RECOGNISING ACHIEVEMENT

2805 / 02 Applications of Genetics

January 2004

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. Strike through the remainder. In specific cases where this rule cannot be applied, the exact procedure to be used is given in the mark scheme.

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 R = answers which are not worthy of credit A = accept this alternative answer ( ) = 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 ora = or reverse argument

Question	Expected Answers	Marks
1 (a)	parents AaBb x aabb; gametes AB Ab aB ab x ab; F_2 AaBb Aabb aaBb aabb; phenotypes given;	4
(b) (i)	-32 1024 20.48; - 28 784 15.68; $\chi^2 = 72.32$;	3
(ii)	< 0.001; ecf	1
(iii)	difference from expectation is significant / below critical value (0.05); ecf hypothesis re expectation should be rejected / prediction incorrect; ecf result, not / unlikely to be, due to chance;	max 2
(c)	loci / genes, are, linked / on the same chromosome; no independent assortment; large numbers of, parental types / specified; small numbers of, recombinants / specified; from crossing over; in, meiosis I / prophase I; between non-sister chromatids of homologous chromosomes / AW / credit diagram; number recombinants depends on how close together the, loci / genes; c. 20 map units apart / cov = 20;	max 5
	[Total:	**15]**

Question		Expected Answers	Marks
2	(a)	ref. how seeds selected for bank; seeds dehydrated / ref. circa 5% water; kept at low temperature / ref. circa –20 ^{o}C; germination tests, at intervals / regularly; when germination falls below c. 85%; plants grown and new seed stored;	**max 3**
	(b)	to maintain genetic diversity / prevent genetic erosion; **A** biodiversity for, future / unknown / potential, use; for changed environmental conditions; e.g. of change; **R** 'environment' to counteract, inbreeding / extinction;	**max 3**
	(c) (i)	ref. $V_P = V_G + V_E$ / heritability = V_G / V_P; estimate of role of genotype in phenotypic variation; when heritability high much of variation seen in phenotype is genetic / ora; no point breeding those whose desirable phenotype is environmental; high heritability will result in successful selective breeding / ora;	**max 3**
	(ii)	heritability (ranges from) 0 - 1; values less than 0.02 mean selective breeding will have little effect / ora; all phenotypic characteristics shown can be selectively bred; mass copra most easily / flowering period least easily; **A** other comparative statement	**max 3**
	(d)	artificial selection not natural selection; man selective agent v. whole environment; for benefit of man not organism / may be to detriment of organism; particular character not whole phenotype; often faster;	**max 3**
			[Total: 15]

Question			Expected Answers		Marks
3	(a)		deleterious recessive alleles, expressed / homozygous; reduced genetic variation; increased homozygosity / decreased heterozygosity; genetic erosion / loss of alleles / reduced gene pool;		**max 3**
	(b)	**1**	DNA extracted, from cell sample / named cell sample;		
		2	cut by restriction enzyme(s);		
		3	enzymes chosen to cut close to but not within VNTRs;		
		4	fragments placed in well at end of gel;		
		5	ref. agarose;		
		6	potential difference applied;		
		7	DNA negatively charged;		
		8	fragments travel to anode;		
		9	smaller / shorter, fragments travel further; ora		
		10	Southern blotting;		
		11	radioactive / ^{32}P, probe;		
		12	single stranded;		
		13	complementary binding;		
		14	autoradiograph / use of X ray film; **R** use of X rays	max 5	
		15	VNTRs / lengths of repeated base sequence;		
		16	in DNA that does not code for a gene;		
		17	number / size, of repeats differs markedly between individuals;		
		18	genetic fingerprint is way of revealing differences;		
		19	only identical twins have the same, numbers of repeats / genetic fingerprint;		
		20	inherited;		
		21	half from each parent;	max 4	**max 8**
			QWC - legible text with accurate spelling, punctuation and grammar		**1**
	(c)		offspring identical (to one another); offspring, identical to / clones of, male parent; no genetic contribution from female parent; offspring developed, from male / without fertilisation / from (diploid) pollen; 2 species have different, fingerprints / VNTRs;		**max 3**
				[Total:	**15]**

