancestor / <u>monophyletic</u> groups **;**		**IGNORE** clades
		can apply to organisms that reproduce asexually **;**		**ORA** for biological species concept – doesn't apply to asexually reproducing organisms
		can apply to, extinct organisms / fossils **;**		**ORA** for biological species concept – doesn't apply to, extinct organisms / fossils
		Total	**18**	

Question			Answer	Marks	Guidance
3	(a)		**D ;** **C ;** **J / M / N ;** **J / K / L ;** **J / K / M ;**	5	**First Answer**

Question			Answer	Marks	Guidance
	(b)		*'Golden Rice^TM'*	9 max	
			B1 reduce vitamin (A) deficiency in named area / ora **;**		**B1** eg Asia / developing world / area where rice is staple diet
			B2 reduce, eye problems / blindness **;**		
			C1 reduce rice <u>genetic</u>, diversity / variation **;**		**C1 ACCEPT** contributes to genetic erosion
			C2 clone may suffer from one, disease / environmental change **;**		
			C3 hybridisation with wild rice / spread genes to wild populations **;**		**C3 ACCEPT** superweeds idea
			C4 seeds expensive / need to be bought each year **;**		**C4 CREDIT** idea of economic exploitation
			C5 rice may not grow in all areas where needed **;**		
			C6 *idea of* doubts whether vitamin A content sufficient **;** **4 max**		
			Somatic Gene Therapy		
			B3 cure / reduce symptoms / better quality of life / less medication**;**		**B3 DO NOT ACCEPT** treat (as in question)
			B4 cystic fibrosis / SCID / Parkinson's / thalassaemia / LCA **;**		**B4** eg single gene recessive conditions, cancer
			B5 extend lifespan / saves lives **;**		
					concerns **IGNORE** references to embryo research, designer babies and germline gene therapy
			C7 <u>virus</u> vector may cause (viral) disease **;**		
			C8 procedure may be, invasive / dangerous / painful / stressful **;**		**C8** eg bone marrow removal and replacement
			C9 temporary / needs to be repeated / limited success **;**		
			C10 immune system / rejection, problems **;**		
			C11 animal testing concerns **;** **4 max**		
			Either Section		
			C12 antibiotic resistance gene transfer to pathogenic bacteria **;**		**C12 IGNORE** idea of resistant viruses
			C13 unknown effects / cause mutation **;**		**C13 ACCEPT** cause cancer (in context of gene therapy)
			QWC – balanced account **;** **1 max**		Award if 1 **C** mark and 1 **B** mark have been awarded for **both** examples
			Total	**14**	