Mark schemes

Q1.

(a) 1. Males have one allele;

Accept males only need one allele.

2. Females need two recessive alleles

OR

Females must be homozygous recessive

OR

Females could have dominant and recessive alleles

OR

Females could be heterozygous/carriers;

Ignore references to X and Y chromosomes.

Accept r as recessive allele and R as dominant allele.

*If no reference to allele, accept for **one mark** male needs one recessive gene whereas females need two recessive genes.*

2

(b) 1. Box 2.

All females red-eyed, all males white-eyed.

Reject if more than one box with tick. Ignore crossed-out ticks.

1

(c) 1. The (two) genes are linked

OR

Autosomal linkage;

Accept that the genes are on the same chromosome.

Accept 'Alleles are linked' (accept symbols for alleles) but reject if context suggests alleles of the 'same gene'.

2. No crossing over (occurs)

OR

(Linked) genes are close together;

Accept crossing over less likely to occur.

3. No GI and no gL (gametes produced)

OR

No GgII and no ggLl (offspring produced)

OR

Only GL and gl (gametes produced);
Ignore reference to independent assortment.

3

(d) 1. Correct answer of 8×10^{10} **= 3 marks**;;;

2. Correct answer **not** in standard form = **2 marks**

OR

1.6×10^{13} = **2 mark**

OR

1.6×10^{11} = **2 mark**

OR

6.4×10^{11} = **2 mark**

OR

Shows 8×10^{10} in the working **= 2 marks;;**

3. 1.28×10^{12} = **1mark**

OR

3.2×10^{11} = **1 mark**

OR

8×10^{11} = 1 **mark**

OR

8×10^{9} = 1 **mark**

OR

Shows 1.6×10^{11} in the working = **1 mark**

OR

Shows 200^{4} in the working = **1 mark**;
*If no other mark is credited accept for **one mark** working which shows multiplication by 200 for 4 generations. This could be shown in a variety of*

ways e.g. multiplied by 400 divided by 2 for 4 generations.

3

[9]

Q2.

(a) 1. Crossing over;

2. Independent segregation/assortment (of homologous chromosomes);

Accept independent assortment of alleles.

Accept meiosis as an alternative for 1 or 2 if neither of these marks is awarded.

3. Random fusion of gametes

OR

Random fertilisation;

Accept random mating.

2 max

(b) Codominance;

Accept incomplete dominance

1

(c) 1. ttC^RC^W **and** TtC^WC^W;

2. TtC^RC^W, TtC^WC^W, ttC^RC^W **and** ttC^WC^W ;

3. Tall pink, tall white, dwarf pink, dwarf white, **and** ratio 1 : 1 : 1 : 1;

Accept: any order of genotypes and phenotypes and ignore if on incorrect answer lines.

Accept: sequence of phenotypes does not need to mirror genotypes but must be correct.

Accept equivalent ratios e.g. 4:4:4:4.

Allow equivalent of mark points 2 and 3 for cross using homozygous tall parent i.e. TTC^WC^W.

*Allow **one mark** for correct dihybrid genotypes of offspring from incorrect parental genotypes.*

3

(d) 1. Correct answer of 42% = **2 marks**;;

Accept: 0.42 for 1 mark.

2. Incorrect answer but shows understanding that 2pq = pink/heterozygous/carriers = **1 mark**

OR

Answer = 0.42 = **1 mark OR**

Answer = 16.38 / 16.4 = **1 mark**;

Accept $1 – (p^2 + q^2)$ for 2pq or equivalent using numbers.

Accept: understanding of 2pq by using a calculation involving 2 × two different numbers.

2

[8]

Q3.

(a) GgX^RX^r ;

Accept alleles in any order.

Accept GgRr with alleles in any order.

1

(b) If it were recessive all flies of 3 and 4 would be grey
OR
3 and 4 produce 9/black (fly)
OR
Grey parents produce black (fly);

1

(c)

***Mark in pairs** 1 and 2 or 3 and 4.*

1. (Fly) 3 (and 4) produce 9/black (fly)
OR
(Fly) 9 would not be black
OR
(Fly) 9 would be grey
OR
Grey parents/male produce black female (fly);

2. (Fly) 3 would pass dominant <u>allele</u> to 9;
Accept <u>allele</u> for grey colour would be passed on by 3.

3. (Fly) 2 (and 1) produce 5/grey (fly)
OR
Black **female** produces grey **male**
OR
(Fly) 5 could not be grey
OR
(Fly) 5 would be black;

4.(Fly) 5 would receive recessive <u>allele</u> from 2;
Accept <u>allele</u> for black colour would be passed on by 2.

2 max

(d) 1. GgX^rX^r **and** ggX^RY;

Accept the following alternative notations for sex-linked crosses e.g. for mp 1

Ggrr and ggRY or

Ggrr and gg R- or

Ggrr and ggR
i.e. space for Y chromosome.

2. GgX^RX^r, ggX^RX^r, GgX^rY **and** ggX^rY;
Accept any order of genotypes and phenotypes.
Accept the following alternative notations for sex-linked crosses e.g. for mp 1
Ggrr and ggRY or
Ggrr and gg R- or
Ggrr and ggR
i.e. space for Y chromosome.

