EXAM PAPERS PRACTICE

Populations

These practice questions can be used by students and teachers and is

Suitable for AQA A Level 7402 Biology Topic Question

Level: AQA A LEVEL 7402

Subject: Biology

Exam Board: AQA A Level 7402

Topic: Populations

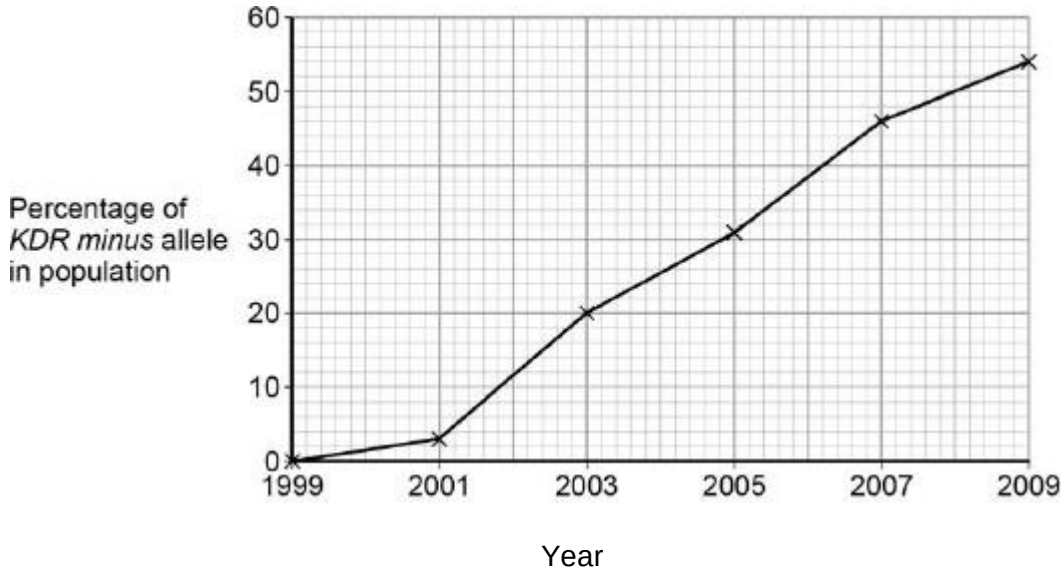
1

used to kill mosquitoes, to try to control the spread of malaria.

Mosquitoes have a gene called *KDR*. Today, some mosquitoes have an allele of this gene, *KDR minus*, that gives them resistance to DDT. The other allele, *KDR plus*, does not give resistance.

Scientists investigated the frequency of the *KDR minus* allele in a population of mosquitoes in an African country over a period of 10 years.

The figure below shows the scientists' results.



(a) Use the Hardy–Weinberg equation to calculate the frequency of mosquitoes heterozygousfor the *KDR* gene in this population in 2003.

Show your working.

Frequency of heterozygotes in population in 2003 _____

(2)

(b) Suggest an explanation for the results in the figure above.

_____

(Extra space) _____

(4)

The *KDR plus* allele codes for the sodium ion channels found in neurones.

(c) When DDT binds to a sodium ion channel, the channel remains open all the time.Use this information to suggest how DDT kills insects.

(2)

(d) Suggest how the *KDR minus* allele gives resistance to DDT.

_____

(2)

(Total 10 marks)

2 (a) Explain what is meant by the term phenotype.

_____

_____

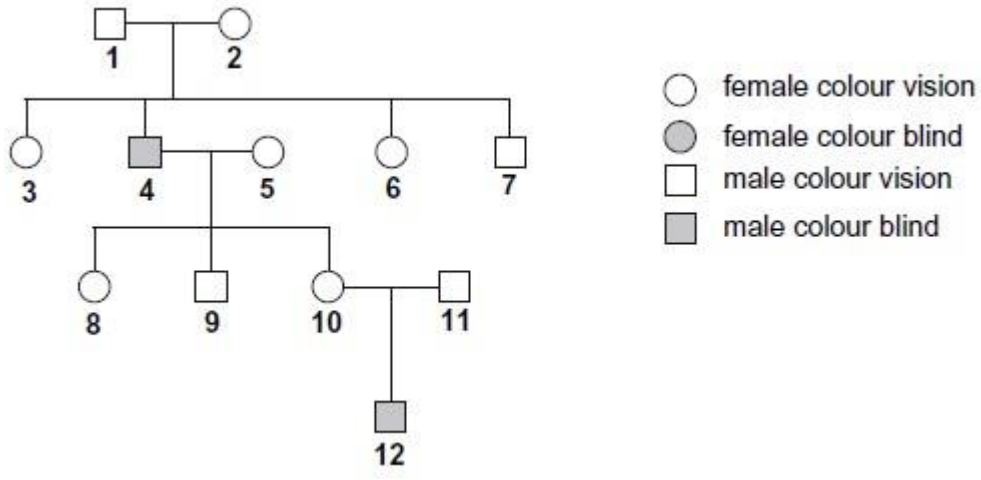
_____

_____

(2)

(b) One type of colour blindness is controlled by a gene carried on the X chromosome. Theallele for this type of colour blindness, **b**, is recessive to the allele for colour vision, **B**.

The diagram shows the phenotypes in a family tree for this sex-linked condition.



(i) Explain **one** piece of evidence from the diagram which shows that colour blindness is recessive.

_____

_____

_____

_____

(2)

(ii) Give the genotype of individual **8**.

