7.1 Genetics, populations, evolution, ecosystems (A-Level Only) - Inheritance and genetic crosses 1 – Questions

Q1.

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

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(1)

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

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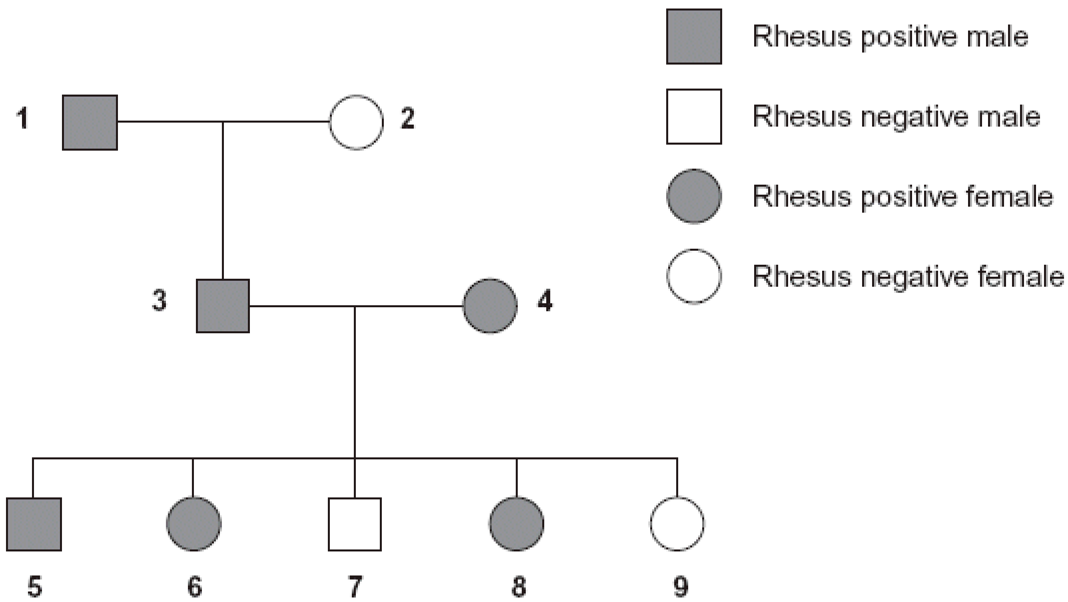
(1)

(b) The Rhesus blood group is genetically controlled. The gene for the Rhesus blood group has 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.

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(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-Weinberg equation 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)

Q2.

(a) What is meant by the term phenotype?

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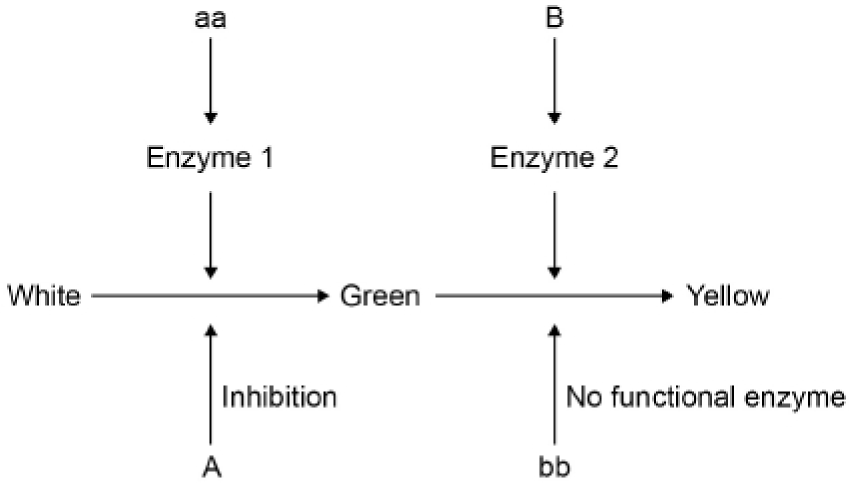
(2)

(b) The inheritance of fruit colour in summer squash plants is controlled by two genes, **A** and **B**. Each gene has two alleles.

The diagram shows the interaction of these two genes in controlling fruit colour in summer squash plants.



Name the type of gene interaction shown in the diagram above.

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(1)

(c) What fruit colour would you expect the following genotypes to have?

AAbb ____

aaBB ____

(1)

(d) Genes **A** and **B** are not linked.

Complete the genetic diagram to show all the possible genotypes and the ratio of phenotypes expected in the offspring of this cross.

