

Interactive Example Candidate Responses

Paper 4 (May/June 2016), Question 6

Cambridge International AS & A Level

Biology 9700

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- 6 The fruit fly, *Drosophila melanogaster*, has eyes, a striped abdomen and wings longer than its abdomen. This is called a 'wild-type' fly.

Mutation has resulted in many variations of these features.

Table 6.1 shows diagrams of a wild-type fly and three other flies, each of which shows **one** recessive mutation.

Table 6.1

				
eyes	present	present	recessive absent	present
abdomen	striped	recessive black	striped	striped
wing description	long	long	long	recessive short

- (a) Using appropriate symbols, complete the genetic diagram below.

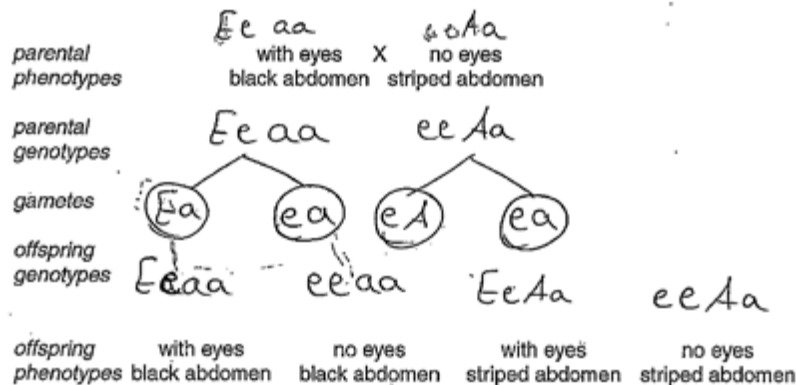
symbols

$E \rightarrow$ eyes present

$e \rightarrow$ eyes absent

$A \rightarrow$ striped abdomen

$a \rightarrow$ black abdomen



[4]

Your
Mark

6(a)

6(b)

6(c)

6(d)

Q6 Mark scheme

- (a) key to 4 chosen symbols ;
A any two lettered pairs (e.g. E/e and A/a) identified | symbols for wing length
no eyes and black abdomen must be lower case (e , a)
with eyes and striped abdomen must be upper case (E , A)
 allow ecf to max 3 if error in symbols
 parents genotypes $Eeaa \times eeAa$;
 gametes $Ea\ ea\ eA\ ea$; A each gamete written twice
 F2 genotypes $Eeaa\ eeaa\ EeAa\ eeAa$; [4]
- (b) cross with, homozygous recessive / black no-eyes, fly ;
A double recessive / $aeee$ (or own symbols) / organism showing recessive characters or phenotype [4]
- (c)
- | observed number (O) | expected number (E) | O - E | (O - E) ² / 2 | (O - E) ² / E |
|---------------------|---------------------|-------|--------------------------|------------------------------|
| 86 | 83 | 3 | 9 | 0.11 |
| 87 | 83 | 4 | 16 | 0.19 |
| 81 | 83 | -2 | 4 | 0.05 |
| 78 | 83 | -5 | 25 | 0.30 |
| 332 | 332 | | | $\therefore \chi^2 = 0.65$; |
- A** fractions in last column **A** 3 s.f. in last column [3]
- (d) no significant deviation from expected / difference not significant ;
A (95% probability that) difference is due to chance
A data is a good fit / match
A null hypothesis (no significant difference between O and E)
R comment on significance of results
R 'the value' is not significant
 probability (of this deviation) is over 0.05 / χ^2 is less than 7.82 ;
A χ^2 / results (of χ^2 test), less than value at probability 0.05
 ref. to critical value ; ecf reverse arguments if answer from 6(c) is over 7.82
 ref. to independent assortment / AW ; [max 2]
 [Total: 10]

- (b) State how you would carry out a test cross.

Cross breed the *Drosophila* showing the dominant feature with a homozygous recessive one [1]

- (c) A cross was carried out between a fly heterozygous for striped abdomen and long wings and a fly with a black abdomen and short wings. $aall$

The results are shown below in Table 6.2.

Table 6.2

offspring	number
striped abdomen long wing	86
black abdomen long wing	87
striped abdomen short wing	81
black abdomen short wing	78
total	332

$AaLl \times aall$
 (AL) $AaLl$
 (Al) $AaLl$
 (aL) $aall$
 (al) $aall$

A chi-squared test (χ^2) was carried out on these data.

Complete Table 6.3 and calculate the value of χ^2 .

