

Question	Answer	Mark	Guidance										
3 (a)	DNA (combined) from (two) , sources / organisms ;	1	ACCEPT DNA, contains / has inserted in it, DNA or gene from, other / another, organism / species ACCEPT foreign for idea of other source										
(b)	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 60%;">application of genetic modification</th> <th style="width: 40%;">vector</th> </tr> </thead> <tbody> <tr> <td>goats making spider silk protein</td> <td>BAC / YAC / virus / liposome</td> </tr> <tr> <td>somatic gene therapy for a recessive human genetic disorder</td> <td>virus / liposome</td> </tr> <tr> <td>plants that express a bacterial toxin that kills insects feeding on them</td> <td><i>Agrobacterium tumefaciens</i> / (Ti) plasmid / liposome</td> </tr> <tr> <td>bacteria that produce a human protein for therapeutic use</td> <td>BAC / (bacterio)phage / plasmid</td> </tr> </tbody> </table>	application of genetic modification	vector	goats making spider silk protein	BAC / YAC / virus / liposome	somatic gene therapy for a recessive human genetic disorder	virus / liposome	plants that express a bacterial toxin that kills insects feeding on them	<i>Agrobacterium tumefaciens</i> / (Ti) plasmid / liposome	bacteria that produce a human protein for therapeutic use	BAC / (bacterio)phage / plasmid	4	<p>FA in each box</p> <p>DO NOT CREDIT microinjection / electroporation / gene gun (as they are not vectors)</p> <p>IGNORE tumour forming bacterium</p>
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3	<p>1 somatic / adult, cell / nucleus ;</p> <p>2 fused with / injected into ;</p> <p>3 empty / enucleate , egg cell ;</p> <p>4 from another goat ;</p> <p>5 <i>idea of electric shock / electrostimulation ;</i></p> <p>6 this cell or embryo, grown on , in vitro / in tied oviduct ;</p> <p>7 (early) embryo / blastocyst , split ;</p> <p>8 <i>idea that embryos replaced in , surrogate mothers / other females ;</i></p> <p>9 AVP ;</p>	max 5	<p>1 <b>ACCEPT</b> differentiated or body cell or example, e.g. skin cell, udder cell</p> <p>2 <b>ACCEPT</b> inserted / placed. If term use is "electrofused" gets mp 2 and mp 5</p> <p>4 <b>ACCEPT</b> named (A, B) or numbered goats</p> <p>5 "electrofused" gets mp 2 and mp 5</p> <p>6 <b>ACCEPT</b> in petri dish / test tube culture</p> <p>7 <b>ACCEPT</b> description of an embryo being split, even if produced by wrong method (IVF)</p> <p>8 <b>IGNORE</b> host mothers</p> <p>9 e.g. further detail of any stage of process correct ref. to haploid / diploid , nuclei</p>

Question	Answer	Mark	Guidance
3 (d)	<p><i>advantages</i></p> <p><b>A1</b> all offspring will inherit the, (silk) gene / foreign DNA ;</p> <p><b>A2</b> all offspring female ;</p> <p><b>A3</b> certain / all make , silk / milk / product ;</p> <p><b>A4</b> faster / many obtained in a short time ;</p> <p><b>A5</b> avoid mating risks ;</p> <p style="text-align: right;"><b>max 3 advantages</b></p> <p><i>disadvantages</i></p> <p><b>D1</b> no genetic variability (in population) / AW ;</p> <p><b>D2</b> (so makes goats) more susceptible to, environmental factors / (infectious) disease ;</p> <p><b>D3</b> cloned animals may, have shorter life spans / be less healthy ;</p> <p><b>D4</b> <i>idea that</i> cloning success rate is very poor ;</p> <p><b>D5</b> (more) expensive / needs (more) technology / (more) labour intensive ;</p> <p style="text-align: right;"><b>max 3 disadvantages</b></p>	5 max	<p><b>IGNORE</b> disadvantages of breeding given in the first (advantages of cloning) section, i.e. <b>DO NOT CREDIT</b> reverse arguments</p> <p><b>A5 ACCEPT</b> idea of physical damage or disease transfer</p> <p><b>IGNORE</b> advantages of breeding given in the second (disadvantages of cloning) section, i.e. <b>DO NOT CREDIT</b> reverse arguments</p> <p><b>D1 ACCEPT</b> they are all genetically identical</p> <p><b>D2 IGNORE</b> disease if stated to be genetic</p>
	<b>Total</b>	<b>15</b>	

