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)	contraction 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** gene bank **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**,** DNA **;** (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 **;** accuracy better / fewer errors (with small fragments) **;** divide job over, time / different labs **;**	2	**ACCEPT ORA** only**,** small sections / 750bp, can be sequenced (at a time) **CREDIT ORA** large sections sequenced less accurately **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 **;** fewer lab hours / fewer staff needed / quicker / cheaper **;**	2	**Read as prose.** **ACCEPT ORA** but must be comparative **IGNORE** refs to chromosome number **ACCEPT ORA** but must be comparative
		(iii)	larger (in size) **;**	1	**ACCEPT** bigger **/** plumper / juicier

Question			Answer	Marks	Guidance
	(e)		*phylogenetic approach* no need to test for interbreeding **;** ref. common ancestor / monophyletic groups **;** can apply to organisms that reproduce asexually **;** can apply to, extinct organisms / fossils **;**	2	 **ORA** for biological species concept – (importance of members of same species) (inter)breeding to give fertile offspring **IGNORE** clades **ORA** for biological species concept – doesn't apply to asexually reproducing organisms **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™'* **B1** reduce vitamin (A) deficiency in named area / ora **;** **B2** reduce, eye problems / blindness **;** **C1** reduce rice genetic, diversity / variation **;** **C2** clone may suffer from one, disease / environmental change **;** **C3** hybridisation with wild rice / spread genes to wild populations **;** **C4** seeds expensive / need to be bought each year **;** **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**;** **B4** cystic fibrosis / SCID / Parkinson's / thalassaemia / LCA **;** **B5** extend lifespan / saves lives **;** **C7** virus vector may cause (viral) disease **;** **C8** procedure may be, invasive / dangerous / painful / stressful **;** **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 **;** **C13** unknown effects / cause mutation **;** **QWC** – balanced account **;** **1 max**	9 max	**B1** eg Asia / developing world / area where rice is staple diet **C1 ACCEPT** contributes to genetic erosion **C3 ACCEPT** superweeds idea **C4 CREDIT** idea of economic exploitation **B3 DO NOT ACCEPT** treat (as in question) **B4** eg single gene recessive conditions, cancer *concerns* **IGNORE** references to embryo research, designer babies and germline gene therapy **C8** eg bone marrow removal and replacement **C12 IGNORE** idea of resistant viruses **C13 ACCEPT** cause cancer (in context of gene therapy) Award if 1 **C** mark and 1 **B** mark have been awarded for **both** examples
			Total	**14**	