Question			Answer	Mark	Guidance
1	(a)	(	polar **and** brown bear **;**	1	
		(ii)	*no because* one, more closely related to / in same group as **,** raccoons **and** one **,** to / with**,** bears / AW **;**	1 max	**DO NOT CREDIT** answer if in context of yes
	(b)	(	knowledge **,** tentative / uncertain / subject to change **;** to re-test / check, hypotheses / results **;**	2	**IGNORE** incomplete, new technology **IGNORE** to validate
		(ii)	**1** *idea that* haemoglobin could be **,** an <u>adapt</u>ation (to the environment) / an <u>adapt</u>ive feature **;** **2** *idea that* low oxygen partial pressure is selective agent **or** 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** **ACCEPT** haemoglobin can uptake O_2 at low partial pressure **4** **ACCEPT** description e.g. "changes happen to both independently" **IGNORE** "red and giant panda may not be closely related" (as given in question)

Question			Answer	Mark	Guidance
	(c)		**step 2** PCR / polymerase chain reaction **;** **step 3** genetic modification / genetic engineering **;** **step 4** electrophoresis **;**	3	**FA on each line** **ACCEPT** gene cloning / transformation **ACCEPT** (gel) chromatography
	(d)		triplet code **or** 3 bases = 1 amino acid **;** 525 **;** 3 bases are **,** stop / (chain) termination **,** codon **;**	3	**DO NOT CREDIT** triplet makes amino acid
	(e)	(	ox **;**	1	**FA**
		(ii)	**1** genetic code is degenerate **;** **2** more than 1**,** triplet / codon**,** for same amino acid **;** **3** silent / neutral, mutations **;** **4** *idea that* DNA, changes more than / is more different to, protein **;**	3 max	**1** **ACCEPT** redundant **2** **DO NOT CREDIT** 'make' the same amino acid **4** **ACCEPT** polypeptide / amino acid sequence **ACCEPT** nucleotide sequence for DNA
			Total	**17**	

Question			Expected Answer	Mark	Additional Guidance
2	(a)	(i)	microbes **/** (living) organisms **/** cells **/** enzymes **;** (make) product **/** for human benefit / (carry out) conversion / reaction / industrial process **;**	**2**	**CREDIT** microorganisms / bacteria / prokaryotes / fungi **CREDIT** living things **CREDIT** cell components / parts of cells **CREDIT** example such as (named) food or medicine BUT **IGNORE** cheese (as stated in question) **IGNORE** process unqualified
2	(a)	(ii)	microbes **/ AW ,** killed / removed / not present **;** enzymes denatured **;** (so no) competitors **/** unwanted reactions **/** (human) health risk **;**	**2 max**	**Mark the first two suggestions** **IGNORE** contamination / sterile **IGNORE** idea of preserving milk **AW** for microbes as in **(a)(i)** plus **ACCEPT** organisms **DO NOT CREDIT** microbes denatured **CREDIT** (no) competition **CREDIT** (no) food spoilage / change of flavour / loss of quality **CREDIT** (no) pathogens / harmful microbes / TB "Kills harmful microbes" or "Kills pathogens" scores 2 marks (mps 1 & 3)

Question			Expected Answer	Mark	Additional Guidance
2	(b)	(i)			**Award mp 1 plus 2 max from the other mark points**
		1	enzyme **;**		***1*** **ACCEPT** globular / tertiary / catalyst / catalytic (protein)
			plus any 2 of the following	**1**	
		2	(enzyme) not, changed / used up **; ora**		***2*** **ora** = can be used again / re-used **IGNORE** enzyme recycled
		3	*idea of* ESC (forms) / substrate and enzyme (bind) **;**		***3*** ESC = enzyme-substrate complex **ACCEPT** substrate entering active site
		4	products (and enzyme) released at end **;**	**max 2**	
2	(b)	(ii)			**Mark the FIRST suggestion on each numbered line** **IGNORE** **'**cheaper' without qualification
		1	(enzyme can be removed to be) used again **;**		
		2	(enzyme can) to leave pure(r) product **; ora**		***2*** **ACCEPT** cheaper / easier, downstream processing
		3	(enzyme) more stable / more efficient / works better **;**		***3*** **CREDIT** less susceptible to, pH / temperature, change / extremes "enzymes work at high temperatures" = 0 "enzymes work at higher temperatures" = 1 (because comparative statement made)
				2	

