1 **(a)**	phenotype **;** gene **;** haploid **;** mitosis **;** [4]	
(b)	*if there is an error in the genetic diagram allow ecf even if final phenotypes are NOT all different as stated in the question* $I^A I^o \times I^B I^o$ **;** $I^A, I^o + I^B, I^o$ **;** $I^A I^o$, $I^A I^B$, $I^B I^o$, $I^o I^o$**;** A AB B O **;** *blood types must match genotypes* [4]	**accept** IA, IB and IO for alleles A, B and O for alleles MP2 and 3 in Punnett square **ignore** spaces, commas or dots in diploid genotypes very little space between gamete genotypes **reject** I^{AB} etc as genotypes for parents or children I without A, B and o
(c)	1 two (or more) alleles **;** **R** two blood groups 2 two / both, are expressed / equally dominant / both dominant / give different phenotype **;** 3 in heterozygous / described (individual) **;** 4 AB, $I^A I^B$ (as example) **;** [3 max]	**A** two (or more) implied, e.g. 'neither' / 'each other' / 'both' **ignore** ref to genes 'neither is fully expressed' = 1 mark for MP1 'neither is dominant over the other' = 2 marks **R** ref. to recessive <u>and</u> dominant **A** *idea* 'when both alleles are present in the genotype' **A** refs. roan cattle, pink flowers as other correct examples

1 **(d)**	*accept converse statements* 1 used to treat diabetes (wherever in answer) **;** 2 insulin the same as human / uses human DNA / human gene / AW **;** 3 not rejected **;** **A** 'people not allergic' 4 no risk of, infection / disease (from animals) **;** 5 GE insulin can be, modified / improved / AW **;** 6 animals not killed / suitable for vegans **;** 7 cheaper / more readily available / produced quickly / constantly / large amounts / large scale **;** **R** 'easier' 8 ref. to bacteria reproduce quickly **;** 9 increasing numbers of people with diabetes / don't produce insulin **;** **A** don't respond to insulin [3 max]	MP2: e.g. animal insulin is 'foreign' / bovine insulin has three different amino acid residues from human insulin / porcine has only one different / insulin from dead animal, is not the same as human amino acid sequence can be modified **A** religious / ethical objections to using animals, but **not** to using GE insulin MP7 is related to production **A** animal insulin has to be obtained from animal soon after its death **R** refs. to side effects
(e) (i)	*note that this is 2 marks* plasmid **;** DNA / <u>genes</u> **;** [2]	**R** plasmic / plasma **R** nucleic acid unqualified by DNA
(ii)	(restriction) enzyme / endonuclease **;** **ignore** restrictive, etc human / insulin, gene / DNA **;** [1]	**R** incorrect enzyme, e.g. ligase **R** gene unqualified
	[Total: 17]	

2 **(a** try to mate them together, failure = suggests different species **;**
mate together, no offspring = suggests different species **;**
breed together and see if any offspring are, sterile / infertile **;**
test DNA / examine chromosomes **;** [max 1]

(b) (i) continuous **;** **A** discrete [1]

(ii) *Equus grevyi* **;** **A** *grevyi* [1]

(c) (i) <u>phenotype</u> ; **A** close phonetic spellings [1]

(ii) *these two points are linked – 'change' unqualified does not get a mark, but 'change in DNA' gets 2 marks*
change / AW **;** e.g. substitution / deletion / error in meiosis
in, DNA / gene(s) / chromosome(s) **;**
change in genotype / 'genetic, structure / genetic make-up' = 1 mark [2]

(d) (i) exoskeleton / external skeleton **;**
segmented / jointed, limbs / legs / appendages **;**
segmented body **;** [max 1]

(ii) three parts to the body / head + thorax + abdomen **;**
A sections / **R** segments
wings **;** *ignore numbers of wings if given*
6 / 3 pairs of, legs **;** [max 2]

(e) (i) stripes (on head and neck), become / are, horizontal (when feeding) **;**
less attractive to (tsetse), flies / insects ; **A** AW
A camouflage in grass **;** [2]

(ii) **1** ref to mutation and number of stripes **;**
2 ref to number of stripes and likelihood of being bitten **;**
3 ref to, disease / death **;**
4 survivors breed **;**
5 ref to offspring **;** (fewer stripes = less / more stripes = more)
6 passing on advantageous, alleles / genes (for more stripes) **;**
7 natural selection / survival of fittest **;**

R artificial selection [max 3]

[Total: 14]

3 **(a) (i)** chloroplasts ; **R** chlorophyll
cellulose cell wall ; **A** 'not made of, murein / peptidoglycan'
(sap / large / permanent) vacuole(s) ; **A** tonoplast
nucleus / nuclear membrane / nuclear envelope ; **R** DNA / RNA
nucleolus ;
mitochondria ;
endoplasmic reticulum / Golgi ;
amyloplasts ; **A** starch, grains / granules
more than one chromosome / linear chromosome(s) ; [4]

(ii) membrane ;
cytoplasm ;
ribosomes ;
chromosomes ; **A** 'strands of DNA' **R** DNA unqualified
glycogen granules ;
oil droplets ; [max 2]

(b)

cheese ;	tofu ;
yoghurt ;	soya sauce ;
sour milk ;	sauerkraut ;
bread ;	vinegar ;
alcohol / any named alcoholic drink ;	tapai ;
Quorn / mycoprotein ;	tempe / tempeh ;
single cell protein ;	kimchee ;

[max 2]

(c) *reject bacteria becoming immune and antibiotics causing mutation*

1 mutation / mutant ;
2 stronger wall / less permeable wall / enzyme to breakdown antibiotic / AW ;
3 antibiotic kills bacteria except those that are , mutant / resistant ;
4 antibiotic is, selective agent / AW ; **A** ref to (natural) selection
5 (resistant) bacteria reproduce ; *ignore mitosis* [max 3]

(d) *this may be answered with reference to insulin*

1 fast reproduction rate / AW ;
2 identical offspring / cloning ;
3 small number of genes ;
4 single cells ;
5 copy / use, genes from, other organisms / viruses ;
6 makes, protein / named protein, from another organism ;
7 have plasmids ;
8 used to transfer gene(s) into bacteria / easy to put gene(s) in bacteria ;
A DNA for gene
R product / protein, taken from, human / other organism [max 2]

[Total: 13]