_____

(1)

(c) (i) The allele for tongue-rolling, **T**, is dominant to the allele for non-tongue rolling, **t**.

The gene controlling tongue-rolling is **not** sex-linked. Individuals **10** and **11** are both heterozygous for tongue-rolling.

What is the probability that individuals **10** and **11** will produce a male child who is colour blind and a non-tongue roller?

Answer = _____

(2)

(ii) In a population, the frequency of the allele for tongue-rolling, **T**, is 0.4.

Use the Hardy-Weinberg equation to calculate the percentage of people in this population that are heterozygous for tongue-rolling.

Answer = _____ %

(2)

(Total 9 marks)

3 In cats, males are XY and females are XX. A gene on the X chromosome controls fur colour in

cats. The allele **G** codes for ginger fur and the allele **B** codes for black fur. These alleles are codominant. Heterozygous females have ginger and black patches of fur and their phenotype is described as tortoiseshell.

(a) Explain what is meant by **codominant** alleles.

_____

_____

_____

(1)

(b) Male cats with a tortoiseshell phenotype do **not** usually occur. Explain why.

_____

_____

_____

(1)

(c) A tortoiseshell female was crossed with a black male. Use a genetic diagram to show allthe possible genotypes and the ratio of phenotypes expected in the offspring of this cross.

Use $\mathbf{X^G}$ to indicate the allele **G** on an X chromosome.

Use $\mathbf{X^B}$ to indicate the allele **B** on an X chromosome.

Genotypes of offspring _____

Phenotypes of offspring _____

Ratio of phenotypes _____

(3)

(d) Polydactyly in cats is an inherited condition in which cats have extra toes. The allele forpolydactyly is dominant.

(i) In a population, 19% of cats had extra toes. Use the Hardy-Weinberg equation tocalculate the frequency of the recessive allele for this gene in this population. Show your working.

Answer = _____

(2)

(ii) Some cat breeders select for polydactyly. Describe how this would affect thefrequencies of the homozygous genotypes for this gene in their breeding populations over time.

_____

_____

_____

_____

(1)

(Total 8 marks)

4 In birds, **males are XX** and **females are XY**.

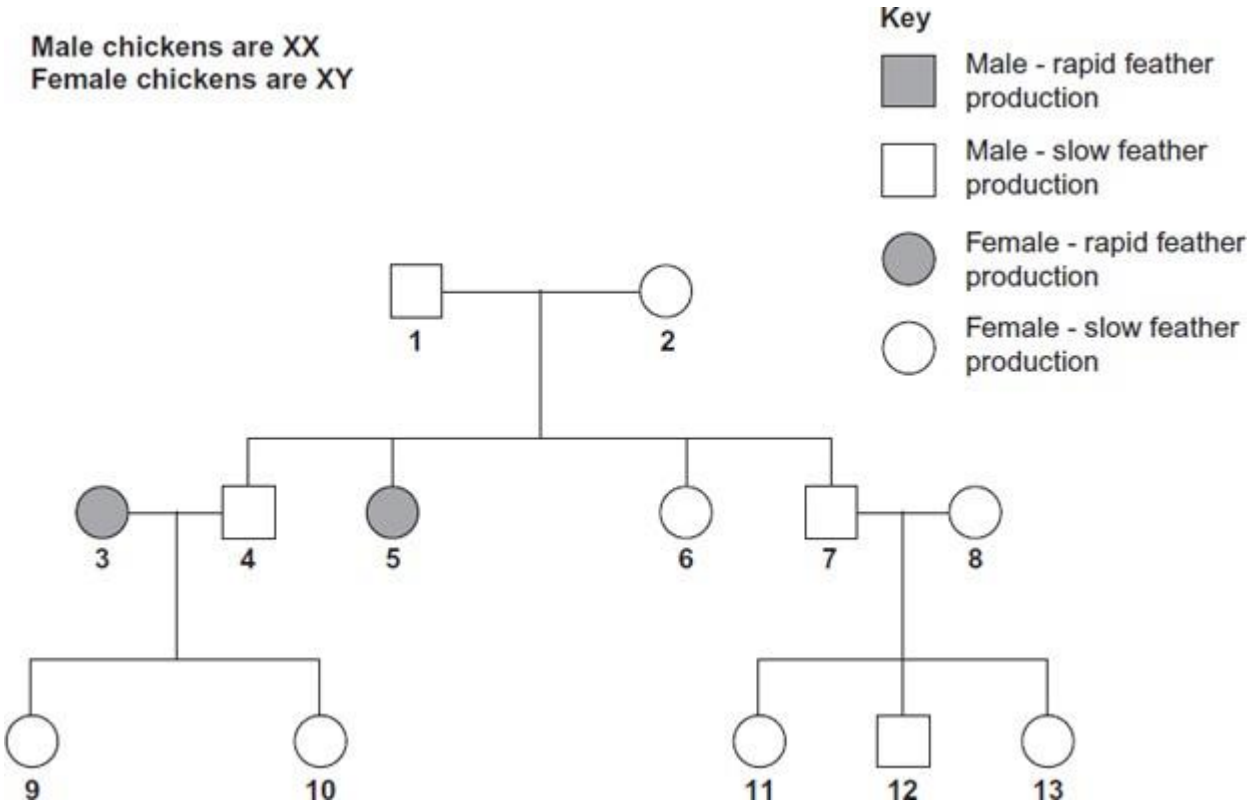
(a) Use this information to explain why recessive, sex-linked characteristics are more commonin female birds than in male birds.