Genotypes of parents **aabb** × **AaBb**

Genotypes of offspring ____

Phenotypes of offspring ____

Ratio of phenotypes ____

(3)

(e) A population of summer squash plants produced only green and yellow fruit. The percentage of plants producing yellow fruit in this population was 36%.

Use the Hardy−Weinberg equation to calculate the percentage of plants that were heterozygous for gene **B**.

Answer = ___________ %

(2)

(Total 9 marks)

Q3.

A student investigated the monohybrid inheritance of eye shape in fruit flies. Two fruit flies with bar (narrow) eyes were crossed. Of the offspring, 1538 had bar eyes and 462 had round (normal) eyes.

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

Explain your answer.

Genotypes ____

Explanation ____

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(2)

(b) The ratio of bar-eyed flies and round-eyed flies in the student's results were not the same as the ratio she had expected.

What ratio of bar-eyed to round-eyed flies was the student expecting?

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(1)

(c) Suggest **two** reasons why observed ratios are often **not** the same as expected ratios.

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(2)

(d) The student wished to test her results with the ones she had expected.

Which statistical test should she use?

(1)

(e) This fruit fly has another characteristic controlled by a pair of codominant alleles, W^N and W^V.

What is meant by **codominant** alleles?

(1)

(f) There were 850 fruit flies in one population. In this population, 510 fruit flies had the genotype W^NW^N, 255 had the genotype W^NW^V and 85 had the genotype W^VW^V.

Calculate the **actual** frequency of the allele W^V. **Do not** use the Hardy-Weinberg equation in your calculation.

Answer = ______________________

(1)

(g) In another population of 950 fruit flies, the frequency of the W^V allele was 0.2.

Use the Hardy-Weinberg equation to calculate the number of insects that would be **expected** to have the genotype W^NW^V.

Answer = ______________________

(2)

(Total 10 marks)

Q4.

(a) In fruit flies, the genes for body colour and wing length are linked. Explain what this means.

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(1)

A scientist investigated linkage between the genes for body colour and wing length.
He carried out crosses between fruit flies with grey bodies and long wings and fruit flies with black bodies and short wings.

Figure 1 shows his crosses and the results.

- **G** represents the dominant allele for grey body and **g** represents the recessive allele for black body.
- **N** represents the dominant allele for long wings and **n** represents the recessive allele for short wings.

Figure 1

Phenotype of parents	grey body, long wings	×	black body, short wings
Genotype of parents	**GGNN**		**ggnn**
Genotype of offspring		**GgNn**	
Phenotype of offspring		all grey body, long wings	

These offspring were crossed with flies homozygous for black body and short wings.

The scientist's results are shown in **Figure 2**.

Figure 2

GgNn crossed with **ggnn**

	Grey body, long wings	**Black body, short wings**	**Grey body, short wings**	**Black body, long wings**
Number of offspring	975	963	186	194

(b) Use your knowledge of gene linkage to explain these results.

(Extra space)

(4)

(c) If these genes were **not** linked, what ratio of phenotypes would the scientist have expected to obtain in the offspring?

(1)

(d) Which statistical test could the scientist use to determine whether his observed results were significantly different from the expected results?

Give the reason for your choice of statistical test.

(2)

(Total 8 marks)

Q5.

Read the following passage carefully.

A large and growing number of disorders are now known to be due to types of mitochondrial disease (MD). MD often affects skeletal muscles, causing muscle weakness.

We get our mitochondria from our mothers, via the fertilised egg cell. Fathers do not pass on mitochondria via their sperm. Some mitochondrial diseases are caused by mutations of mitochondrial genes inside the mitochondria. Most mitochondrial diseases are caused by mutations of genes in the cell nucleus that are involved in the functioning of mitochondria. These mutations of nuclear DNA produce recessive alleles.

One form of mitochondrial disease is caused by a mutation of a mitochondrial gene that codes for a tRNA. The mutation involves substitution of guanine for adenine in the DNA base sequence. This changes the anticodon on the tRNA. This results in the formation of a non-functional protein in the mitochondrion.

There are a number of ways to try to diagnose whether someone has a mitochondrial disease. One test involves measuring the concentration of lactate in a person's blood after exercise. In someone with MD, the concentration is usually much higher than normal. If the lactate test suggests MD, a small amount of DNA can be extracted from mitochondria and DNA sequencing used to try to find a mutation.

Use information in the passage and your own knowledge to answer the following questions.

(a) Mitochondrial disease (MD) often causes muscle weakness (lines 1–3). Use your knowledge of respiration and muscle contraction to suggest explanations for this effect of MD.

