RECOGNISING ACHIEVEMENT

2805/02 Applications of Genetics

January 2006

Mark Scheme

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

1. Please ensure that you use the **final** version of the Mark Scheme.
   You are advised to destroy all draft versions.

2. Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks (½) should never be used.

3. The following annotations may be used when marking. No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.

   x = incorrect response (errors may also be underlined)
   ^ = omission mark
   bod = benefit of the doubt (where professional judgement has been used)
   ecf = error carried forward (in consequential marking)
   con = contradiction (in cases where candidates contradict themselves in the same response)
   sf = error in the number of significant figures

4. The marks awarded for each part question should be indicated in the margin provided on the right hand side of the page. The mark total for each question should be ringed at the end of the question, on the right hand side. These totals should be added up to give the final total on the front of the paper.

5. In cases where candidates are required to give a specific number of answers, (e.g. 'give three reasons'), mark the first answer(s) given up to the total number required. Examiners will be expected to use their professional judgment in marking answers that contain more than the number required. Advice about specific cases will be given at the standardisation meeting.

6. Correct answers to calculations should gain full credit even if no working is shown, unless otherwise indicated in the mark scheme. (An instruction on the paper to 'Show your working' is to help candidates, who may then gain partial credit even if their final answer is not correct.)

7. Strike through all blank spaces and/or pages in order to give a clear indication that the whole of the script has been considered.

8. An element of professional judgement is required in the marking of any written paper, and candidates may not use the exact words that appear in the mark scheme. If the science is correct and answers the question, then the mark(s) should normally be credited. If you are in doubt about the validity of any answer, contact your Team Leader/Principal Examiner for guidance.

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

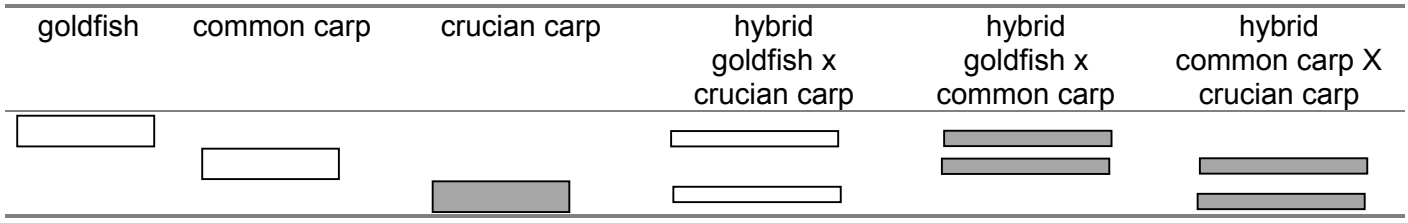
Question			Expected Answers	Marks
1	(a)	(i)	epistasis ; dominant ; correct ref to epistatic and hypostatic gene ; ref to protein / enzyme / inhibitor, product of allele A ; prevents, transcription / translation ; inhibits, expression / gene action ; blocks enzyme activity ;	**3 max**
		(ii)	small number of phenotypes ; distinct (phenotypic) classes ; qualitative ; two genes / AW ; large effect ; different genes have different effects ; not environmental ; AVP ;	**3 max**
	(b)	(i)	emasculate /remove stamens from / male sterility gene in, seed parent ; bag flowers, before / after, pollination ; grow in isolation ; transfer pollen by hand ;	**2 max**
		(ii)	increase genetic contribution of that species / *ora* ; keep (alleles of) background genes of that species ; so that only A/a exchanged / AW ; to see effect of A/a in other species ;	**2 max**
		(iii)	to produce, homozygous recessive / aa / AW ; so that, wanted allele / desired trait, expressed ;	**1 max**

(c) pollinators can distinguish colour ;
bees attracted to pink ; [A refs to 'blue' or UV re pink]
swapping alleles reduces visits by normal pollinator ;
swapping alleles attracts wrong pollinator ;
selectively bred / aa / red *M lewisii*, decreases bumblebee visits;
but does not attract many hummingbirds ;
selectively bred / Aa / pink *M. cardinalis*, attracts bumblebees;
and decreases hummingbird visits only slightly ;
ref comparative figures ;
colour important to bees ;
colour not important to humming birds / some other feature important to humming birds ;
AVP ; **4 max**

[Total: 15]

Question		Expected Answers	Marks
2	(a)	*max 5 for each section (1 to 10 and 11 to 18)*	
	1	need to choose parents whose desirable phenotype due to genotype ;	
	2	rather than environment ;	
	3	ref VP = VG + VE ;	
	4	heritability is measure of proportion of phenotype due to genotype / AW ;	
	5	1 all genetic - 0 all environmental ;	
	6	higher heritability value can be selected for more successfully / *ora* ;	
	7	values < 0.02 mean selective breeding will have little effect / *ora* ;	
	8	pig e.g.s given can be selectively bred ;	
	9	broad sense heritability = , proportion of total phenotypic variation due to genotype / V_G over V_P;	
	10	narrow sense heritability = variation due to additive effect of polygenes ; *max 5*	
	11	progeny testing tests value of individual's genotype ;	
	12	gives individual's value for selective breeding ;	
	13	by looking at progeny from different matings ;	
	14	mated with proven individuals ;	
	15	average performance found ;	
	16	important for sex-<u>limited</u> characters ;	
	17	e.g. sex-limited character ;	
	18	AVP ; *max 5*	**8 max**
		QWC – clear, well-organised using specialist terms;	**1**
		award the QWC mark if four of the following are used in correct context variation, variance, equations, broad sense, narrow sense, polygene, sex-limited	
	(b)	more transcription by QQ genotype ;	
		at both ages ;	
		in both skeletal and cardiac muscle ;	
		A *'throughout' / 'in all cases' for 1 mark of these 2*	
		much more in skeletal muscle / slightly more in cardiac muscle ;	
		in QQ genotypes expression falls with age in both skeletal and cardiac muscle ;	
		in qq genotypes expression rises with age in skeletal but falls in cardiac muscle ;	
		use of comparative figures ;	**4 max**
	(c)	changes shape of 'switch' ;	
		alters binding of stimulating, hormone / chemical ;	
		increased affinity for, RNA polymerase / enzyme ;	
		prevents production of repressor ;	
		allows RNA polymerase to bind ;	
		comparison *lac* operon ;	
		AVP ;	**2 max**
			[Total: 15]