_____

_____

(1)

(b) In chickens, a gene on the X chromosome controls the rate of feather production.The allele for slow feather production, **F**, is dominant to the allele for rapid feather production, **f**. The following figure shows the results produced from crosses carried out by a farmer.



(i) Explain **one** piece of evidence from the figure which shows that the allele for rapid feather production is recessive.

_____

_____

_____

_____

(2)

(ii) Give all the possible genotypes of the following chickens from the figure.

Chicken 5 _____

Chicken 7 _____

(2)

(iii) A cross between two chickens produced four offspring. Two of these were males withrapid feather production and two were females with slow feather production. Give the genotypes of the parents.

_____

(1)

(c) Feather colour in one species of chicken is controlled by a pair of codominant alleles which are **not** sex-linked. The allele $\mathbf{C^B}$ codes for black feathers and the allele $\mathbf{C^W}$ codes for white feathers. Heterozygous chickens are blue-feathered.

On a farm, 4% of the chickens were black-feathered. Use the Hardy-Weinberg equation to calculate the percentage of this population that you would expect to be blue-feathered. Show your working.

Answer _____ %

(3)

(Total 9 marks)

5 Malaria is a disease that destroys red blood cells. Scientists investigated whether certain red blood cell phenotypes were associated with developing severe or mild malaria. They compared the red blood cell phenotypes of hospital patients suffering from severe malaria with the red blood cell phenotypes of patients suffering from mild malaria. The results are shown in the table.

Red blood cell phenotype	Ratio of patients with severe malaria : patients with mild malaria
Sickle cell trait	0.48 : 1
Blood group A	2.45 : 1
Blood group O	0.96 : 1

(a) Explain the advantage of presenting the results as a ratio.

(2)

(b) What do these data show about the effect of red blood cell phenotypes on the chance ofdeveloping severe malaria rather than mild malaria?

(Extra space)

(2)

(c) The allele for normal haemoglobin in red blood cells is **Hb^A**. In some parts of Africa where malaria occurs there is a high frequency in the population of the allele **Hb^C**.
Individuals possessing the **Hb^C** allele have a lower chance of developing severe malaria.
Severe malaria causes a large number of deaths in Africa.

Explain the high frequency of the **Hb^C** allele in areas where malaria occurs.

(Extra space) _____

_____

_____

(3)

(Total 7 marks)

6 The Hardy-Weinberg equation is

$$p^2 + 2pq + q^2 = 1$$

The Hardy-Weinberg equation can be used to estimate the frequency of a recessive allele in a population. Haemochromatosis is a condition caused by a recessive allele.
In one country, 1 in every 400 people was found to have haemochromatosis.

Describe how you would use the Hardy-Weinberg equation to calculate the frequency of people who are healthy but carriers (heterozygotes) of the allele for haemochromatosis.

_____

_____

_____

_____

_____

_____

(Extra space)_____

_____

_____

(Total 3 marks)

7 In a species of snail, shell colour is controlled by a gene with three alleles. The shell may be brown, pink or yellow. The allele for brown, $\mathbf{C^B}$, is dominant to the other two alleles. The allele for pink, $\mathbf{C^P}$, is dominant to the allele for yellow, $\mathbf{C^Y}$.

(a) Explain what is meant by a *dominant* allele.

_____

_____

_____

(1)

(b) Give **all** the genotypes which would result in a brown-shelled snail.

_____

(1)

(c) A cross between two pink-shelled snails produced only pink-shelled and yellow-shelledsnails. Use a genetic diagram to explain why.

(3)

(d) The shells of this snail may be unbanded or banded. The absence or presence of bands iscontrolled by a single gene with two alleles. The allele for unbanded, **B**, is dominant to the allele for banded, **b**.

A population of snails contained 51% unbanded snails. Use the Hardy-Weinberg equation to calculate the percentage of this population that you would expect to be heterozygous for this gene. Show your working.

Answer _____ %

(3)

(Total 8 marks)

EXAM PAPERS PRACTICE

8 Sea otters were close to extinction at the start of the 20th century. Following a ban on hunting sea otters, the sizes of their populations began to increase. Scientists studied the frequencies of two alleles of a gene in one population of sea otters. The dominant allele, **T**, codes for an enzyme. The other allele, **t**, is recessive and does not produce a functional enzyme.

In a population of sea otters, the allele frequency for the recessive allele, **t**, was found to be 0.2.

(a) (i) Use the Hardy-Weinberg equation to calculate the percentage of homozygousrecessive sea otters in this population. Show your working.

Answer _____ %

(2)

(ii) What does the Hardy-Weinberg principle predict about the frequency of the **t** allele after another 10 generations?

_____

_____

(1)

(b) Several years later, scientists repeated their study on this population. They found that thefrequency of the recessive allele had decreased.

(i) A statistical test showed that the difference between the two frequencies of the **t** allele was significant at the P = 0.05 level.

Use the terms **probability** and **chance** to help explain what this means.

_____

_____

_____

_____

_____

(2)

(ii) What type of natural selection appears to have occurred in this population of seaotters? Explain how this type of selection led to a decrease in the frequency of the recessive allele.

Type of selection _____

Explanation _____

_____

_____

_____

(2)

(Total 7 marks)

9

(a) (i) Explain what is meant by a **recessive** allele.

_____

_____

_____

(1)

(ii) Explain what is meant by **codominant** alleles.

