RECOGNISING ACHIEVEMENT

2805/02 Applications of Genetics

June 2005

Mark Scheme

Abbreviations, annotations and conventions used in the Mark Scheme	/	=	alternative and acceptable answers for the same marking point
	;	=	separates marking points
	NOT	=	answers which are not worthy of credit
	R	=	reject
	( )	=	words which are not essential to gain credit
		=	(underlining) key words which **must** be used to gain credit
	ecf	=	error carried forward
	AW	=	alternative wording
	A	=	accept
	ora	=	or reverse argument

Question			Expected Answers	Marks
1	(a)	(i)	Aabb - pink ; aaBB - green ;	2
		(ii)	(dominant) epistasis ; ref to, epistatic / hypostatic, gene ; ref to, promoter / gene switching ; increased, transcription / expression ; AVP ; enzyme to alter pigment / change structure of pigment / make more pigment / complementary action	max 3
	(b)	(i)	*parents* (AaBb) red spines x (aabb) green spines ; *gametes* AB Ab aB ab x ab ; ***A*** *from Punnett square* *offspring* genotypes ; ; *minus 1 for each of first two mistakes* phenotypes related to genotypes ; ***A*** *key* *ratio* 1 red spines : 1 pink spines : 2 green spines ;	max 5
			gametes *AB* *Ab* *aB* *ab* *ab* *AaBb* *Aabb* *aaBb* *aabb* *red spines* *pink spines* *green spines* *green spines*	
		(ii)	many AaBb and aabb ; ref 1 : 1 ratio of these ; ref linkage ; ref parental types ; few Aabb and aaBb ; ref 1 : 1 ratio of these ; ref recombinants ; ref crossing over ; many red and green spined ; few / no, pink spined ; 1 : 1 green : red / more green than red ; ref proportions depend on how close, loci / genes, are ;	max 5
				[Total: 15]

2 (a) **1** prevent, self-pollination / unwanted pollination, of flowers **;**
2 detail of prevention **;**
3 cross-pollinate two varieties **; A** crossed / mated / hybridised
4 detail pollination **;**
5 isolate, plants / flowers **;**
6 collect seeds and sow **;**
7 in high salt concentration **;**
8 select plants, which survive / can tolerate, high concentration **;**
9 and have large, tasty tomatoes **;**
10 interbreed these plants **;**
11 repeat selection **;**
12 ref many generations **;**
13 cross with variety with large tomatoes to improve size **;**
14 cross with variety with good flavour to improve taste **;**
15 ref backcrossing with original variety for salt tolerance **;**
16 AVP **;** **max 8**
17 AVP **;**
e.g. ref background genes / hybrid vigour / heritability / effect on vigour / ref setting up pure-breeding initial lines

QWC – legible text with accurate spelling, punctuation and grammar ; **1**

(b) **(i)** <u>active transport</u> **;**
(energy from), ATP / respiration **;**
against concentration gradient **;**
ref binding site for ion / AW **;**
ref change of shape of protein **;** **max 3**

(ii) GE quick(er) / SB slow(er) **;**
(tolerance) in one generation (v. many generations) **;**
ref one gene / rest of genome unaltered (v. hybridisation) **;**
background genes intact (v. need for backcrossing) **;**
different varieties engineered for different conditions **;**
no problem re interbreeding **;**
can select, transporter system / AW, / from, another species / named taxon **;**
can select, transporter system / AW, / for maximum efficiency **;**
AVP **;** **max 3**

[Total: 15]

Question			Expected Answers	Marks
3	(a)		loss of genetic, diversity / variation ; **A** gene pool, reduced / eroded loss of <u>alleles</u> ; increased homozygosity / decreased heterozygosity ; increased expression / accumulation, of deleterious recessives ; <u>inbreeding depression</u> ; loss of, vigour / fertility / fitness ;	**max 3**
	(b)		(selective) advantage / named (selective) advantage ; behaviour favouring mating with non close relative ; increased genetic variation (so more offspring survive) ; hybrid vigour / increased heterozygosity / decreased homozygosity / reduced inbreeding depression ; AVP ; e.g. idea dominant male	**max 2**
	(c)	**1**	DNA extracted from cell sample / named cell sample ;	
		2	cut by restriction enzyme(s) ;	
		3	electrophoresis ;	
		4	fragments placed in well at (cathode) end of gel ;	
		5	ref to, agarose / polyacrylamide ;	
		6	PD applied ;	
		7	DNA negatively charged ;	
		8	fragments travel to anode ;	
		9	smaller / shorter, fragments travel further (ora) ;	
		10	Southern blotting ;	
		11	radioactive / ^{32}P / fluorescent, probe(s) ;	
		12	single stranded ;	
		13	ref single locus probe ;	
		14	complementary binding ;	
		15	autoradiograph / use of X ray film ; **R** use of X rays	
		16	share pattern of bands ;	
		17	ref VNTRs ;	
		18	same, number of repeats / lengths, DNA move same distances ;	**max 9**
		19	number of repeats / lengths / VNTRs, inherited ;	
		20	AVP ; e.g. scale from fragments of known size / PCR	
			QWC – clear well organised using specialist terms ;	**1**
			award the QWC mark if three of the following are used in correct context *do not award if the sequence is seriously incorrect* restriction enzyme electrophoresis agarose polyacrylamide Southern blotting autoradiograph VNTRs PCR	
				[Total: 15]