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(Extra space) ___

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(3)

Two couples, couple **A** and couple **B**, had one or more children affected by a mitochondrial disease. The type of mitochondrial disease was different for each couple.

None of the parents showed signs or symptoms of MD.

- Couple **A** had four children who were all affected by an MD.
- Couple **B** had four children and only one was affected by an MD.

(b) Use the information in lines 5–9 and your knowledge of inheritance to suggest why:

- all of couple **A**'s children had an MD
- only one of couple **B**'s children had an MD.

Couple **A** ____

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____

____

Couple **B** ____

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(Extra space) ____

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(4)

(c) Suggest how the change in the anticodon of a tRNA leads to MD (lines 10–13).

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(Extra space) ____

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(3)

(d) If someone has MD, the concentration of lactate in their blood after exercise is usually much higher than normal (lines 15–17). Suggest why.

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(Extra space)

(3)

(e) A small amount of DNA can be extracted from mitochondria and DNA sequencing used to try to find a mutation (lines 18–19).

From this sample:

- how would enough DNA be obtained for sequencing?
- how would sequencing allow the identification of a mutation?

(2)
(Total 15 marks)

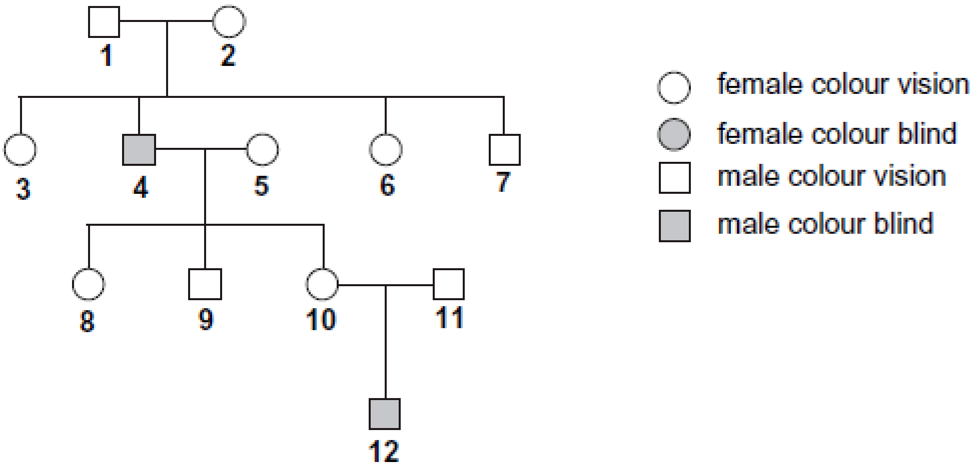
Q6.

(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. The allele 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.

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(2)

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

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(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)

Q7.

(a) What is the role of ATP in myofibril contraction?

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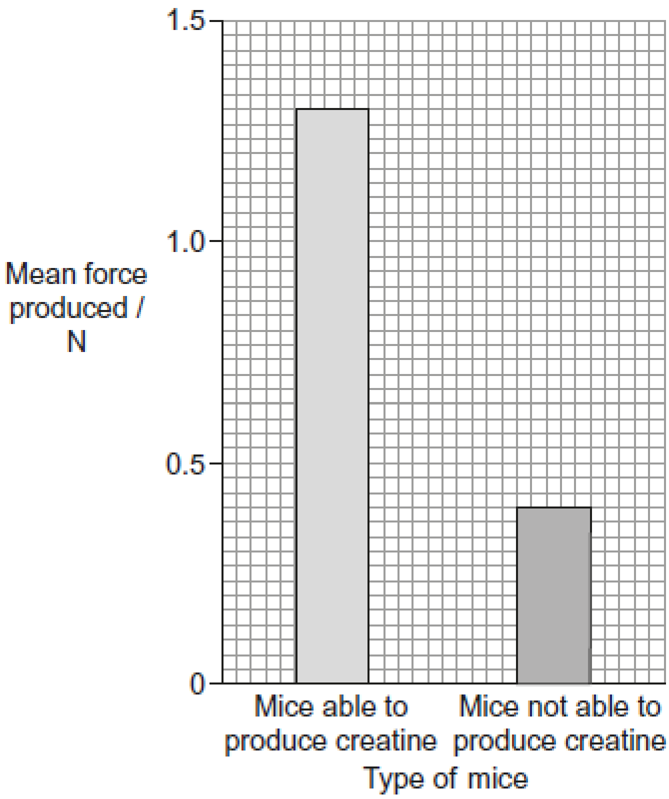
(2)

(b) Scientists investigated the effect of not being able to produce creatine on the force produced by muscle. They used mice with a mutation that made them not able to produce creatine.
The force produced when these mice gripped with their paws was compared with the force produced by normal mice that were able to produce creatine.