Question	Answer	Marks	Guidance
1 (a) (i)	tyrosinase ;	1	<b>First Answer</b> (Mark the <b>first answer</b> . If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks).
	(ii) phenylketonuria / PKU ;	1	<b>Mark the First Answer</b>
(b)	<i>both have an</i> amine / amino / NH <sub>2</sub> ; COOH / carboxyl / carboxylic ;	2	<b>DO NOT CREDIT</b> if formula given does not match name <b>DO NOT ACCEPT</b> ammonia, amide
(c)	1 low / less / no, thyroid hormones ; 2 less (aerobic) respiration ; 3 less, <u>ATP</u> produced / energy ; 4 slow(er) metabolism / low(er) (B)MR ; 5 low body temperature ; 6 AVP ;	3 max	<b>DO NOT CREDIT</b> no respiration / ATP  eg sleep more, get tired quickly, poor muscle tone, mental retardation
(d) (i)	<u>homozygous</u> ;	1	<b>Mark the First Answer</b> <b>IGNORE</b> dominant / recessive
(ii)	<i>genotype</i> combination of <u>alleles</u> ; possessed by organism ;  <i>allele</i> alternative / mutant, form / version ; of, a gene ;	4	<b>ACCEPT</b> <i>idea of all alleles</i> or ' <b>the</b> ' alleles (suggesting all) <b>ACCEPT</b> <i>idea of eg that a, person has / you have / of an individual / cell</i> ' <i>all my alleles</i> ' = 2 marks  <b>ACCEPT</b> altered, different (form / version) <b>CREDIT</b> DNA if qualified, eg at a locus / codes for X

Question	Answer	Marks	Guidance
(e)	population, not large / (too) small ; not randomly-mating / matings arranged ;	2	
(f)	natural / artificial / directional, <u>selection</u> ; <u>genetic drift</u> ; <u>mutation</u> ; migration / AW ;	2 max	Mark the first two suggestions only ACCEPT <u>selection</u> pressure, <u>selective</u> breeding, <u>selective</u> advantage
	<b>Total</b>	<b>16</b>	

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

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

Question	Answer	Marks	First Answer	Guidance
6		1		
(a)	artificial selection / selective breeding ;			
(i)				
(ii)	<p><i>idea that males can father many offspring / mate several females ;</i>  <i>idea that females produce only a few offspring ;</i></p> <p>(so) more females (than males) needed to maintain numbers (each generation) ;</p> <p>(20% females chosen as) inbreeding / genetic problems, if breeding population is too small ;</p> <p>(5% males chosen as) selection pressure stronger if fewer (tamest) are used ;</p>	2 max	<b>IGNORE</b> artificial insemination eg one litter at a time	
(b)	<p>1 (mostly) <u>genetic</u> ;</p> <p>2 as can be selected for / selective breeding increases frequency ;</p> <p>3 <u>allele(s)</u> for tameness ;</p> <p>4 (from) mutation ;</p> <p>5 query role of environment / learning ;</p> <p>6 ref. DRD4 / dopamine receptor ;</p>	3 max	<p><b>DO NOT CREDIT</b> if environment also given as cause  <b>IGNORE</b> genetic drift</p> <p><b>DO NOT CREDIT</b> if environment given as main cause  <b>ACCEPT</b> query about experimental method, eg was environment controlled for?</p>	

Question	Answer	Marks	Guidance
(c)	<p><u>linkage</u> tameness genes and genes for these traits <u>on same chromosome</u> ; (so) inherited together ;</p> <p><u>epistasis</u> (product of) one gene affects expression of another ; via enzyme pathway ;</p> <p><u>inbreeding</u> (hidden / masked) recessive alleles ; selected for, as well / unintentionally ; more chance homozygous as, small gene pool / parents related ;</p> <p><u>genetic drift</u> random / chance (which alleles, present / passed on) ; (effect stronger because) small breeding population ;</p>	2	<p><b>First Answer</b> Look for the two mark points relevant to the first word of the four on offer that the candidate has chosen.</p> <p><b>ACCEPT</b> idea of (recessive )allele inherited from both parents because, they are closely-related / small gene pool / reduced genetic diversity</p>
(d)	<p><b>1</b> <u>geographic</u> ; <b>2</b> wolves avoid human settlements / dogs confined by humans ;</p> <p><b>3</b> <u>behavioural</u> ; <b>4</b> detail / description ;</p> <p><b>5</b> <u>mechanical</u> ; <b>6</b> idea of different size of wolves and some small dogs ;</p> <p><b>7</b> gamete incompatibility ; <b>8</b> possibility of different chromosome numbers ;</p> <p><b>9</b> <u>seasonal / temporal</u> ; <b>10</b> different breeding, seasons / times ;</p>	3 max	<p><b>IGNORE</b> reproductive isolation</p> <p><b>4</b> eg differences in, pheromones / courtship</p> <p><b>6 ACCEPT</b> different genitalia</p> <p><b>10 CREDIT</b> <i>the idea that dogs breed all year round / wolves breed once a year</i></p>