Question		Expected Answers	Marks
4	(a)	*no mark for name of crop* *oilseed rape, maize, sugar beet* allows crop to be sprayed with herbicide; after germination; reduces competition from weeds; increases yield; *potato* removes need to use, insecticide; **A** pesticide saves cost of insecticide; saves, contamination / pollution, of environment; saves poisoning of sprayer; only kills those insects that eat crop; reduces insect damage; increases yield;	**max 4**
	(b)	not significantly different; both very low; only 2 - 4%; only in maize is survival of transgenic crop greater than non-transgenic / ora; potato has greatest difference between transgenic and non-transgenic; any comparative figures;	**max 4**
	(c) **1**	low / small, in terms of, survival / invasiveness;	
	2	ref. 4 year extinction of, oilseed rape / maize / sugar beet;	
	3	ref. only non-transgenic potatoes after 10 years;	
	4	but may allow pollination of wild relatives;	
	5	which become, more invasive / weedier / a superweed;	
	6	or become, allergenic / toxic;	
	7	transfer to certificated organic crop;	
	8	transfer inactivates (vital) gene in another organism;	
	9	unforeseen effect;	
	10	transfer via vector to other organism (with undesirable consequences);	
	11	encourage use of, herbicide / insecticide, with effect on environment;	
	12	AVP re danger; e.g. resistance / loss pollinators / soil organisms	
	13	results may not generalise to other habitats;	
	14	ethical implications different from above ;;;	
	15	*3 marks for ethical implications, but **R** 'playing God'*	
	16	***A*** *questionable right to change for human benefit* *profit and improved nutrition for impoverished countries*	**max 7**
			[Total: 15]

Question			Expected Answers	Marks
5	(a)		*Hae III* no, target site / sequence inverted; ref. antiparallel DNA strands / AW; active site of enzyme only fits one way round;	**max 2**
			HpaII yes, target site /sequence correct / can be any base outside target sequence;	**1**
	(b)	(i)	cuts plasmid with 'sticky ends' / -CC GG- ; human gene must be cut with, same enzyme / HpaII; complementary ends; ends then H-bond; ref. action of ligase;	**max 4**
		(ii)	cuts with 'blunt ends' ; must be given sticky ends; e.g.s of nucleotides; *nucleotides with C and G* ref. enzyme / polymerase / terminal transferase; human gene given complementary ends;	**max 3**
	(c)	(i)	treatment of a genetic, disorder / condition; by altering a patient's, genotype / genome; by adding a, useful / normal, allele; by inactivating an undesirable (AW) allele; only for recessive diseases at present;	**max 3**
		(ii)	*benefit* new blood vessels grow (in damaged heart muscle); more oxygen reaches heart muscle; other sensible comment re damaged heart muscle; *hazard* allele may insert within another, gene / cell, and disrupt its function / with unknown consequences / with damaging consequences; may insert in gonad / named, and be passed to offspring with unknown consequences / etc.; vector may cause damage;	**max 2**
				[Total: 15]

Question			Expected Answers	Marks
6	(a)	1	usually / most cases / c. 95% cases;	
		2	trisomy 21 / x3 chromosomes 21;	
		3	nondisjunction / AW;	
		4	in meiosis; **A** *here or in next section*	
		5	usually maternal / rarely paternal;	
		6	chance (event);	
		7	increased chance with increased parental age;	
		8	rarely / few cases / c. 5% cases;	
		9	translocation;	
		10	part chromosome 21 breaks and joins another, chromosome / autosome;	
		11	ref. chromosome, 13 / 14 / 15;	
		12	ref. Robertsonian;	
		13	heritable / can be passed to next generation;	
		14	credit diagram of gametes produced;	**max 8**
			QWC - clear, well organised using specialist terms	**1**
	(b)		*two of* amniocentesis / chorionic villus sampling (CVS) / blood test ;;	**2**
	(c)	(i)	67.9% / 68%;	**1**
		(ii)	oocytes held (in ovary) for long time; since before birth; held in prophase I of meiosis; meiosis I only completed, at / just before, ovulation; vulnerable to internal and external factors;	**max 3**
				[Total: 15]