Table 6.3

observed number (O)	expected number (E)	O - E	(O - E) ²	$\frac{(O - E)^2}{E}$
86	83	3	9	0.11
87	83	4	16	0.19
81	83	-2	4	0.05
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332	332			

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

Σ = sum of...

$$\chi^2 = 0.65$$

Your
Mark

6(a)

6(b)

6(c)

6(d)

Q6 Mark scheme

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 allow ecf to max 3 if error in symbols
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 gametes Ea ea \times eA ea ; A each gamete written twice
 F2 genotypes Eeaa eeaa EeAa eeAa ; [4]
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 ref. to critical value ; ecf reverse arguments if answer from 6(c) is over 7.82
 ref. to independent assortment / AW ; [max 2]
[Total: 10]

(d) Table 6.4 shows χ^2 values.

Table 6.4

degrees of freedom	probability						
	0.50	0.20	0.10	0.05	0.02	0.01	0.001
3	2.37	4.64	6.25	7.82	9.84	11.34	16.27

Using Table 6.4, explain what conclusions can be made about the results of the χ^2 test.

The value of χ^2 shows a probability greater than 0.05. So the difference between observed numbers and expected numbers is not significant and only due to chance.

[2]

[Total: 10]

Your
Mark

6(a)

6(b)

6(c)

6(d)

Q6 Mark scheme

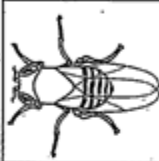



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Table 6.1 shows diagrams of a wild-type fly and three other flies, each of which shows **one** recessive mutation.

Table 6.1

				
eyes	present	present	absent	present
abdomen	striped	black	striped	striped
wing description	long	long	long	short

- (a) Using appropriate symbols, complete the genetic diagram below.

symbols

E - With Eyes (Dominant)

e - Without eyes

S - striped Abdomen (Dominant)

s - black abdomen

parental phenotypes with eyes X no eyes
black abdomen striped abdomen

parental genotypes $EeSs \times eeSs$

gametes $(Es) (es) \times (eS) (es)$

offspring genotypes $EeSs$ $eeSs$ $EeSs$ $eeSs$

offspring phenotypes with eyes no eyes with eyes no eyes
black abdomen black abdomen striped abdomen striped abdomen

[4]

Your
Mark

6(a)

6(b)

6(c)

6(d)

Q6 Mark scheme

- (a) key to 4 chosen symbols ;
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- (b) cross with, homozygous recessive / black no-eyes, fly ;
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ref. to critical value ; ecf reverse arguments if answer from 6(c) is over 7.82
ref. to independent assortment / AW ; [max 2]
[Total: 10]

(b) State how you would carry out a test cross.

A test cross is carried out using two heterozygous species.
[1]

(c) A cross was carried out between a fly heterozygous for striped abdomen and long wings and a fly with a black abdomen and short wings.

The results are shown below in Table 6.2.

Table 6.2

offspring	number
striped abdomen long wing	86
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total	332

A chi-squared test (χ^2) was carried out on these data.

Complete Table 6.3 and calculate the value of χ^2 .

Table 6.3

observed number (O)	expected number (E)	O - E	(O - E) ²	$\frac{(O - E)^2}{E}$
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$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

Σ = sum of... 0.11 + 0.19 + 0.05 + 0.30

$$\chi^2 = 0.65 \quad [3]$$

Your
Mark

6(a)

6(b)

6(c)

6(d)

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degrees of freedom	probability					
	0.50	0.20	0.10	0.05	0.02	0.01
3	2.37	4.64	6.25	7.82	9.84	11.34

Using Table 6.4, explain what conclusions can be made about the results of the χ^2 test.

Using the 0.05 probability, it can be seen that the χ^2 result is far below 7.82. This means that the value is by chance and not significant.

[2]

[Total: 10]

Your
Mark

6(a)

6(b)

6(c)

6(d)

Q6 Mark scheme





(a)	key to 4 chosen symbols ; A any two lettered pairs (e.g. E/e and A/a) identified symbols for wing length <i>no eyes and black abdomen</i> must be lower case (e, a) <i>with eyes and striped abdomen</i> must be upper case (E, A) <i>allow ecf to max 3 if error in symbols</i> <i>parents genotypes</i> Eeaa × eeAa ; <i>gametes</i> Ea ea × eA ea ; A each gamete written twice <i>F2 genotypes</i> Eeaa eeaa EeAa eeAa ; [4]																														
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- (a) Using appropriate symbols, complete the genetic diagram below.