Question	Answer	Marks	Guidance
(e)	<p><i>biological species concept</i></p> <p>1 (members of same species) need can interbreed to produce fertile offspring ;</p> <p>2 not all dog breeds can do this therefore not same species ;</p> <p>3 dog and wolf can so they should be same species ;</p> <p><i>phylogenetic species concept</i></p> <p>4 idea that dogs and wolves monophyletic group / tip of phylogeny ;</p> <p>5 genetic differences, between dogs and wolves small ;</p> <p>6 gene flow between wolves → big dogs → little dogs / analagous to ring species ;</p> <p>7 (PSC) one species (with a lot of phenotypic variation) ;</p>	4 max	<p><b>4 ACCEPT</b> share a common ancestor</p> <p><b>5 CREDIT</b> question of how much DNA difference needed to classify as separate species</p>
	<b>Total</b>	<b>15</b>	

Question	Answer	Marks	Guidance
7 (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	<b>IGNORE</b> <i>hox</i>  <b>CREDIT</b> controls gene expression, ref. transcription factor(s) <b>ACCEPT</b> 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	<b>ACCEPT</b> example, eg no arms  <b>CREDIT</b> selected against in context of survival, not reproduction <b>DO NOT CREDIT</b> ora, not beneficial so not selected for
(c)	protein synthesis / transcription and translation ; respiration ; DNA replication ; mitosis ; cytokinesis ; apoptosis ; differentiation / gene switching ;	2 max	<b>Mark the first two suggestions only</b> <b>IGNORE</b> growth  <b>ACCEPT</b> programmed cell death
(d)	fungi / plants ;	1	
	<b>Total</b>	<b>7</b>	

Question	Expected Answers	Marks	Additional Guidance
3 (a) (i)	DNA / gene / genetic, fingerprinting / profiling / analysis ; DNA / protein / gene, sequencing ; electrophoresis ;	1 max	IGNORE gene testing / gene probing / gene mapping / genome sequencing
3 (a) (ii)	rarely / do not, produce seed / cross-pollinate / interbreed ; <u>only</u> reproduce asexually ;	1 max	
3 (a) (iii)	<u>vegetative propagation</u> ;	1	IGNORE asexual reproduction (as given in the question)
3 (b)	1 genetically identical / little genetic variation ; 2 all susceptible / none resistant, to <u>this</u> disease ;  3 beetles, move / fly, from tree to tree or beetles are vector ; 4 trees grow, in clonal patch / close together or disease spreads through, suckers / roots or connected by, suckers / roots ; 5 the beetles <u>only</u> , live on / target, elm trees ;  6 attempts at control contributed to spread ; 7 as <b>more</b> trees became diseased then <b>more</b> tree surgery was necessary (contributing to spread of problem) ; 8 as <b>more</b> trees became infected then <b>more</b> , saws / equipment, were contaminated ;	4 max	1 IGNORE clone 2 IGNORE all susceptible to 'disease' in general. Only credit if <b>one particular</b> disease is implied e.g. the / new / fungus / same, disease <b>DO NOT CREDIT</b> immune instead of resistant  3 IGNORE simple repetition of text 'beetles spread disease'

