



# **A-Level Biology**

## **Hardy-Weinberg**

### **Mark Scheme**

**Time available: 64 minutes**

**Marks available: 47 marks**

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## Mark schemes

1.

(a) 1. Answer of 12/13 = **2 marks**;;

2.  $0.36(48)/0.365/0.37 = 1 \text{ mark}$

**OR**

$36(.48)/36.5/37\% = 1 \text{ mark}$

**OR**

$q^2 = 0.06/0.059/0.0588 = 1 \text{ mark}$

**OR**

or  $q = 0.2/0.24/0.243 = 1 \text{ mark}$ ;

*For 1 mark accept  $q^2 = 6\%/5.9\%/5.88\%$*

2

(b) 0.71

1

(c) Second box ticked/answer key: B:

The mutation that caused black fur happened in a common ancestor of *S. carolinensis* and other closely related species.

1

(d) 1. 2.55% = **2 marks**;;

2. 2.61% = **1 mark** (question misread ie  $8/306 \times 100$ )

**OR**

Evidence of dividing by 314 or 942 = **1 mark**

**OR**

Answers **not** given to three significant figures = **1 mark**;

2

(e) 1. Mutation/lack of glutamic acid leads to (permanent) activation of the receptor/protein;

2. (Because) the receptor/protein does not require the binding/leaving of  $\alpha$ MSH (to become activated);

*Answer must convey the idea that binding/leaving is not required*

3. ASIP (might) not (be) able to bind to the receptor/protein;

4. (Only) the dark pigment is produced

3 max

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2.

(a) 0.32.

*Correct answer = 2 marks*

*Accept 32% for 1 mark max*

*Incorrect answer but identifying 2pq as heterozygous = 1 mark*

2

- (b) 1. Mutation produced *KDR minus* / resistance allele;
- 2. DDT use provides selection pressure;
- 3. Mosquitoes with *KDR minus* allele more likely (to survive) to reproduce;
- 4. Leading to increase in *KDR minus* allele in population.

4

- (c) 1. Neurones remain depolarised;
- 2. So no action potentials / no impulse transmission.

2

- (d) 1. (Mutation) changes shape of sodium ion channel (protein) / of receptor (protein);
- 2. DDT no longer complementary / no longer able to bind.

2

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3.

(a) Both alleles are expressed / shown (in the phenotype).

*Accept: both alleles contribute (to the phenotype)*

*Neutral: both alleles are dominant*

1

(b) Only possess one allele / Y chromosome does not carry allele / gene / can't be heterozygous.

*Accept: only possess one gene (for condition)*

*Neutral: only 1 X chromosome (unqualified)*

1

(c) 1.  $X^G X^B$ ,  $X^B X^B$ ,  $X^G Y$ ,  $X^B Y$ ;

*Accept: equivalent genotypes where the Y chromosome is shown as a dash e.g.  $X^G-$ , or is omitted e.g.  $X^G$*

*Reject: GB, BB, GY, BY as this contravenes the rubric*

2. Tortoiseshell female, black female, ginger male, black male;

3. (Ratio) 1:1:1:1

*2 and 3. Award one mark for following phenotypes tortoiseshell, black, (black) ginger in any order with ratio of 1:2:1 in any order.*

*Allow one mark for answers in which mark points 1, 2 and 3 are not awarded but show parents with correct genotypes i.e.  $X^G X^B$  and  $X^B Y$  or gametes as  $X^G$ ,  $X^B$  and  $X^B$ , Y*

*3. Neutral: percentages and fractions*

*3. Accept: equivalent ratios e.g. for 1:1:1:1 allow 0.25 : 0.25 : 0.25 : 0.25*

3

(d) (i) Correct answer of 0.9 = 2 marks;

Incorrect answer but shows  $q^2 = 0.81 =$  one mark.

*Note: 0.9% = one mark*

2

(ii) Homozygous dominant increases and homozygous recessive decreases.

1

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4.