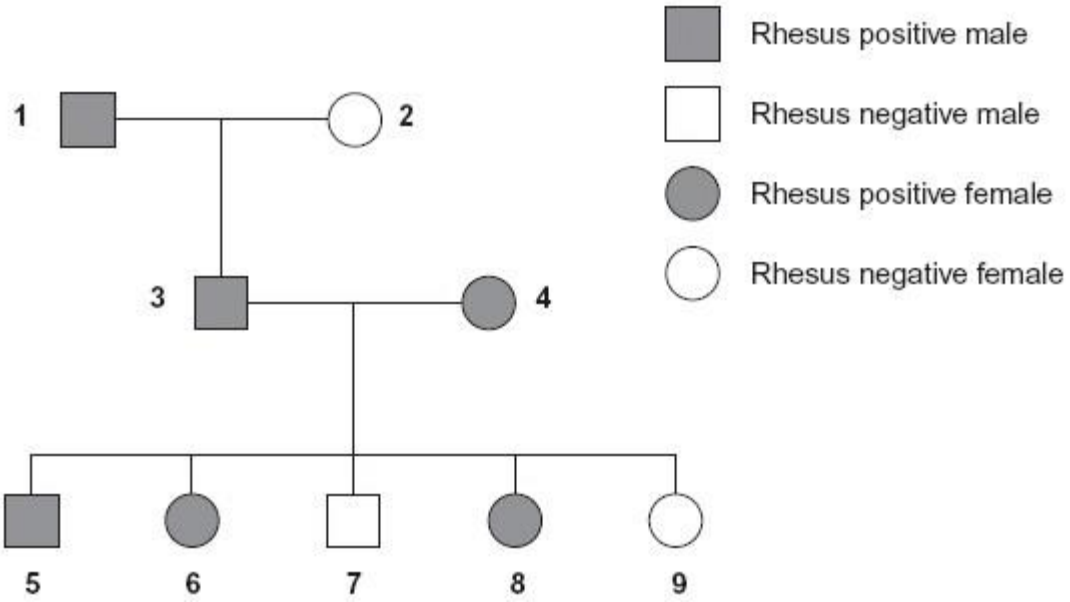
_____

_____

_____

(1)

(b) The Rhesus blood group is genetically controlled. The gene for the Rhesus blood grouphas two alleles. The allele for Rhesus positive, **R**, is dominant to that for Rhesus negative, **r**. The diagram shows the inheritance of the Rhesus blood group in one family.



(i) Explain **one** piece of evidence from the diagram which shows that the allele for Rhesus positive is dominant.

_____

_____

_____

_____

_____

(2)

(ii) Explain **one** piece of evidence from the diagram which shows that the gene is **not** on the X chromosome.

_____

_____

_____

_____

_____

(2)

(c) Sixteen percent of the population of Europe is Rhesus negative. Use the Hardy-Weinbergequation to calculate the percentage of this population that you would expect to be heterozygous for the Rhesus gene.

Show your working.

Answer _____

(3)

(Total 9 marks)

10 (a) What does the Hardy–Weinberg principle predict?

_____

_____

_____

_____

_____

_____

(3)

The table shows the frequencies of some alleles in the population of cats in three cities.

City	Frequency of allele

	White	Non-agouti	Blotched	Long-haired
Athens	0.001	0.72	0.25	0.50
Paris	0.011	0.71	0.78	0.24
London	0.004	0.76	0.81	0.33

(b) White cats are deaf. Would the Hardy–Weinberg principle hold true for white cats? Explainyour answer.

_____

_____

_____

_____

_____

(2)

(c) What is the evidence from the table that non-agouti and blotched are alleles of differentgenes?

_____

_____

(1)

(d) Hair length in cats is determined by a single gene with two alleles. The allele for long hair(h) is recessive. The allele for short hair (H) is dominant.

Use the information in the table and the Hardy–Weinberg equation to estimate the percentage of cats in London that are heterozygous for hair length. Show your working.

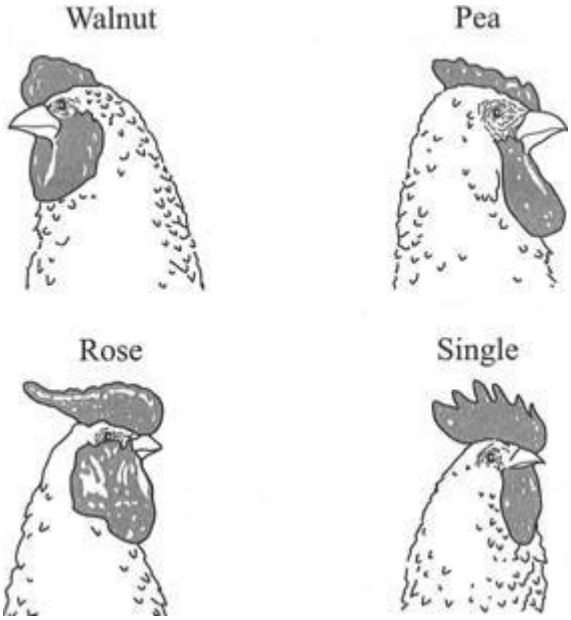
Answer _____

(2)

(Total 8 marks)

11 Chickens have a structure on their heads called a comb. The diagram shows four types of comb:

walnut, pea, rose and single.



Two genes control the type of comb; each gene has a dominant and a recessive allele. The two genes are inherited independently, but interact to produce the four types of comb.

Genotype	Phenotype
A- B-	Walnut
A- bb	Pea
aa B-	Rose
aa bb	Single

The symbol **-** indicates that either the dominant allele or recessive allele could be present

(a) A male with a pea comb, heterozygous for gene A, was crossed with a rose-combedfemale, heterozygous for gene B. Complete the genetic diagram to show the offspring expected from this cross.