symbols

$EeAa$
 $Eeaa$
 $eeAa$
 $eeAa$

dominant $E A$
 recessive $e a$

parental
phenotypes

with eyes X no eyes
black abdomen striped abdomen

parental
genotypes

$Eeaa$ $eeAa$

gametes

Ea ea eA ea

offspring
genotypes

$EeAa$, $Eeaa$, $eeAa$, $eeaa$

offspring
phenotypes

with eyes no eyes with eyes no eyes
black abdomen black abdomen striped abdomen striped abdomen

[4]

Your
Mark

6(a)

6(b)

6(c)

6(d)

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Your
Mark

6(a)

6(b)

6(c)

6(d)

(b) State how you would carry out a test cross.

to dihybrid cross

[1]

(c) A cross was carried out between a fly heterozygous for striped abdomen and long wings and a fly with a black abdomen and short wings.

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black abdomen short wing	78
total	332

*EeAa → 4
eeAa → 4
Eeaa → 4*

	Ea	Ea	ea	ea
eA	EeAa	EeAa	eeAa	eeAa
ea	EeAa	EeAa	eeAa	eeAa
eA	EeAa	EeAa	eeAa	eeAa
ea	EeAa	EeAa	eeAa	eeAa

A chi-squared test (χ^2) was carried out on these data.

Complete Table 6.3 and calculate the value of χ^2 .

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Σ = sum of...

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(a)	key to 4 chosen symbols ; A any two lettered pairs (e.g. E/e and A/a) identified I symbols for wing length <i>no eyes and black abdomen</i> must be lower case (e, a) <i>with eyes and striped abdomen</i> must be upper case (E, A) <i>allow ecf to max 3 if error in symbols</i> <i>parents genotypes</i> Eeaa × eeAa ; <i>gametes</i> Ea ea × eA ea ; A each gamete written twice <i>F2 genotypes</i> Eeaa eeaa EeAa eeAa ; [4]																														
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(c)	<table><tr><th>observed number (O)</th><th>expected number (E)</th><th>O – E</th><th>(O – E)²</th><th>(O – E)² E</th></tr><tr><td>86</td><td>83</td><td>3</td><td>9</td><td>0.11</td></tr><tr><td>87</td><td>83</td><td>4</td><td>16</td><td>0.19</td></tr><tr><td>81</td><td>83</td><td>-2</td><td>4</td><td>0.05</td></tr><tr><td>78</td><td>83</td><td>-5</td><td>25</td><td>0.30</td></tr><tr><td>332</td><td>332</td><td colspan="3">∴ $\chi^2 = 0.65$;</td></tr></table> A fractions in last column A 3 s.f. in last column [3]	observed number (O)	expected number (E)	O – E	(O – E) ²	(O – E) ² E	86	83	3	9	0.11	87	83	4	16	0.19	81	83	-2	4	0.05	78	83	-5	25	0.30	332	332	∴ $\chi^2 = 0.65$;		
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(d)	no significant <u>deviation</u> from expected / <u>difference</u> not significant ; A (95% probability that) difference is due to chance A data is a good fit / match A null hypothesis (no significant difference between O and E) R comment on significance of results R 'the value' is not significant probability (of this deviation) is over 0.05 / χ^2 is less than 7.82 ; A χ^2 / results (of χ^2 test), less than value at probability 0.05 <i>ref. to <u>critical value</u> ; ecf reverse arguments if answer from 6(c) is over 7.82</i> <i>ref. to independent assortment / AW ;</i> [max 2] [Total: 10]																														

(d) Table 6.4 shows χ^2 values.

Table 6.4

degrees of freedom	probability						
	0.50	0.20	0.10	0.05	0.02	0.01	0.001
3	2.37	4.64	6.25	7.82	9.84	11.34	16.27

Using Table 6.4, explain what conclusions can be made about the results of the χ^2 test.

to see if observed and expected values are
significant or no
there is significance between observed and
expected value.

[2]

[Total: 10]

Your
Mark

6(a)

6(b)

6(c)

6(d)

Q6 Mark scheme

(a)	key to 4 chosen symbols ; A any two lettered pairs (e.g. E/e and A/a) identified I symbols for wing length <i>no eyes and black abdomen</i> must be lower case (e, a) <i>with eyes and striped abdomen</i> must be upper case (E, A) <i>allow ecf to max 3 if error in symbols</i> parents genotypes Eeaa × eeAa ; gametes Ea ea × eA ea ; A each gamete written twice F2 genotypes Eeaa eeaa EeAa eeAa ; <div>[4]</div>																														
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