RECOGNISING ACHIEVEMENT

Subject: Applications of Genetics
Code: 2805/02

Session: January Year: 2002

Mark Scheme

MAXIMUM MARK	90

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.

1	**(a)**	**(i)**	entirely green leaves are dominant to finely striped leaves;	**1**
		(ii)	resistance to *Helminthosporium* is recessive to low resistance;	**1**
	(b)		ffhh;	**1**
	(c)	**(i)**	$\eta = 3$;	**1**
		(ii)	p = < 0.001	**1**
		(iii)	difference between expected and actual results is significant; occurs by chance in fewer than 1 in 20; prediction of 1:1:1:1 incorrect;	**max 2**
		(iv)	two loci, linked/on the same chromosome; fh/recessive, and, FH/dominant, alleles inherited together; gives large numbers (78 and 82) of parental types; crossing over; in prophase I of meiosis; gives smaller numbers of recombinant types; cov = 21%/loci 21 map units apart;	**max 4**
		(v)	breed true for resistance; must be, homozygous recessive/hh; will not breed true for green leaves; heterozygous/Ff;	**max 3**

Total: 14

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2 **(a)** **(i)** suitable example of character in named organism; (mass/height/other parameter) [R Mendel's peas] **1**

(ii) suitable example of character in named organism; (Mendel's peas/ABO/CF/HD/etc.) **1**

(b)

continuous variation	*discontinuous variation*
no discrete classes/AW v.	discrete classes/AW;
vary between, limits/extremes;	no intermediates;
quantitative v.	qualitative;
plotted as normal distribution curve;	plotted as bar chart;

continuous variation	*discontinuous variation*
>3 genes;	one/few, genes;
polygenes;	
many alleles;	few alleles;
different alleles have small effects;	different alleles have large effects;
different genes have additive effects;	different genes have different effects;
	different genes may interact;
large environmental effect v	little environmental effect;
.use of e.g.;	use of e.g.;

Q - legible text with accurate spelling, punctuation and grammar **1**

max 9

(c) v. many phenotypes;
difficulty in finding match;
chance of finding match greater in family;
loci linked;
therefore inherited as haplotype;
lack of match results in rejection;
ref. immunosuppression;
A.V.P.; **max 3**

Total: 14

3 (a) can only select for variation due to genotype/cannot select for variation due to environment;
V_G important;
not V_E;
(broad sense) heritability gives value for effect of genotype on phenotype;
(narrow sense) heritability gives measure of additive effect of polygenes; **max 3**

(b) scale 0 -1;
high value = trait easily selected for;
e.g. spotting of coat;
value <0.02 = no effect of selective breeding;
even calving interval can be selected for;
ref. ease of selection of spotting > birth mass > milk yield > gestation length > calving interval(any two);
A.V.P.; **max 4**

(c) by progeny testing;
mate male with number of females;
with, proven milk yield/range of milk yields;
measure milk yields of female offspring;
after calving/when mature/ref. time scale;
ref. use of AI;
gives value of male genotype; **max 4**

(d) both speed up selective breeding;

more offspring from desirable male by AI;
AI available, quickly/at any time;
at a distance/internationally;
use after death of male;
AVP;

more offspring from, desirable female/both desirable female and male;
with no risk of pregnancy;
allows cloning;
use of, temporary surrogate/portmanteau/e.g. such, for transport;
AVP; **max 7**

Total: 18

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4 **(a)** **(i)** substitution;
of one base (pair) for another;
that does not alter sense of triplet code;
same amino acid coded for (at site of mutation);
silent mutation;
or that alters amino acid;
but does not alter shape of enzyme;
no frame shift; **max 3**

(ii) different amino acid coded for;
different R group;
different, 3^{o}/3D, structure of, polypeptide/enzyme;
different shape active site;
different affinity of active site;
stop signal coded for (near end of gene);
a-acid chain cut short;
ref. change in regulator region reducing gene expression; **max 3**

(b) ref. R plasmid/resistance genes on plasmid;

same species vertical transmission/fission;
plasmid replicated and passed to offspring;

same/different, species horizontal transmission/conjugation/process described;
copy of plasmid passed via pilus;

different species transformation/process described;
transduction/process described; **max 4**

(c) wild type and minus R strains killed by vancomycin;
no difference until 1 h;
shape curve for wild type and minus R similar;
ref. figures; [no. viable cells and time]
minus E strain less affected;
ref. figures; [no. viable cells and time] **4**

(d) when missing (minus R) gene switched on;
when cannot be altered (minus E) gene, not/only just, switched on;
ref. bacterial numbers; **max 2**

Total: 16

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5 **(a)** specific site;
small number of base-pairs/4 - 6 base pairs;
palindromic/symmetrical/AW; **max 2**

(b) **(i)** 3; **1**

(ii) 4 **1**

(c) ref. specific shape active site;
different base-pairs have different shapes;
must fit;
ref. affinity active site;
binds to specific base pairs; **max 3**

(d) fragment DNA;
for genetic fingerprinting;
before use of gene probe;
for genetic screening;;
cut gene out of, genome/AW;
for gene therapy;
open vector DNA;
e.g. plasmid/virus DNA/YAC/MAC;
allow formation of, recombinant DNA/rDNA;
via sticky ends;
A.V.P.; (restrict growth of, viruses/phage, in bacteria)

Q - clear, well-organised answer using specialist terms **1**
max 7
Total: 14

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6 **(a)** **(i)** placed at, one end/cathode end, of gel;
ref. electrolyte/buffer;
PD applied;
-ve charged DNA;
moves to anode;
smallest/shortest/lightest, fragment move furthest; [ora] [R different charge] **max 3**

(ii) Southern blotting;
detail blotting;
radioactive probe;
single strand DNA/ref. ^{32}P;
autoradiograph/process described; [R X ray}
[A stain gel; ethidium bromide/other; ref. fluorescence/UV light;] **max 3**

(iii) produces banding pattern;
of DNA of different lengths;
differences in number of bands;]
differences in position;
= differences in DNA sequence;
restriction sites/AW, in different places;
many differences = greater variation/few differences = less variation; **max 3**

(b) inbreeding depression;
loss, fitness/fertility/size/other;
loss alleles;
loss genetic variation;
increased homozygosity/decreased heterozygosity; **max 3**

(c) environmental variation/V_E ;
different soils;
different, nutrients/minerals;
different growing conditions;
different temperatures;
different water content;
different host; **max 2**

Total: 14