Phenotypes of parents Pea comb Rose comb

Genotypes of parents _____ _____

Gametes formed _____ _____

Offspring genotypes _____

Ratio of offspring phenotypes _____

_____

(3)

(b) Chickens with rose or single combs made up 36% of one population. Assuming theconditions of the Hardy-Weinberg equilibrium apply, calculate the frequency of allele **a** in this population. Show how you arrived at your answer.

Frequency of allele **a** = _____

(2)

(Total 5 marks)

12 (a) Some antibiotics bind with specific receptors in the plasma membranes of bacteria. The structure of these receptors is determined genetically. Bacteria can become resistant to an antibiotic because a gene mutation results in an altered receptor.

Explain how resistance to an antibiotic could become widespread in a bacterial population following a gene mutation conferring resistance in just one bacterium.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(5)

(b) Some humans have a genetic resistance to infection. A recessive allele gives increased resistance to infection by the malarial parasite. In a population, the proportion of babies born who are homozygous for this allele is 0.01. Use the Hardy-Weinberg equation to calculate the expected proportion of heterozygotes in this population. Show your working.

Answer _____

(4)

(Total 9 marks)

13 (a) Explain the meaning of these ecological terms.

Population _____

_____

Community _____

_____

(2)

(b) Some students used the mark-release-recapture technique to estimate the size of apopulation of woodlice. They collected 77 woodlice and marked them before releasing them back into the same area. Later they collected 96 woodlice, 11 of which were marked.

(i) Give **two** conditions necessary for results from mark-release-recapture investigations to be valid.

1. _____

_____

2. _____

_____

(2)

(ii) Calculate the number of woodlice in the area under investigation. Show your working.

Answer _____

(2)

(c) Explain how you would use a quadrat to estimate the number of dandelion plants in a fieldmeasuring 100 m by 150 m.

_____

_____

_____

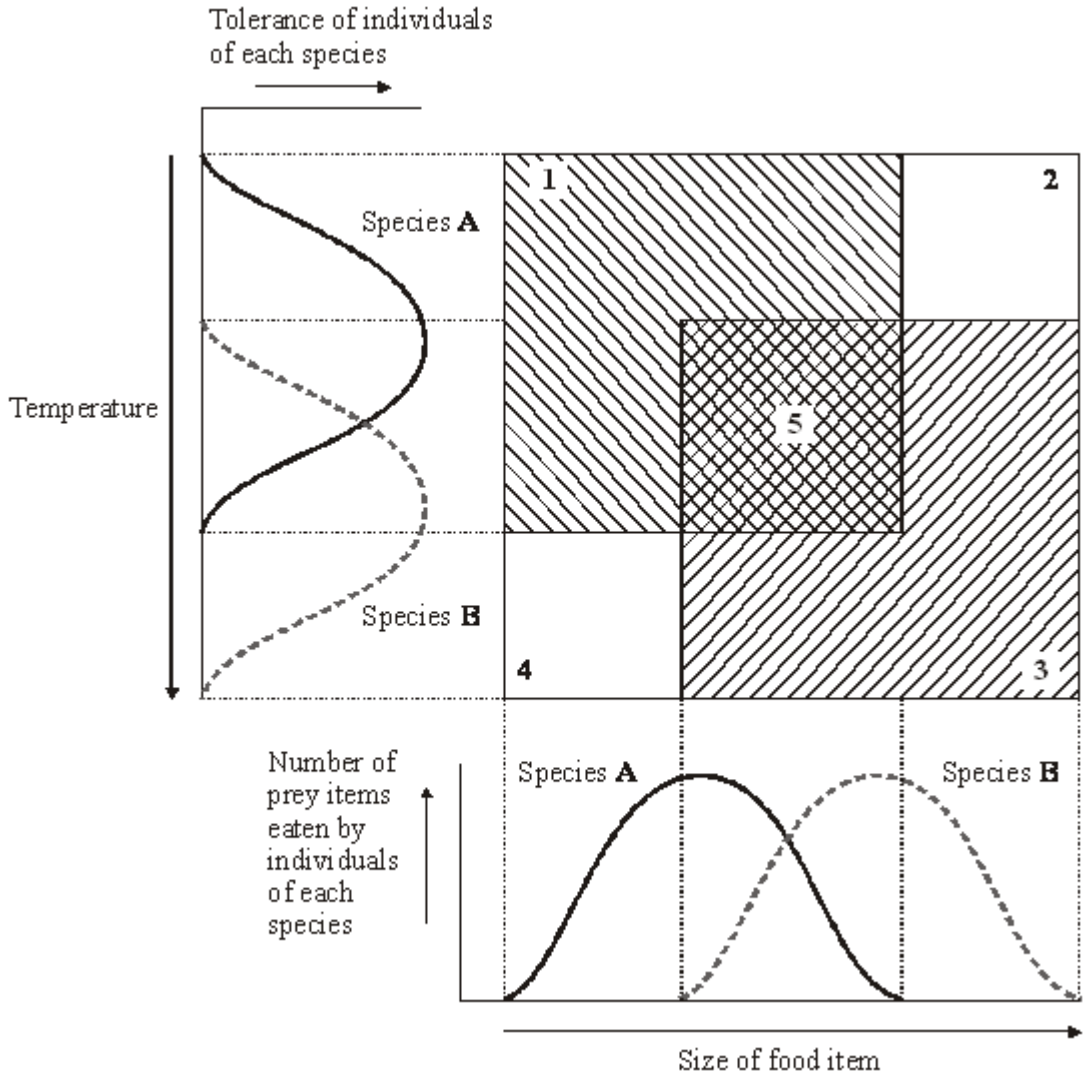
_____

_____

_____

(3)

(d) Two similar species of birds (species **A** and species **B**) feed on slightly different sized insects and have slightly different temperature preferences. The diagram represents the response of each species to these factors.