Question			Expected Answers	Marks
4	(a)		store of <u>alleles</u> ; to maintain, genetic diversity / genetic variation / gene pool ; to counteract, inbreeding / genetic erosion ; to maintain traits for future use ; (allele) for resistance to, 'new' / mutated, pathogen ; for tolerance to environmental change ; ref to, endangered species / rare breeds ; for post-mortem use ; AVP ;	**max 4**
	(b)	**(i)**	1 ^{o}C min^{-1} ;	**1**
		(ii)	ice crystals ; grow in size ; break membranes ; when insufficient water withdrawn from cell ; when freezing, not quick enough / not uniform ;	**max 3**
		(iii)	not only need mitochondria ; ref energy / ATP ; some other essential component damaged ; e.g. other essential component ;; AVP ;	**max 3**
	(c)		*advantages* two of following ;; saves cost of male saves problems of keeping male access to range of males saves, cost / stress, of transport of male saves stress of mating speeds up selective breeding speeds up progeny testing quickly available sperm can be, genetically tested / sexed AVP *disadvantages* two of following ;; damage of stored sperm overuse of one sire so (potential) inbreeding requires, vet / skill problem should sire have genetic defect cost AVP	**max 4**
				[Total: 15]

Question			Expected Answers	Marks
5	(a)	(i)	mutation ; chance / random / preexisting ; insecticide acts as selective, agent / pressure ; susceptibles die / resistants survive ; resistants pass, mutation / allele, to offspring ; **A** gene	**max 3**
		(ii)	mosquito is vector ; **A** carrier obligatory / AW ; part of life cycle is in mosquito ; not killed by insecticide ;	**max 2**
	(b)	(i)	DNA from two different sources ; combined / joined / AW ;	**2**
		(ii)	restriction enzymes cut DNA ; at specific sites ; detail of sites ; may give sticky ends ; complementary sticky ends join ; terminal transferase / enzyme, adds sticky ends ; ligase joins, gaps / nicks ;	**max 3**
	(c)	(i)	fewer genetically engineered mosquitoes pass parasites across midgut ; **A** figures fewer g e mosquitoes have parasites in salivary glands ; **A** figures fewer g e mosquitoes can infect (uninfected) mice ; **A** figures *'less good as vectors' instead of all of first three points = 1 only* use of comparative figures ;	**max 3**
		(ii)	*benefit* one of following ; reduce use of, insecticide / drug safer than, insecticide / drug AVP	**max 1**
			hazard one of following ; parasite may develop resistance gene may pass to other species AVP	**max 1**
				[Total: 15]

Question			Expected Answers	Marks
6	(a)	(i)	change in sequence of base pairs (in a DNA molecule) ; unpredictable / AW ; detail ; e.g. addition / substitution / deletion / frame shift / small part of chromosome / may code for different protein / may code for no protein	max 2
		(ii)	recessive (allele) ; autosomal / chromosome 7 ; homozygote recessive = sufferer ; heterozygote = carrier ; correct statement re inheritance ; e.g. both parents of sufferer must be carriers / 1 in 4 chance of sufferer from carrier parents	max 3
		(iii)	thick / dehydrated, mucus builds up in lungs ; and gut ; (bacterial) infections in lungs ; scar / damage, lungs ; mucus blocks secretion of digestive enzymes (from pancreas) ; malnutrition / inadequate, digestion / absorption ; mucus blocks sperm duct / males sterile ;	max 4
		(iv)	large number of mutations ; ref unrecognised / unknown, mutations ; each test specific ; DNA has different, code / base sequence ; probe binds to complementary base sequence ;	max 2
	(b)		mutation may give different, amino acid / primary structure ; **A** ref stop codon some mutations alter, molecular shape / tertiary structure / binding ; so unable to, accept / transport, HCO_3^- ; unable to bind ATP ; so increase in acidity / decrease in pH ; effect on mucus ; effect on enzyme(s) ; ref pH optimum of enzyme(s) ; poor digestion of, protein / lipid / starch ; some mutations, give some transport / have less effect ; $\geq$ 33% (of norm) allows normal digestive function / $\leq$ 6% (**A** very low) does not ;	max 4
				[Total: 15]