Question	Expected Answers	Marks	Additional Guidance
3 (c)	<p>(i)</p> <p>1 less / no , movement of water or less / no , water reaches leaves ;</p> <p>2 less / no , minerals / nitrate / phosphate / magnesium / iron ;</p> <p>3 less / no , chlorophyll formation ;</p> <p>4 chlorophyll breakdown / leaf senescence ;</p>	2 max	<p>2 CREDIT correct symbols <math>\text{NO}_3^-</math>, <math>\text{PO}_4^{2-}</math>, <math>\text{Mg}^{2+}</math>, <math>\text{Fe}^{2+}</math>, <math>\text{Fe}^{3+}</math> IGNORE nutrients IGNORE reference to other substances such as sugars</p>
3 (c)	<p>(ii)</p> <p>1 less / no , photosynthesis ;</p> <p>2 less / no , sugar(s) / amino acid(s) / assimilates / organic molecules ;</p> <p>3 <u>roots</u> cannot , respire / do active transport / metabolise ;</p> <p>4 the falling leaves carry the fungus ;</p>	2 max	<p>2 CREDIT named sugars, e.g. sucrose , glucose , hexose IGNORE nutrients / food</p>

Question	Expected Answers	Marks	Additional Guidance
3 (d)	<p>1 cut plant material into , explants / small pieces ;</p> <p>2 example of part of plant used e.g. leaf / stem / root / bud / meristem / dividing region at tip of plant ;</p> <p>3 sterilise explant ;</p> <p>4 (with) bleach / sodium hypochlorite / alcohol ;</p> <p>5 place on , agar / growth medium ;</p> <p>6 containing , glucose / amino acids / nitrates / phosphates ;</p> <p>7 callus</p> <p>8 or mass of , undifferentiated / totipotent , cells ; high auxin and cytokinin (for callus formation) ;</p> <p>9 subdivide callus / sub-culturing ;</p> <p>10 treat to induce , roots / shoots ;</p> <p>11 change plant hormone ratio ;</p> <p>12 transfer to , greenhouse / soil / less controlled environment / non-sterile environment ;</p> <p>13 ref. aseptic conditions (anywhere within stages 5-11) ;</p> <p><b>QWC – described in logical sequence of steps ;</b></p>	<p><b>6 max</b></p> <p><b>1</b></p>	<p><b>1 DO NOT CREDIT</b> a single cutting</p> <p><b>5 CREDIT</b> place in aerated solution</p> <p><b>6 IGNORE</b> polymers / carbohydrates</p> <p><b>7 DO NOT CREDIT</b> description of single cell</p> <p><b>9 IGNORE</b> ref. single cells</p> <p><b>11 CREDIT</b> description , e.g. high auxin to give roots or (relatively) high cytokinin to give shoots (auxin : cytokinin ratio = 100 : 1 for roots, 4 : 1 for shoots, or similar figures)</p> <p><b>13</b> Do not award for sterilising explant (which is mp3)</p> <p><b>Award QWC for sequence of marks as follows:</b>  either mp 1 or 2  then 1 mark from mps 5 – 8  then 1 mark from mp 9 - 12</p>

Question	Expected Answers	Marks	Additional Guidance
3 (e)	<p><i>advantages</i></p> <ol style="list-style-type: none"> <li>1 quick ;</li> <li>2 disease-free / virus-free , stock created ;</li> <li>3 plants have same feature / uniform plants created ;</li> <li>4 can reproduce infertile plants ;</li> <li>5 can reproduce plants that are hard to grow from seed ;</li> <li>6 create whole plants from GM cells ;</li> <li>7 production , not determined by seasons / at any time / anywhere in the world ;</li> <li>8 (plantlets small) can be transported easily / grown in small space ;</li> <li>9 can save rare species from extinction ;</li> </ol> <p><i>disadvantages</i></p> <ol style="list-style-type: none"> <li>10 expensive / labour intensive , process ;</li> <li>11 process can fail due to microbial contamination ;</li> <li>12 all offspring susceptible to same , pest / disease / named environmental factor (e.g. drought) ;</li> <li>13 no / low / little , genetic variation ;</li> </ol>	4	<p><b>CREDIT</b> the first answer on each prompt line</p> <ol style="list-style-type: none"> <li>1 <b>IGNORE</b> ref. large numbers alone</li> <li>3 refers to plant phenotype e.g. plants , grow at same rate / grow to same height</li> </ol> <p><b>12 IGNORE</b> all are susceptible to disease in general (as in 3b)</p> <p><b>13 IGNORE</b> loss of alleles</p>
		<b>22</b>	

