

# The roles of genes in determining the phenotype

## Mark Scheme 3

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Inherited change
Sub Topic	The roles of genes in determining the phenotype
Booklet	Theory
Paper Type	Mark Scheme 3

Time Allowed : 66 minutes

Score : / 55

Percentage : /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

- 1 (a)
1. chance / random / spontaneous ;
  2. change in, base / nucleotide, sequence (in DNA ;
  3. during DNA replicatio ;
  4. base substitutio ;
  5. often no effec / silent mutation / may code for same amino acid ;
  6. base additio / base deletion ;
  7. have great effect on phenotyp ;
  8. frame shift ;
  9. alters whole sequence of bases after mutatio ;
  10. may lead to stop cod ;
  11. different / new, alle ;
  12. protein, different shape / different function / not ma ;

[max 9]

- (b)
1. no / no functional, channels for  $\text{Cl}^-$  ions ;
  2.  $\text{Cl}^-$  ions do not move out ;
  3. le water leaves cell ;
  4. mucus (on cell surface membrane) stays, thick / stick ;
  5. *symptoms – an 4 from:*  
mucus not moved effectively by cilia / mucus accumulates ;
  6. reduced gaseous exchange / longer diffusion pathwa ;
  7. difficulty in breathin ;
  8. more infections / (mucus) traps bacteri ;
  9. lungs are scarre ;
  10. blocked sperm duc ;
  11. blocked pancreatic du ;

[max.6]

[Total: 15]

- 2 (a)  $X^R Y$  and  $X^r X^r$  ;  
 $X^R$   $Y$   $X^r$  ( $X^r$ ) ; allow ecf from incorrect parental genotypes  
 $X^R X^r$  and  $X^r Y$  ; [3]

(b) (i)

phenotype of fly	O	E	O-E	(O-E) <sup>2</sup>	$\frac{(O-E)^2}{E}$
red-eyed female	54	50	(+ )4	16	0.32 ;
white-eyed male	46	50	(- )4	16	0.32 ;

0.64 ;  
allow ecf [3]

- (ii) probability is greater than 0.05 ; A chi squared smaller than 3.84  
no significant difference ;  
due to chance ; [max 2]

[Total: 8]

- 3 (a) transfer of pollen from anther to stigma ;  
on the same, flower / plant ; [2]
- (b) 1. *idea of* genetic variation ;  
2. increased heterozygosity ; **ora**  
3. hybrid vigour / decreased inbreeding depression ;  
4. able to adapt to changing conditions ;  
5. *idea of* some individuals surviving ;  
6. AVP ; e.g. reduced risk of expression of harmful recessive alleles [3 max]
- (c) (i) 1. initially / first 24 mins, exposure time increases, number of seeds produced /  
(chance of) fertilisation ;  
2. then / after 24 or 44 mins, steep decrease in, number of seeds produced /  
(chance of) fertilisation ;  
3. from 120 mins, no seeds produced / no fertilisation ; [2 max]
- (ii) 1. plant GM maize some distance away from places that teosinte grows ;  
2. estimate how far pollen can travel in 120 minutes ;  
3. need more results between 60–120 minutes ; [2 max]

[Total:9]

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- 4 (a)
1. reduction division / (to) halve number of chromosomes / diploid to haploid / AW ;
  2. homologous chromosomes pair up / bivalents form ;
  3. ref. chiasmata / ref. crossing over ;
  4. homologous chromosome pairs / bivalents, line up on equator ;
  5. independent assortment ;
  6. spindle / microtubules, attached to centromeres ;
  7. chromosomes of each pair pulled to opposite poles ;
  8. by shortening of, spindle / microtubules ;
  9. nuclear envelopes re-form ;
  10. cytokinesis / AW ;

[6 max]

(b) *accept alternative symbols for alleles throughout*

11. frequency of sickle cell anaemia is highest in areas where malaria is common ;
12. sickle cell anaemia red blood cells cannot carry oxygen very well / AW ;  
**A** sickling blocks capillaries
13. homozygous  $H^S / H^S H^S$ , have sickle cell anaemia / may die ;
14. homozygous  $H^N / H^N H^N$ , have normal, Hb / red blood cells ;
15. heterozygotes, have sickle cell trait  
**or**  
 (sickle cell trait) red blood cells not (severely) affected ;
16. malaria parasite / *Plasmodium*, affects red blood cells ;
17. malaria lethal ;
18. sickle cell trait people / heterozygotes, less likely to suffer from (severe effects of) malaria ;
19. have selective advantage ;
20. pass on both  $H^N$  and  $H^S$  ;
21. malaria selects against, homozygous  $H^N / H^N H^N$  ;
22. sickle cell anaemia selects against, homozygous  $H^S / H^S H^S$  ;
23. *idea that* sickle cell allele is maintained within population  
 because of sickle cell trait individuals ;

[9 max]

**[Total: 15]**

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- 5 (a) (i) *accept answers in a genetic diagram where genotypes are linked to phenotypes*
- 1 agouti allele /  $C^a$ , dominant to black allele /  $C^b$  ; **ora**
  - 2 black parents homozygous recessive ;
  - 3 agouti parents heterozygous **or** homozygous ; [2 max]
- (ii) *accept answers in a genetic diagram where genotypes are linked to phenotypes*
- 1 yellow allele /  $C^y$ , dominant to, black allele /  $C^b$  ;
  - 2 ref. to modified 3:1 ;
  - 3 (homozygous) genotype  $C^y C^y$ , lethal / does not survive ; [2 max]
- (iii) *accept answers in a genetic diagram where genotypes are linked to phenotypes*
- 1 yellow allele /  $C^y$ , dominant to **all** others ;
  - 2 agouti /  $C^a$  **or** black and tan /  $C^{bt}$ , allele, dominant to black allele ;  
**A** black allele recessive to all other alleles
  - 3 yellow mice all heterozygous (must be stated) ; [2 max]
- (b) 1 cross (black and tan mouse) with, black mouse / homozygous recessive mouse /  $C^b C^b$  ;
- 2 if **all** offspring black and tan then parent,  $C^{bt} C^{bt}$  / homozygous ;
  - 3 if some offspring are black (and some are black and tan) then parent,  
 $C^{bt} C^*$  / heterozygous ; [2 max]

[Total: 8]

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