Question		Expected Answers	Marks
3	(a)	**1** gene bank **;** **2** ref to wild type **;** **3** maintain genetic diversity **;** **4** ref to, loss of alleles / genetic erosion **;** **5** may have appropriate trait for breeding **;** **6** for future use **;** **7** requirements of breeders change **;** **8** in case, climate change / different conditions **;** **9** ref to, temperature / global warming **;** **10** ref to, pH tolerance / acid rain **;** **11** as yet unknown traits may be useful **;** **12** in case other named change **;** **13** may lose trait if interbred **;** **14** may form part of, food web / community **;** **15** that cannot be replaced **;** **16** adapted for, habitat / niche **;** **17** hybrids less well adapted **;** **18** ref to extinction **;** **19** AVP **;** e.g. need to maintain population for leisure fishing **20** AVP **;**	**8 max**
		QWC – legible text with accurate spelling, punctuation and grammar;	**1**
	(b)	**(i)** enzyme from bacterium **;** break down DNA of invading (bacterio)phages **;** ref to specific site of DNA **;** detail of site (4 - 6 bp / palindromic) **;** cut DNA **;** leaving blunt ends **;** or sticky ends **;**	**3 max**
		(ii) *crucian carp* 1 (thick) band in correct position (*see diagram*) **;** *hybrid goldfish x common carp* 2 (thin) bands in correct position **;** *hybrid common carp x crucian carp* 2 (thin) bands in correct position **;**	**3**
			[Total: 15]



Question			Expected Answers	Marks
4	(a)		mRNA and its complementary RNA bind together ; hydrogen bonding ; A to U and C to G ; **R** 'T' double stranded RNA / duplex RNA ; cannot bind to ribosome ; tRNA cannot bind ; cannot be translated / AW; ref to, RNA interference / RNAi ;	**4 max**
	(b)	**(i)**	theobromine content, reduced / approximately halved ; no significant difference between short and long lengths of RNA ; caffeine content reduced ; to half by short lengths of RNA ; **A** figures to about a third by long lengths of RNA ; **A** figures	**3 max**
		(ii)	(re caffeine) greater chance of pairing longer length with mRNA ; AVP ;	**1 max**
		(iii)	explant of meristematic / cambium / totipotent / pluripotent, cells / tissue ; explant (surface) sterilised / sterile nutrient ; appropriate hormone to stimulate, mitosis / division ; callus formed ; subdivided ; appropriate hormone to stimulate differentiation ; plantlet formed ; hardening medium / sterile soil	**4 max**
		(iv)	genetically identical ; genotype does not affect result ; easily genetically engineered ; plants derived from it identically genetically engineered / AW ; large numbers easily obtained ; early stages compact ; so easily kept in identical conditions ;	**3 max**
				[Total: 15]

Question		Expected Answers	Marks
5	(a)	penetration of biofilm difficult ; ref to diffusion of antibiotic ; detail of diffusion ; larger SA of separate bacteria / *ora* ; does not reach all bacteria in film / *ora* ; antibiotic trapped by film ; detail of entrapment ; dead bacteria in film form barrier ; AVP ; e.g. horizontal transmission / conjugation, easier in biofilm AVP ;	**4 max**
	(b)	both strains have identical sensitivity when in suspension ; to all three antibiotics ; both, less sensitive / more resistant, when in biofilms (*ora*) ; strain 1 much, less sensitive / more resistant ; comparative figures ; C most effective / AW ; B least effective / AW ;	**4 max**
	(c)	mutation ; random / chance / pre-existing ; detail of mutation ; e.g. base substitution, addition, deletion ref to, selection / selective advantage ; codes for different, glucan / biofilm ; affects all three antibiotics ; blocks antibiotic from reaching cells ; binds antibiotics ;	**4 max**
	(d)	horizontal transmission ; (copy of) plasmid ; via conjugation ; detail ; conjugation tube / 'R' plasmid / single strand DNA transferred via transformation ; transferred by (bacterio)phage ;	**3 max**
			[Total: 15]

Question			Expected Answers	Marks
6	(a)	(i)	found, in / on, membrane ; cell surface ; antigen ; recognition signal ; self / not-self, marker ; detail ; (might act as) receptor ;	3 max
		(ii)	glycoproteins = antigens ; *do not give if awarded in (i)* not-self / foreign, tissue / cells ; stimulate immune response ; greater response with more, antigens / mismatches ; ref comparative figures ; rejection ; ref to T cells ; antibodies / receptors, bind with antigens ; killer T / cytotoxic T, cells destroy transplant ;	4 max
		(iii)	weakened due to, previous rejection / long term illness ; so more likely to die ; memory of any antigen in previous graft; memory cells become active quickly when antigen seen again ; secondary response ; quicker rejection ; AVP ;	3 max
	(b)	(i)	haplotype ;	1
		(ii)	correct genotype ;	1
		(iii)	0.25 / AW ;	1
	(c)		HLA loci linked / on same chromosome / on chromosome 6 ; tightly (linked) / close together / AW ; rarely separated by crossing-over ; inherited as, unit / haplotype ; child receives one haplotype from each parent ;	2 max
				[Total: 15]