Question	Expected Answers	Marks	Additional Guidance
6 (a)	<p><i>somatic</i> changes / uses , body cells ; change cannot be passed to offspring ; cures / alleviates , genetic disease in one individual ; short-lived / repeat treatments needed ;</p> <p><i>germ line</i> changes / uses , gametes / zygote / embryo / reproductive tissue ; banned ;</p>	2 max	<p>ORA germ line changes could be passed to offspring</p> <p>ACCEPT sperm / eggs</p>
6 (b)	<p><i>central</i> C1 brain and spinal cord ; C2 intermediate neurones ; C3 has , coordinating role / many synapses ;</p> <p><i>peripheral</i> P1 <u>nerves</u> , from sense organs / to muscles / to glands ; <b>max 3</b> P2 sensory <b>and</b> motor , neurones / nerve cells ;</p> <p>P3 role in , sensing stimuli / controlling effectors or conducting impulses, to / from , CNS / brain / spinal cord ;</p> <p>P4 includes , somatic / autonomic / sympathetic / parasympathetic ;</p>	4 max	<p>For full marks needs at least 1 C mark</p> <p>C2 CREDIT relay / internuncial / bipolar C3 IGNORE processing</p> <p>P1 IGNORE effectors P2 DO NOT CREDIT if intermediate included DO NOT CREDIT nerves</p> <p>P3 IGNORE messages / signals / information</p>
6 (c)	<p><i>prophase 1</i> <u>homologous chromosomes</u> pair up / <u>bivalents</u> form ; <u>chiasmata</u> / crossing-over / recombination ;</p>	2	<p>CREDIT reverse arguments for prophase 2</p> <p>ACCEPT description e.g. <u>non-sister chromatids</u> exchange , (matching sections of ) DNA / alleles / genetic material</p>
		8	

Question	Expected Answer	Mark	Additional Guidance
1 (a)	<p>1 <i>idea that (produces)</i> large, yield / volume / amount, of milk ;</p> <p>2 <i>idea of</i> long lactation period ;</p> <p>3 <i>idea of</i> high milk quality ;</p> <p>4 large udders / correct udder shape (for milking machine) ;</p> <p>5 resistance to, (named) disease / mastitis / pathogens or effective immune system ;</p> <p>6 <i>idea of</i> calm temperament ;</p> <p>7 AVP ;</p>		<p>Mark the first suggestion on each line</p> <p>1 <b>DO NOT CREDIT</b> milk yield unqualified</p> <p>2</p> <p>3 <b>DO NOT CREDIT</b> milk quality unqualified or ref. meat</p> <p>4</p> <p>5 <b>DO NOT CREDIT</b> disease free</p> <p>6 <b>CREDIT</b> docile / placid</p> <p>7 eg • walk / stand, comfortably without need for hoof-trimming • <i>idea that</i> converts food to milk efficiently</p>
1 (a) (ii)	<p>normal shaped curve ;</p> <p>shifted to the right of original ;</p>	3 max	<p>Position of curve must meet the following conditions:</p> <ul style="list-style-type: none"> <li>• <b>curve must end</b> to right of original end</li> <li>• <b>must not start</b> to left of original</li> <li>• <b>may start</b> at same point as original or to right of original</li> </ul>
		2	

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

Question	Expected Answer	Mark	Additional Guidance
1 (c)	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	<b>DO NOT CREDIT</b> if context wrong (eg heat)  eg • glucose (and galactose)
1 (d)	<ol style="list-style-type: none"> <li>1 lactose binds to repressor protein ;</li> <li>2 changes , shape / structure (of protein) ;</li> <li>3 removes it from / stops it binding to , operator ;</li> <li>4 RNA polymerase binds to promoter ;</li> <li>5 <i>idea that</i> (so that Z and Y) are , transcribed / mRNA made ;</li> </ol>	<ol style="list-style-type: none"> <li>1 <b>DO NOT CREDIT</b> regulator substance</li> <li>2 <b>IGNORE</b> ref. to active site</li> <li>3</li> <li>4 <b>DO NOT CREDIT</b> DNA polymerase</li> <li>5 <b>CREDIT</b> lactose permease and <math>\beta</math>-galactosidase for Z and Y</li> </ol>	
	<b>Total</b>	<b>16</b>	