Question			Expected Answer	Mark	Additional Guidance
2	(c)		***This is a QWC question***		
			Section I - Obtaining the gene		
		1	use restriction, enzyme / endonuclease ;		
		2	to, cut out / get / isolate, (rennin) gene / DNA coding for rennin ***or*** to, fragment / digest, DNA ;		***1*** **CREDIT** named example e.g. *Eco* R1, *Bam* H1, *Hin* dIII ***2*** **DO NOT CREDIT** 'cut gene' **IGNORE** 'break up DNA'
		3	gene probe ;		
			OR		
		4	obtain rennin mRNA ;		***NOTE***
		5	(use) reverse transcriptase ;		***1-9*** **CREDIT** whichever of the three alternative "obtaining the gene" protocols yields most marks, **either award marking points 1- or 4-6 or 7-9**
		6	to make cDNA ;		
			OR		
		7	sequence, rennin (protein) ;		
		8	work out base code ;		
		9	make this DNA sequence ;		
		10	sticky ends ;		***10*** can be awarded, once only, in Sections I or II
			Section II - Vector		
		11	cut (open), plasmid / phage ;		***11*** **DO NOT CREDIT** 'cut out plasmid' **DO NOT CREDIT** 'ring of DNA' unless it is clear that plasmid is being referred to
		12	using same restriction enzyme ;		***12*** **CREDIT** same named enzyme (re. mp1)
		13	annealing / base pairing of sticky ends ;		***13*** **CREDIT** idea of sticky end bases hydrogen bonding
		14	join sugar-phosphate backbones ;		***14*** **CREDIT** formation of phosphodiester bonds
		15	(using DNA) ligase ;		
		16	recombinant, vector / plasmid / phage / DNA ;		
			Section III - Introduction into host cell		
		17	mix with bacteria ;		
		18	detail of conditions ;		***18*** e.g. Ca^{2+} ions added / heatshock (freeze then inc to 40°C)
		19	transformation (plasmid) / transduction (phage) ;	max 7	***19*** **CREDIT** transform / transformed / transduce / transduced **IGNORE** transgenic
			QWC – sequencing of steps – at least 1 mark point scored from each of the three sections, in the correct order ;	1	I. obtaining gene (mp **1 – 9**) followed by II. vector (mp **13 – 16**) followed by III. introduction to host cell (mp **17 – 19**)
			TOTAL	17	

<table>
<tr><th colspan="3">Question</th><th>Expected Answers</th><th>Marks</th><th>Additional Guidance</th></tr>
<tr><td>3</td><td>(a)</td><td></td><td>
<table>
<tr><th></th><th>similarity</th><th>difference</th></tr>
<tr><td>structure</td><td>mitochondria
or
vesicles
or
postsynaptic receptors ;</td><td>NMJ membrane(s), wavy / AW * ora
or
receptors different (shape)
or
enzymes in different places ;</td></tr>
<tr><td>function</td><td>(neuro)transmitter, released / crosses gap
or
changes potential difference / AW **
or
enzymes break down (neuro)transmitter ;</td><td>different neurotransmitters / ACh vs. dopamine
or
muscle contraction vs. nerve impulse
or
different enzymes ;</td></tr>
</table>
</td><td>4</td><td>One mark per box

difference
NMJ is neuromuscular junction
* AW A CEPT wiggly / bumpy / not smooth / rough / larger SA / any suitable description but IGNORE microvilli

difference
ACh is acetylcholine

similarity
** AW CREDIT depolarises / -70 mV → +40 mV but IGNORE pass on action potential</td></tr>
<tr><td>3</td><td>(b)</td><td>(i)
1

2
3

4</td><td>phenelzine ;

no ecf from incorrect drug
idea that does not bind to (dopamine) receptor ; ora
idea that binds to, MAO / enzyme ;

allosteric site / non-competitive inhibitor ;</td><td>1

max 1</td><td>Award mp1 and, if correct, any 1 from the remaining points

2 CREDIT other two do bind to dopamine receptor
3 IGNORE inhibits, MAO / enzyme (as given in the question)
4 ACCEPT “not a competitive inhibitor”</td></tr>
<tr><td>3</td><td>(b)</td><td>(ii)</td><td>(drug) occupies / blocks / binds to, (dopamine) receptors ;
without causing, action potential / response ;
reduces effect of dopamine / is a dopamine antagonist ;</td><td>2</td><td>CREDIT “without causing depolarisation” / AW
DO NOT CREDIT “inhibits dopamine” or “reduces dopamine levels</td></tr>
</table>

Question			Expected Answers	Marks	Additional Guidance
3	(c)	(i)	humans are, diploid / 2n ; chromosomes, are in pairs / homologous ; one, (copy / gene / allele), from each parent / on each chromosome of pair ;	2 max	**DO NOT CREDIT** ref to bivalents
3	(c)	(ii)	(gel) <u>electrophoresis</u> ;	1	
3	(d)	1	13 b-p deletion (has most serious consequences) ;		
		2	frameshift / alter reading frame ;		
		3	genetic code is triplet / read in groups of 3 bases ;		
		4	alters all amino acids (coded for) after the mutation ;		
		5	21 b-p deletion causes 7 amino acids to be lost ;		
		6	substitution changes, one / no, amino acids ;	3 max	*6* **CREDIT** could be a silent mutation / 1 b-p substitution may not have an effect
3	(e)	1	<u>natural selection</u> ;		
		2	<u>selective advantage</u> ;		
		3	(allele / behaviour) increases, survival / breeding / AW ;		*3* **CREDIT** increases reproductive success / AW
		4	(because) helped, find food / find new resources / make new tools / get mates ;		*4* **ACCEPT** more promiscuous / AW
		5	<u>allele</u> passed on (to next generation) ;		
		6	(allele / behaviour) increased in frequency over, generations / time ;	4 max	*6* **MUST HAVE** time element
			Total	**18**	