(i) Which of the numbered boxes describes conditions which represent

the niche of species **A**; _____ the

niche of species **B**; _____

insects too small for species **B** and temperature too warm for species **A**; _____

insects too large for species **A** and temperature too cool for species **B**? _____

(2)

(ii) These two species are thought to have evolved as a result of sympatric speciation.Suggest how this might have occurred.

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 15 marks)

14 Warfarin is a substance which inhibits blood clotting. Rats which eat warfarin are killed due to internal bleeding. Some rats are resistant to warfarin as they have the allele $\mathbf{W^R}$.

Rats have three possible genotypes:

$\mathbf{W^RW^R}$ resistant to warfarin

$\mathbf{W^RW^S}$ resistant to warfarin

$\mathbf{W^SW^S}$ susceptible (not resistant) to warfarin.

In addition, rats with the genotype $\mathbf{W^RW^R}$ require very large amounts of vitamin K in their diets. If they do not receive this they will die within a few days due to internal bleeding.

(a) How can resistance suddenly appear in an isolated population of rats which has neverbefore been exposed to warfarin?

_____

_____

(1)

(b) A population of 240 rats was reared in a laboratory. They were all fed on a diet containingan adequate amount of vitamin K. In this population, 8 rats had the genotype $\mathbf{W^SW^S}$, 176 had the genotype $\mathbf{W^RW^S}$ and 56 had the genotype $\mathbf{W^RW^R}$.

(i) Use these figures to calculate the actual frequency of the allele $\mathbf{W^R}$ in this population. Show your working.

Answer _____

(2)

(ii) The diet of the rats was then changed to include only a small amount of vitamin K.The rats were also given warfarin. How many rats out of the population of 240 would be likely to die within a few days?

_____

(1)

(c) In a population of wild rats, 51% were resistant to warfarin.

(i) Use the Hardy-Weinberg equation to estimate the percentage of rats in thispopulation which would be heterozygous for warfarin resistance. Show your working.

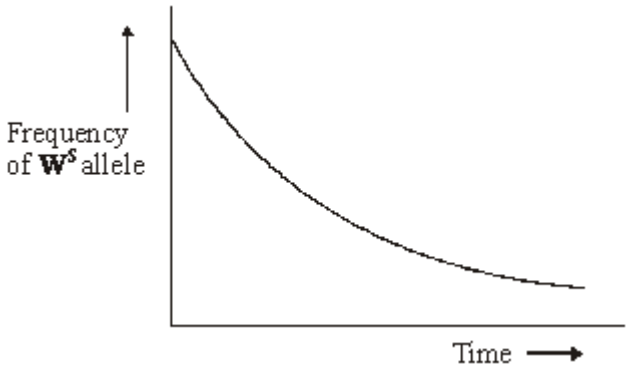
Answer _____ %

(3)

(ii) If all the susceptible rats in this population were killed by warfarin, more susceptiblerats would appear in the next generation. Use a genetic diagram to explain how.

(2)

(iii) The graph shows the change in the frequency of the $\mathbf{W^S}$ allele in an area in which warfarin was regularly used. Describe and explain the shape of the curve.



(4)

(iv) Give **two** assumptions that must be made when using the Hardy-Weinberg equation.

1. _____

_____

2. _____

_____

(2)

(Total 15 marks)

15 The inheritance of body colour in fruit flies was investigated. Two fruit flies with grey bodies were crossed. Of the offspring, 152 had grey bodies and 48 had black bodies.

(a) Using suitable symbols, give the genotypes of the parents. Explain your answer.

Genotypes _____

Explanation _____

_____

_____

_____

(2)

(b) Explain why a statistical test should be applied to the data obtained in this investigation.

_____

_____

_____

_____

(2)

(c) A species of insect, only found on a remote island, has a characteristic controlled by a pairof codominant alleles, $\mathbf{C^M}$ and $\mathbf{C^N}$.

(i) What is meant by *codominant*?

_____

_____

(1)

(ii) There were 500 insects in the total population. In this population, 300 insects had thegenotype **C^M C^M**, 150 had the genotype **C^M CN** and 50 had the genotype **C^N C^N**.

Calculate the actual frequency of the allele **C^N** by using these figures. Show your working.

Answer _____

(2)

(iii) Use your answer to (ii) and the Hardy-Weinberg equation to calculate the number ofinsects that would be **expected** to have the genotype **C^N C^N**.

Answer _____

(3)

(Total 10 marks)

Mark schemes

1 (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]

2

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

Accept: named characteristic.

Accept: homozygous/ heterozygous/genes/DNA.

Ignore: chromosomes.

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

2

(b) (i) 1. (Individual) 2 has colour vision but 4 is colour blind / 10 has colour vision but 12 is colour blind
OR
4/12 is colour blind but parents have colour vision;

2. So 2/10 must be heterozygous/carriers;

*Accept: (1), 2 and 4 **or** 10, (11) and 12.*

Accept: any suitable description and explanation equivalent to points 1 and 2.

Reject: (both) parents heterozygous/carriers.

