Question			Answer	Marks	Guidance
1	(a)			5	**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.)

control element	made of protein	binds to a protein	codes for protein	
insulin	✓	✓	×	;
c AMP	×	✓	×	;
lac I (inhibitor) gene	×	✓	✓	;
lac O (operator) gene	×	✓	×	;
homeotic gene product	✓	×	×	;

Question			Answer	Marks	Guidance
1	(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** **CREDI** replicates / replicated **5** Must be a clear statement **6** **CREDIT** before **,** mitosis / meiosis / cytokinesis **CREDIT** in S phase (of interphase) **IGNORE** interphase unqualified
1	(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** **ACC PT** cancer / carcinoma
			Total	**15**	

Question			Answer	Marks	Guidance
2	(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	**IGNORE** *hox* **CREDIT** controls gene expression, ref. transcription factor(s) **ACCEPT** description, eg polarity, segmentation, position of limbs
	(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
	(c)		protein synthesis / transcription and translation **;** respiration **;** DNA replication **;** mitosis **;** cytokinesis **;** apoptosis **;** differentiation / gene switching **;**	2 max	**Mark the first two suggestions only** **IGNORE** growth **ACCEPT** programmed cell death
	(d)		fungi / plants **;**	1	
			Total	**7**	

Question			Expected Answers	Marks	Additional Guidance
3	(a)		1 methionine 2 arginine 4 threonine 5 tryptophan ; ;	2	**AWARD** 2 marks if all four correct **AWARD** 1 mark if two or three correct **AWARD** 0 marks if only one correct **IGNORE** incorrect spelling if meaning is clear
	(b)		translation ; ribosome / rough ER / RER ;	2	**IGNORE** ER alone **DO NOT CREDIT** smooth ER
	(c)		messenger / m ; RNA / ribonucleic acid ;	2	*'mRNA'* = 2 marks **IGNORE** incorrect 'r' or 't' prefix for 2nd mark
	(d)		UAA **and** UAG **and** UGA ; do not code for an amino acid / no matching tRNA ;	2	**NEED** all 3 for one mark **ACCEPT** do not code for anything **ACCEPT** no , matching / complementary , anticodon
	(e)		neutral / silent / substitution / point ;	1	
				9	

Question			Answer	Marks	Guidance
4	(a)		metaphase **I and** metaphase **II ;** prophase **I ;** anaphase **II ;** telophase **II ;** anaphase **I ;**	5	**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**
	(b)		to, **halve** chromosome number / **reduce from** 2n **to** n **;** to separate homologous pairs (of chromosomes) **and** sister chromatids **;** because, DNA (previously) replicated / chromosomes are two chromatids at start **;**	2	**IGNORE** all references to mitosis **CREDIT 'from** diploid **to** haploid' **ACCEPT 'from** 46 **to** 23 chromosomes' **IGNORE** halve, genetic material / DNA **ACCEPT** genetic, material / information
	(c)	**(i)**	sequence / order, of bases / nucleotides **;**	1	**CREDIT** base pairs **DO NOT CREDIT** amino acid sequence
		(ii)	different, primary / secondary / tertiary, structure **;** (protein) shorter due to, deletion / stop codon **OR** longer due to, insertion / duplication **;** (protein) unchanged due to, silent mutation / non-coding DNA altered **;** (function is) lost / worse / better **;**	3	**ACCEPT** different <u>sequence</u> or <u>order</u> of amino acids **ACCEPT** different 3D folding or 3D shape for 'silent' **CREDIT** 'neutral' or a description of more than one triplet coding for one amino acid **IGNORE** different / altered function **ACCEPT** idea that change is harmful
			Total	**11**	

Question			Answer	Marks	Guidance
5	(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 / <u>monophyletic</u> 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			Expected Answer	Mark	Additional Guidance
6	(a)	(i)	**1** *idea that* (produces) large , yield / volume / amount, of milk ; **2** *idea of* long lactation period ; **3** *idea of* high milk quality ; **4** large udders / correct udder shape (for milking machine) ; **5** resistance to , (named) disease / mastitis / pathogens **or** effective immune system ; **6** *idea of* calm temperament ; **7** AVP ;	**3 max**	**Mark the first suggestion on each line** ***1*** **DO NOT CREDIT** milk yield unqualified ***2*** ***3*** **DO NOT CREDIT** milk quality unqualified or ref. meat ***4*** ***5*** **DO NOT CREDIT** disease free ***6*** **CREDIT** docile / placid ***7*** eg • walk / stand , comfortably without need for hoof-trimming • *idea that* converts food to milk efficiently
	(a)	(ii)	normal shaped curve ; shifted to the right of original ;	**2**	Position of curve must meet the following conditions: • **curve must end** to right of original end • **must not start** to left of original • **may start** at same point as original or to right of original

Question			Expected Answer	Mark	Additional Guidance
6	(a)	(iii)	**1** artificial insemination / AI **;** **2** in vitro fertilisation / IVF **;** **3** *idea of* progeny testing **;** **4** embryo transplantation / use of surrogate mother **;** **5** cloning **;** **6** genetic screening / use of gene probes **;** **7** AVP **;** **8** AVP **;**	**2 max**	**Mark the first suggestion on each line** ***1*** **IGNORE** performance testing ***2*** ***3*** ***4*** **CREDIT** embryo splitting ***5*** ***6*** **ACCEPT** genetic engineering ***7*** eg ● sex selection technique / screening X and Y sperm ***8*** eg ● portmanteau animals
6	(b)	(i)	*idea of* change to **,** <u>DNA</u> / <u>base</u>(s) / <u>nucleotide</u>(s) **;**	**1**	
6	(b)	(ii)	natural / directional **,** selection **;**	**1**	**ACCEPT** evolution **DO NOT CREDIT** genetic drift
+	**(c)**	**(i)**	*regulatory* *idea that* makes **,** repressor protein / transcription factor **or** *idea that* product switches (structural / another) gene **,** on / off **;** *structural* *idea that* makes **,** enzyme / polypeptide / protein **;** *relationship between the 2* *idea that* regulatory <u>gene</u> **,** controls / affects **,** the expression of structural <u>gene</u> **;**	**2 max**	**ACCEPT** 'makes regulatory protein' **ACCEPT** 'switching on / off' for idea of control **IGNORE** explanation involving repetition of word "regulates"

Question			Expected Answer	Mark	Additional Guidance
6	(c)	(ii)	lactose has been , removed / digested / respired / broken down (by bacteria) ; to , lactic acid / lactate / other sugars ; yogurt still a good source of , calcium / vitamins ;	2 max	**DO NOT CREDIT** if context wrong (eg heat) eg • glucose (and galactose)
6	(d)		**1** lactose binds to repressor protein ; **2** changes , shape / structure (of protein) ; **3** removes it from / stops it binding to , operator ; **4** RNA polymerase binds to promoter ; **5** *idea that* (so that Z and Y) are , transcribed / mRNA made ;	3 max	***1*** **DO NOT CREDIT** regulator substance ***2*** **IGNORE** ref. to active site ***3*** ***4*** **DO NOT CREDIT** DNA polymerase ***5*** **CREDIT** lactose permease and β-galactosidase for Z and Y **IGNORE** gene , switched on / expressed
			Total	**16**	