3. Grey-bodied red-eyed female, black-bodied

red-eyed female, grey-bodied white-eyed

male, black-bodied white-eyed male **and** ratio

1 : 1 : 1 : 1;
Accept any order of genotypes and phenotypes.
Accept sequence of phenotypes does not need to mirror genotypes but must be correct.
Accept alternative ratios in correct proportions e.g. 4:4:4:4

If 1, 2 and 3 incorrect **allow one mark** for correct gametes from incorrect dihybrid parental genotypes.

3

(e) 1. Correct answer of 48% = **2 marks**;;
Accept 0.48 for 1 mark.

2. Incorrect answer but shows understanding that

2pq = heterozygous/carriers = **1 mark**
OR
Incorrect answer but shows understanding that

$1 – (p^2 + q^2)$ = heterozygous/carriers = **1 mark**;
Accept understanding of 2pq by using a calculation involving 2 x two different numbers.

2

[9]

Q4.

(a) 1. Small sample size;

2. Fusion/fertilisation of gametes is random;

Ignore breeding is random

3. Linked Genes;

Accept crossing over / sex linkage

4. Epistasis;

5. Lethal genotypes;

2 max

(b) ttmm;

Accept mmtt or any order of these alleles e.g. mtmt, tmtm etc

1

(c) 1. Genes are linked;

Accept 'Alleles are linked' but reject if context suggests alleles of the 'same gene'

2. Produces few(er) tall, mottled and dwarf, normal offspring;

Accept produces few Tm and tM gametes

Accept 'fewer recombinants'

3. Crossing over (has occurred);

3

(d) One mark for each correct column;;

Phenotype of offspring	**Ratio of offspring**
Tall (plant and) normal (leaves)	9
Tall (plant and) mottled (leaves)	3
Dwarf (plant and) normal (leaves)	3
Dwarf (plant and) mottled (leaves)	1

Accept correct phenotypes in any order for one mark and correct ratio in any order e.g. 3:9:3:1 for one mark

However, phenotypes and ratio must match for two marks

Accept alternative wording e.g. short for dwarf

Accept $^{9}/_{16}$ $^{3}/_{16}$ $^{3}/_{16}$ $^{1}/_{16}$

2

[8]

Q5.

(a) 1. (Expression / appearance / characteristic due to) genetic constitution / genotype / allele(s);

2. (Expression / appearance / characteristic due to) environment;

1. Accept: named characteristic.

1. Accept: homozygous / heterozygous / genes / DNA.

1. Ignore: chromosomes.

2

(b) Epistasis
OR
Epistatic (interaction / control);

Accept: phonetic spellings.

Ignore: preceding word e.g. (recessive / dominant) epistasis.

1

(c) **AAbb** – white
aaBB – yellow;

Both correct for one mark.

1

(d) 1. AaBb, Aabb, aaBb, aabb;
2. White, (white), yellow, green;
3. 2 : 1 : 1;

Note: If genotypes are incorrect = zero marks.

1. Accept: equivalent genotypes e.g. ABab for AaBb.

Accept: sequence of phenotypes does not need to mirror genotypes but must be correct.

*3. Accept: ratios of 2:1:1 or 1:2:1 or 1:1:2 even if sequence of phenotypes do not match if mark points 1 **and** 2 have been awarded.*

3. Accept: alternative ratios in correct proportions e.g. 4:2:2

3. Ignore: percentages / fractions.

3

(e) 1. Correct answer of 32% = **2 marks**;
2. Incorrect answer but shows understanding that 2pq = heterozygous / carriers = 1 mark;

Accept: understanding of 2pq by using a calculation involving 2 × two different numbers.

2

[9]

Q6.

(a) 1. Bb / suitable equivalent;

Reject sex linkage or superscripts

2. Both parents have bar eyes, but have some offspring with round eyes, so parents must be carriers of recessive allele for round eyes;

2

(b) 3:1;

1

(c) Fertilisation is random
OR
Fusion of gametes is random;

2. Small / not large population / sample;

3. Selection advantage / disadvantage / lethal alleles;

2 max

(d) χ^2 / chi squared;

1

(e) Both alleles expressed in the phenotype (if both are present);

1

(f) 0.25;

1

(g) 304;

Award 1 mark for answers which show understanding that 2pq represents heterozygous

2

[10]

Q7.

(a) (Genes / loci) on same chromosome.

1

(b) 1. GN and gn linked;
2. GgNn individual produces mainly GN and gn gametes;
3. Crossing over produces some / few Gn and gN gametes;
4. So few(er) Ggnn and ggNn individuals.

4

(c) (Grey long:grey short:black long:black short) =1:1:1:1

1

(d) 1. Chi squared test;
2. Categorical data.

2

[8]

Q8.

(a) 1. Reduction in ATP production by aerobic respiration;
2. Less force generated because fewer actin and myosin interactions in muscle;
3. Fatigue caused by lactate from anaerobic respiration.

3

(b) Couple **A**,
1. Mutation in mitochondrial DNA / DNA of mitochondrion

affected;
2. All children got affected mitochondria from mother;
3. (Probably mutation) during formation of mother's ovary / eggs;

Couple **B**,
4. Mutation in nuclear gene / DNA in nucleus affected;
5. Parents heterozygous;
6. Expect 1 in 4 homozygous affected.

4 max

(c) 1. Change to tRNA leads to wrong amino acid being incorporated into protein;
2. Tertiary structure (of protein) changed;

3. Protein required for oxidative phosphorylation / the Krebs cycle, so less / no ATP made.

3