Accept: correct genotypes for 2 and 10.

Accept: for 2 marks, if it was dominant the daughters (8 and 10) of individual 4 would be colour blind.

2

(ii) X^BX^b **or** X^bX^B;

Reject: Bb / bB

Accept: XBXb or XbXB;

Accept: use of other letter than B

e.g. X^RX^r, X^HX^h.

1

(c) (i) 2 marks for the correct answer of 0.0625 / 6.25% / $\frac{1}{16}$;;

1 mark for incorrect answer but shows 0.03125 / 3.125% / $\frac{1}{32}$;

Accept: 0.063 / 0.06 / 6.3% / 6% for 2 marks.

Accept: incorrect answer but shows / 0.0313 / 0.031 / 0.03 / 3.13% / 3.1% / 3% / ¼ × ¼ / 0.25 × 0.25 for 1 mark.

Note: if probability is calculated as a percentage but no % shown in the answer then deduct one mark. For example 6.25 = one mark, 3.125 = zero.

2

(ii) 2 marks for the correct answer of 48(%);;
1 mark for an incorrect answer but shows understanding that 2pq = heterozygous or attempts to calculate 2pq;

1 mark maximum for the answer of 0.48.

2

[9]

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 beheterozygous.

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] (a) (Recessive) allele is always expressed in females / females have one

4

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

5

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]

6 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] (a) Is always expressed / shown (in the phenotype);

7

Reject 'is always present' without further qualification

1

(b) C^BC^B, C^BC^P and C^BC^Y;

All three are required for the mark

Or

C^BC^B, C^PC^B and C^YC^B;

Accept C^BC^B, C^BC^P, C^BC^Y,

C^YC^B and C^PC^B

Accept BB, BP and BY or

BB, BP, BY, YB and PB

1

(c) 1. Two genotypes (as parents) shown as C^P C^Y

*Award **one mark maximum** for candidates who have misread the question and complete a correct genetic cross between a pink snail,*
C^PC^Y and a yellow snail, C^YC^Y to give pink and yellow offspring

Or

Two sets of gametes shown as C^P and C^Y;

2. Genotypes of offspring shown as C^P C^Y, C^P C^P and C^Y C^Y;

3. Above genotypes of offspring correctly linked to phenotypes i.e. pink andyellow;

Accept ratio (or equivalent) of 3 pink: 1 yellow for mark point 3

3

(d) 1. Correct answer of 42% = 3 marks

Answer of 0.42 = 2 marks

*Award **one mark maximum** for answer of*

49.9 / 49.98 / 50% or 0.49 / 0.5

2. q^2 = 0.49 / 49% ***OR*** q = 0.7 / 70%

*Award **one mark maximum** for answer of 40.8 / 41% or 0.41*

3. Shows understanding that 2pq = heterozygotes / carriers / shows answer isderived from 2pq;

Accept: b^2 = 0.49 / 49% or b = 0.7 / 70% for mark point 2

3

[8] (a) (i) Two marks for correct answer of 4;;

8

One mark for calculation involving 0.2 × 0.2 or 0.04;

2

(ii) 0.2 / the frequency remains the same;

Reject if wrong frequency is quoted

1

(b) (i) 1. There is a probability of 5% / 0.05;

2. That difference in frequencies / difference in results are due to chance;

Accept 95% probability changes in frequencies not different as a result of chance

2

(ii) 1. Directional;

2. The recessive allele confers disadvantage / the dominant allele confers advantage / more likely to survive / reproduce;

Assume "it" to refer to the recessive allele

2. References to selection do not gain credit as the term is in the question. Allow reference to phenotype / enzyme functionality (instead of allele) when describing advantage / disadvantage.

2

[7

9 **]** (a) (i) Only expressed / shown (in the phenotype) when homozygous / two (alleles) are present / when no dominant allele / is not expressed when heterozygous;

1

(ii) Both alleles are expressed / shown (in the phenotype);

Allow both alleles contribute (to the phenotype).

1

(b) (i) Evidence (not a mark)

3 and 4 / two Rhesus positives produce Rhesus negative child / children / 7 / 9;

Explanation (not a mark)

Both Rhesus positives / 3 and 4 carry recessive (allele) / are heterozygous / if Rhesus positive was recessive, all children (of 3 and 4) would be Rhesus positive / recessive;

Do not negate mark if candidate refers to gene rather than allele.

Answers including correct and incorrect evidence = zero marks evidence and explanation.

2

(ii) Evidence (not a mark)

3 would not be / is Rhesus positive / would be Rhesus negative;

Explanation (not a mark)

3 would receive Rhesus negative (allele) on X (chromosome) from mother / 3 could not receive Rhesus positive (allele) from mother / 3 would not receive

Rhesus positive (allele) / X (chromosome) from father / 1 / 3 will receive Y (chromosome) from father / 1;

OR

Evidence (not a mark)

9 would be Rhesus positive / would not be / is Rhesus negative / 8 and 9 / all daughters of 3 and 4 would be Rhesus positive;

Explanation (not a mark)

As 9 would receive X chromosome / dominant allele from father / 3;

Do not negate mark if candidate refers to gene rather than allele.

One mark for evidence and one mark for explanation linked to this evidence.

Any reference to allele being on Y chromosome negates mark for explanation.

2

(c) Correct answer of 48(%) = 3 marks;;;

q^2 / p^2= 16% / 0.16 / p / q = 0.4;

Shows that 2pq = heterozygotes / carriers;

Final answer of 0.48 = 2 marks

Allow mark for identifying heterozygotes if candidate multiplies incorrect p and q values by 2.