Question	Expected Answer	Mark	Additional Guidance
5 (a)	<p>A <u>DNA</u> polymerase / <u>Taq</u> polymerase ;            B restriction endonuclease ;            C (DNA) ligase ;            D plasmid(s) ;            E reverse transcriptase ;</p>	5	<p>Mark the first answer on each prompt line. If an additional answer is given that is incorrect or contradicts the correct answer, then = 0 marks</p> <p><b>B ACCEPT</b> restriction enzyme or named example  <b>DO NOT ACCEPT</b> restriction endonucleus</p>
5 (b)	<p>1 <i>hospital</i>            WBCs , easy to obtain / obtained from blood sample ;</p> <p>2 WBCs good source of DNA ;</p> <p>3 mutant gene's location unknown /            need to look in whole genome ;</p> <p>4 <i>biotechnology company</i>            idea that insulin made in pancreas ;</p> <p>5 many <u>mRNA</u> copies there / <u>mRNA</u> easier to find ;</p> <p>6 AVP ;</p>	4 max	<p>1 <b>ACCEPT</b> idea that these cells less ,            painful / expensive / dangerous , to obtain</p> <p>2</p> <p>3</p> <p>4</p> <p>5</p> <p>6 eg • introns already removed in mRNA</p>

Question	Expected Answer	Mark	Additional Guidance
5			<p>For A marks points must be comparative - need to either match the 2 processes and state the advantage (eg PCR is quick and in vivo is slow) or use a comparative adjective (-----er, less, more, least, most, better, best etc) as shown in the mark scheme.</p> <p>For the related E mark, accept any explanation that is true of one of the processes <i>and relates to the advantage described</i>. (Note that in some cases a statement could be considered as an advantage or as an explanation.)</p>
A1 E1	<p><i>advantages of PCR</i> PCR quicker; explanation;</p>		<p>eg</p> <ul style="list-style-type: none"> <li>• few hours versus weeks</li> <li>• 30 cycles</li> <li>• no bacterial growth or screening stages</li> </ul>
A2 E2	<p>PCR uses <b>less</b> equipment; explanation;</p>		<p>eg</p> <ul style="list-style-type: none"> <li>• tube and heat block for PCR</li> <li>• multiple test tubes or agar plates for in vivo</li> </ul>
A3 E3	<p>PCR uses <b>less</b> space; explanation;</p>		<p>eg</p> <ul style="list-style-type: none"> <li>• DNA and enzyme more compact than whole cells</li> <li>• no growth medium required</li> <li>• in vivo requires many plates to be , stored / incubated / refrigerated</li> </ul>
A4 E4	<p>PCR <b>less</b> labour-intensive / easier / (some parts of process) <b>less</b> costly ; explanation ;</p>		<p>eg</p> <ul style="list-style-type: none"> <li>• PCR set to run and left</li> <li>• in PCR gene is identified &amp; cloned in one stage</li> <li>• in vivo requires work to pick out and transfer colonies</li> <li>• in vivo requires more purification of DNA at end</li> </ul>
A5 E5	<p>PCR combines selection of gene and amplification <b>but</b> in vivo requires separate steps ; explanation ;</p>		<p>eg</p> <ul style="list-style-type: none"> <li>• primer selects only correct gene to be copied</li> <li>• in vivo needs probe to identify correct gene</li> </ul>
<i>cont'd</i>			

Question		Expected Answer	Mark	Additional Guidance		
5	(c)	A6 E6		<ul style="list-style-type: none"> <li>• PCR uses DNA and enzymes</li> <li>• PCR does not use whole cells which could cause contamination</li> </ul>		
		A7 E7		<ul style="list-style-type: none"> <li>• can use , old / prehistoric / forensic , DNA</li> </ul>		
		A8 E8		<ul style="list-style-type: none"> <li>• Taq polymerase occasionally inserts wrong base</li> <li>• early mutation reproduced many times in PCR</li> <li>• exact correct sequence needed for making therapeutic proteins</li> </ul>		
		A9 E9		<ul style="list-style-type: none"> <li>• materials for growing bacteria cheap</li> <li>• PCR chemicals / primers / Taq polymerase / high temperatures , expensive</li> </ul>		
		A10 E10		<ul style="list-style-type: none"> <li>• conditions not so critical</li> <li>• optimising PCR takes time</li> </ul>		
		A11 E11		<ul style="list-style-type: none"> <li>• searching for new gene</li> <li>• obtains complete gene</li> <li>• PCR has limited size (for cloning)</li> </ul>		
		7 max				
		QWC – clearly stated advantage linked to correct explanation ;		1	2 pairs of A & E marks awarded. (eg A1 & E1 and A5 & E5 A9 & E9 and A4 & E4 etc)	
		<b>Total</b>		<b>17</b>		

