M1.(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^GX^B, X^BX^B, X^GY, X^BY;

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 <u>with</u> 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^GX^B and X^BY ***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

[8]

M2.(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

[10]

M3.(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^FX^f **and** X^fY **or** X^fX^F **and** X^fY

or X^FX^f **and** X^fY^- or X^fX^F **and** X^fY^- /

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

1. p^2 / q^2 = 4% / 0.04 / or p / q = 0.2;

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

[9]

M4.(a) 1. Allows (valid) comparison;

2. Number / sample size may vary;

2

(b) 1. Increased chance of (severe malaria) with blood group A / decreased chance of (severe malaria) with sickle cell;
   Accept: converse for mild malaria i.e. increased chance of mild malaria with sickle cell / decreased chance of mild malaria with blood group A.
   Accept: if answer is comparative e.g. greatest risk of severe malaria with blood group A.

2. One mark for one of the following:

   almost equal chance with blood group O / slightly greater chance of mild malaria with O / slightly lower chance of severe malaria with O / 2.5 x / 2.48 x / more than twice the chance of severe with blood group A / (almost) 50% / half the chance of severe malaria with sickle cell / twice the chance of mild malaria with sickle cell;
   Neutral: answers which only refer to or use ratios.

2

(c) 1. Individuals with the **Hb**^{C} (allele) reproduce;

2. Pass on **Hb**^{C} (allele) which increases in frequency;

3. **Hb**^{A} **Hb**^{A} individuals less likely to survive / reproduce / frequency of **Hb**^{A} (allele) decreases;

3

[7]

M5.1. 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

2. Find square root of q^2 / find square root of 0.0025;

3. Use of $p + q = 1.0$ / determine frequency of both alleles / both p and q / find $p = 0.95$ and $q = 0.05$;

4. Use of $2pq$ to find carriers / heterozygotes;

The question requires a description but credit working where correct as alternative since this shows the stages

[3]