3

[9]

10

(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]

11 (a) Parents genotypes Aabb aaBb ;

Gametes formed Ab ab aB ab ;

if parental genotypes wrong allow correctly derived gametes only

Offspring genotypes AaBb Aabb aaBb aabb

and

Offspring phenotypes 1 Walnut ; 1 Pea : 1 Rose : 1 single ;

*Just **one** mark for offspring genotypes **and** phenotypes*
If parents not diploid, no marks gained

3

(b) Correct answer 0.6, however derived, scores 2 marks
Wrong answer, but evidence of correct working
(e.g. $p^2 / q^2 = 0.36$) scores 1 mark

2

[5] (a) 1. frequent use of antibiotic creates selection pressure / antibiotic kills bacteria;

12

2. bacteria with mutation / resistance have (selective) advantage over others / described;
3. (survive to) reproduce more than other types pass on advantageous allele / mutated allele in greater numbers;
4. frequency of (advantageous) allele increases in subsequent generations;

(penalise use of "gene" instead of allele once only)

5. frequency of resistant types increases in subsequent generations;

5

(b) correct answer = 0.18; And
three marks for three of: p + q
= 1 and $p^2 + 2pq + q^2 = 1$;
$0.01 = q^2$; q = 0.1; p = 0.9 frequency of heterozygotes = 2pq = 2 × 0.1 × 0.9 / 2 × candidates p × candidates q;

4 max

[9] (a) Population – organisms of one species in an ecosystem / habitat / area;

13

Community – organisms of all species / all populations in an ecosystem / habitat / area;

2

(b) (i) No immigration / migration (Ignore references to emigration);
No reproduction *(Ignore references to death)*;
Idea of mixing;
Marking does not influence behaviour / increase vulnerability to predation;
Sample / population large enough;

max 2

(ii) $\frac{96 \times 77}{11}$; 672;
Correct answer (however derived) scores 2 marks
Incorrect answer with evidence of correct method scores 1 mark.

2

(c) Principle of randomly placed quadrats and method of producing randomquadrats; **3**
(Reject 'throwing')
Valid method of obtaining no. dandelions in given area (mean per quadrat / total no. in many quadrats);
Multiply to give estimate for total field area;

(d) (i) Niche of A – 1; **2**
Niche of B – 3;
Too small for B / too hot for A – 4;
Too large for A / too cold for B – 2;
All four correct = 2 marks; any 2 correct = 1 mark

(ii) Original population living in one area / 2 species evolved in the area;
Idea of genetic variability; **max 4**
Concept of reproductive isolation;
Possible mechanism;
Gene pools become increasingly different;
Until interbreeding does not produce fertile offspring;

[15]

14 (a) Mutation / (spontaneous) change in a gene / change in DNA; **1**

(b) (i) Correct answer: 0 / 6;; 2 marks
OR

Use of 56 $\frac{176}{2}$
and

or 88 / 56 × 2 or 112 and 176; 1 mark **max 2**

(ii) 64; **1**

(c) (i) Correct answer = 42%;;; (only if $q^2 = 0.49$) 3 marks
OR 0.42;; 2 marks
OR
$p + q = 1$ / $p^2 + 2pq + q^2 = 1$ / $p = 1 – 0.7$ / $q^2 = 0.49$ / $q = 0.7$;

Answer = 2pq / use of appropriate numbers; 2 marks
max 3

(ii) 1. Parental genotypes correct: both $\mathbf{W^RW^S}$
(ACCEPT 'RS')

AND

W^S (*ACCEPT 'S'*) / gamete from each parent;

2. $\mathbf{W^SW^S}$ (*ACCEPT 'SS'*) / offspring formed and identified as susceptible;
If different symbols:
– defined : max 2 marks
– not defined max 1 mark (= pt.2)
2

(iii) 1. Description: decrease + rate of decrease slows with time;

Explanation: Any **three** from:

2. Resistant rats / rats with $\mathbf{W^R}$ allele survive
OR susceptible / $\mathbf{W^SW^S}$ rats killed

3. (more likely) to pass on $\mathbf{W^R}$ allele to offspring / less likely to pass on $\mathbf{W^S}$ **/**
higher proportion of next generation has $\mathbf{W^R}$ allele / lower proportion has $\mathbf{W^S}$;

4. Chance of mating with $\mathbf{W^SW^S}$ is reduced / $\mathbf{W^SW^S}$ becomes rare;

5. Rate of selection against $\mathbf{W^S}$ slows because $\mathbf{W^S}$ allele is in heterozygotes;
max 4

(iv) No selective advantage / All genotypes equally fertile;
Large population;
Random mating; (IGNORE 'random fertilisation')

No mutation;
No emigration / immigration;

max 2

[15] (a) Gg / suitable equivalent;

15

Grey : black about 3: 1;

[Note: Can be in table / diagram]

2

(b) To determine the probability;

[Accept: Likelihood]

Of the results being due to chance;

[Accept: Coincidence]

2

(c) (i) both alleles will be expressed (in the phenotype);

1

(ii) 0.25 / 25%; = 2 marks

C^N = 250 / 1000; = 1 mark

2

(iii) P^2 = $(0.25)^2$ / 0.0625 / square of calculated figure for C^N; = 2 marks $p^2 + 2pq +$ q^2 = 1.0; = 1 mark

= 31.25 / 31;

[Accept: Derived from either p^2 or q^2]

3

[10]