(a) (Recessive) allele is always expressed in females / females have one (recessive) allele / males need two recessive alleles / males need to be homozygous recessive / males could have dominant and recessive alleles / be heterozygous / carriers;

*Accept: Y chromosome does not carry a dominant allele. Other answers must be in context of allele not chromosome or gene.*

1

(b) (i) 1. 1, (2) and 5;

*Accept: for 1 mark that 1 and 2 have slow (feather production) but produce one offspring with rapid (feather production).*

*Neutral: any reference to 3 being offspring of 1.*

2. 1 must possess / pass on the recessive allele / 1 must be a carrier / heterozygous / if slow (feather production) is recessive all offspring of (1 and 2) would be slow (feather production) / if rapid (feather production) was dominant 1 would have rapid (feather production);

*Reject: both parents must be carriers / possess the recessive allele.*

*Reject: one of the parents (i.e. not specified) must be a carrier / heterozygous.*

2

(ii) 5 =  $X^fY / X^fY^- / f / f^- / fY$  ;

7 =  $X^FX^f$  **and**  $X^FX^F$  (either way round) /

**or**  $X^fX^F$  **and**  $X^FX^F$  (either way round) /

**or**  $X^FX^f, X^fX^F$  **and**  $X^FX^F$  (in any order);

*Note: allow 5 =  $X^fY, X^fY$ .*

*Accept: for both 5 and 7 a different letter than F. However, lower case and capital letter must correspond to that shown in the answer. For example accept 7 =  $X^RX^r$  and  $X^RX^R$ .*

2

- (iii)  $X^F X^f$  and  $X^f Y$  or  $X^f X^F$  and  $X^f Y$   
 or  $X^F X^f$  and  $X^f Y^-$  or  $X^f X^F$  and  $X^f Y^-$  /  
 or  $Ff$  and  $fY$  /  
 or  $Ff$  and  $fY^-$  /  
 or  $Ff$  and  $f^-$  /  
 or  $Ff$  and  $f$ ;

*Accept: a different letter than F. However, lower case and capital letter must correspond to that shown in the answer.*

*Accept: each alternative either way round.*

1

- (c) Correct answer of 32 (%) = 3 marks;;;  
 Accept: 0.32 = 2 marks

If incorrect answer, allow following points

- $p^2 / q^2 = 4\% / 0.04$  / or  $p / q = 0.2$ ;
- Shows understanding that  $2pq$  = heterozygotes / carriers;  
*Accept: answer provided attempts to calculate  $2pq$ . This can be shown mathematically i.e. 2 x two different numbers.*

3

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5.

- Use 1 in 400 to find frequency of homozygous recessive /  $q^2$

**OR**

1 in 400 gives frequency of 0.0025;

*Note - convention has recessive allele as q and dominant allele as p but allow reversal (since outcome is the same) as long as this is consistent throughout*

- Find square root of  $q^2$  / find square root of 0.0025;
- Use of  $p + q = 1.0$  / determine frequency of both alleles / both  $p$  and  $q$  / find  $p = 0.95$  and  $q = 0.05$ ;
- Use of  $2pq$  to find carriers / heterozygotes;  
*The question requires a description but credit working where correct as alternative since this shows the stages*

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6.

- (a) The frequency / proportion of alleles (of a particular gene);

Will stay constant from one generation to the next / over generations / no genetic change over time;

Providing no mutation / no selection / population large / population genetically isolated / mating at random / no migration;

*The three principles for marking are:*

*What feature*

*What happens to it*

*Providing . . .*

*Accept: genotype / explanation of genotype*

*Accept: alternative wording, e.g. there is no gene flow / genetic drift for genetically isolated.*

3

- (b) White / deaf cats unlikely to survive / selected against;

Will not pass on allele (for deafness / white fur) (to next generation) / will reduce frequency of allele;

*Accept: alternative wording, e.g. have a disadvantageous phenotype*

*Neutral: will not breed*

2

- (c) In Paris / London frequencies (of these alleles) add up to more than 1;

*Can be shown by correct figures to be more than 1  
e.g.  $0.71 + 0.78 = 1.49$*

*Accept: more than 100%*

1

- (d) Two marks for correct answer of 44(.22);;

One mark for incorrect answer in which p / frequency of H determined as 0.67 and q / frequency of h as 0.33

**OR**

Answer given as 0.44(22);

2

**[8]**