Question	Answer	Marks	Guidance																								
5 (a)	<table border="1"> <thead> <tr> <th>control element</th> <th>made of protein</th> <th>binds to a protein</th> <th>codes for protein</th> </tr> </thead> <tbody> <tr> <td>insulin</td> <td>✓</td> <td>✓</td> <td>✗</td> </tr> <tr> <td>cAMP</td> <td>✗</td> <td>✓</td> <td>✗</td> </tr> <tr> <td>lac I (inhibitor) gene</td> <td>✗</td> <td>✓</td> <td>✓</td> </tr> <tr> <td>lac O (operator) gene</td> <td>✗</td> <td>✓</td> <td>✗</td> </tr> <tr> <td>homeotic gene product</td> <td>✓</td> <td>✗</td> <td>✗</td> </tr> </tbody> </table>	control element	made of protein	binds to a protein	codes for protein	insulin	✓	✓	✗	cAMP	✗	✓	✗	lac I (inhibitor) gene	✗	✓	✓	lac O (operator) gene	✗	✓	✗	homeotic gene product	✓	✗	✗	5	<p>Award one mark for each correct row.  <b>DO NOT CREDIT</b> blank spaces, <b>multiple answers</b> or <b>hybrid ticks</b> (a tick that has been crossed through, so it cannot be judged if it is a tick or a cross.)</p>
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5 (b)	RNA polymerase makes 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 CREDIT replicates / replicated 5 Must be a clear statement 6 CREDIT before , mitosis / meiosis / cytokinesis CREDIT in S phase (of interphase) IGNORE interphase unqualified
5 (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 ACCEPT cancer / carcinoma
	Total	15	

Question	Answer	Mark	Guidance
7			
(a)	(i) polar <b>and</b> brown bear ;	1	
	(ii) <i>no because</i> one, more closely related to / in same group as , raccoons <b>and</b> one , to / with, bears / AVV ;	1 max	<b>DO NOT CREDIT</b> answer if in context of yes
(b)	(i) knowledge , tentative / uncertain / subject to change ; to re-test / check, hypotheses / results ;	2	<b>IGNORE</b> incomplete, new technology <b>IGNORE</b> to validate
	(ii) 1 <i>idea that</i> haemoglobin could be , an <u>adaptation</u> (to the environment) / an <u>adaptive</u> feature ; 2 <i>idea that</i> low oxygen partial pressure is selective agent <b>or</b> both subject to the same selection pressure ; 3 (haemoglobin of both) has high oxygen affinity / dissociation curve shifted to left ; 4 convergence / similarity not due to shared ancestry ;	3 max	3 <b>ACCEPT</b> haemoglobin can uptake O <sub>2</sub> at low partial pressure 4 <b>ACCEPT</b> description e.g. "changes happen to both independently" <b>IGNORE</b> "red and giant panda may not be closely related" (as given in question)

Question	Answer	Mark	Guidance
(c)	<p><b>step 2</b> PCR / polymerase chain reaction ;</p> <p><b>step 3</b> genetic modification / genetic engineering ;</p> <p><b>step 4</b> electrophoresis ;</p>	3	<p><b>FA on each line</b></p> <p><b>ACCEPT</b> gene cloning / transformation</p> <p><b>ACCEPT</b> (gel) chromatography</p>
(d)	<p>triplet code <b>or</b> 3 bases = 1 amino acid ;</p> <p>525 ;</p> <p>3 bases are , stop / (chain) termination , codon ;</p>	3	<b>DO NOT CREDIT</b> triplet makes amino acid
(e)	(i) ox ;	1	<b>FA</b>
	(ii) <ol style="list-style-type: none"> <li>1 genetic code is degenerate ;</li> <li>2 more than 1, triplet / codon, for same amino acid ;</li> <li>3 silent / neutral, mutations ;</li> <li>4 <i>idea that</i> DNA, changes more than / is more different to, protein ;</li> </ol>	3 max	<ol style="list-style-type: none"> <li>1 <b>ACCEPT</b> redundant</li> <li>2 <b>DO NOT CREDIT</b> 'make' the same amino acid</li> <li>4 <b>ACCEPT</b> polypeptide / amino acid sequence</li> <li><b>ACCEPT</b> nucleotide sequence for DNA</li> </ol>
	<b>Total</b>	<b>17</b>	

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