The graph shows the scientists' results.



(i) What was the percentage fall in the mean force produced by mice not able to produce creatine, compared with the normal mice? Show your working.

Answer ____________________ %

(2)

(ii) Suggest an explanation for these results.

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(2)

(c) The mice that were not able to produce creatine were homozygous for a recessive allele of a gene. Mice that are heterozygous for this allele are able to produce forces similar to those of normal mice that are homozygous for the dominant allele of the same gene.

Explain why the heterozygous mice can produce forces similar to those of normal mice.

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(2)

(Total 8 marks)

Q8.

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.

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(1)

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

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(1)

(c) A tortoiseshell female was crossed with a black male. Use a genetic diagram to show all the 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 for polydactyly is dominant.

(i) In a population, 19% of cats had extra toes. Use the Hardy-Weinberg equation to calculate 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 the frequencies of the homozygous genotypes for this gene in their breeding populations over time.

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(1)

(Total 8 marks)

Q9.

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

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

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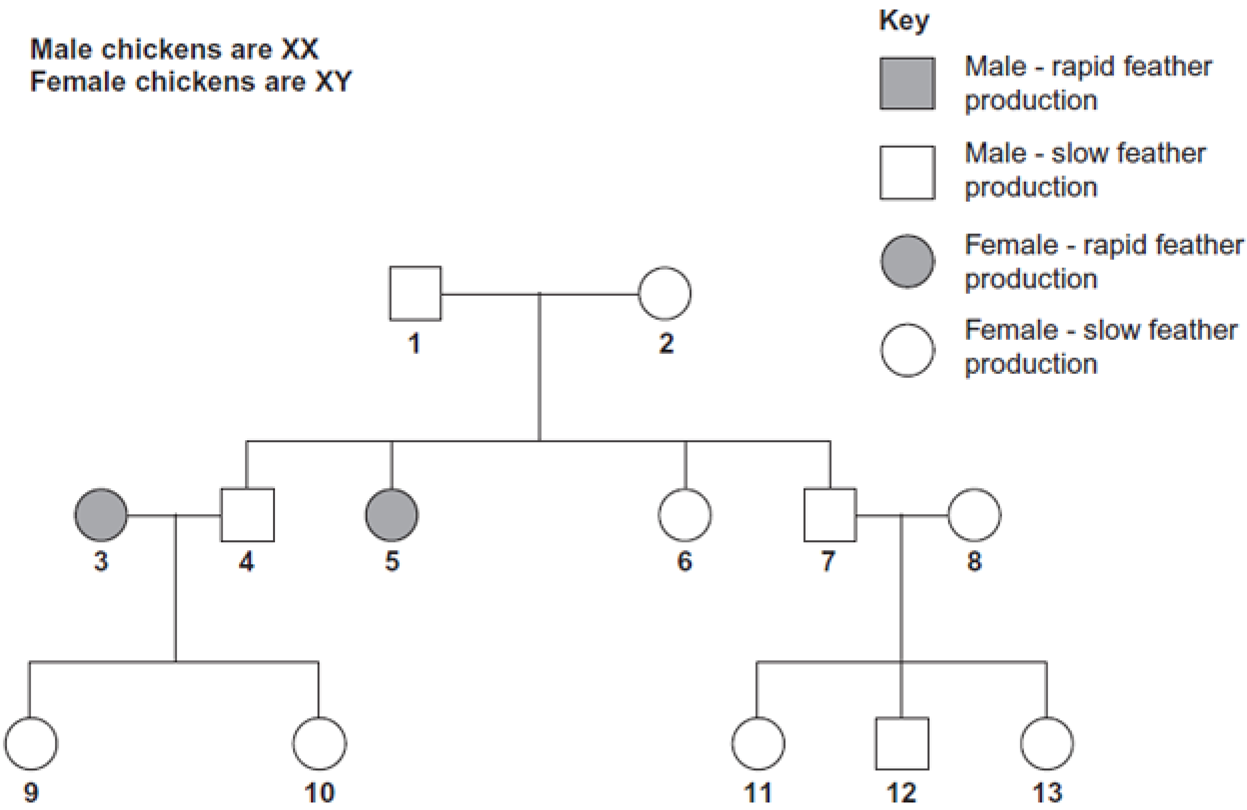
(1)

(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.

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(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 with rapid feather production and two were females with slow feather production. Give the genotypes of the parents.

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(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)

Q10.

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

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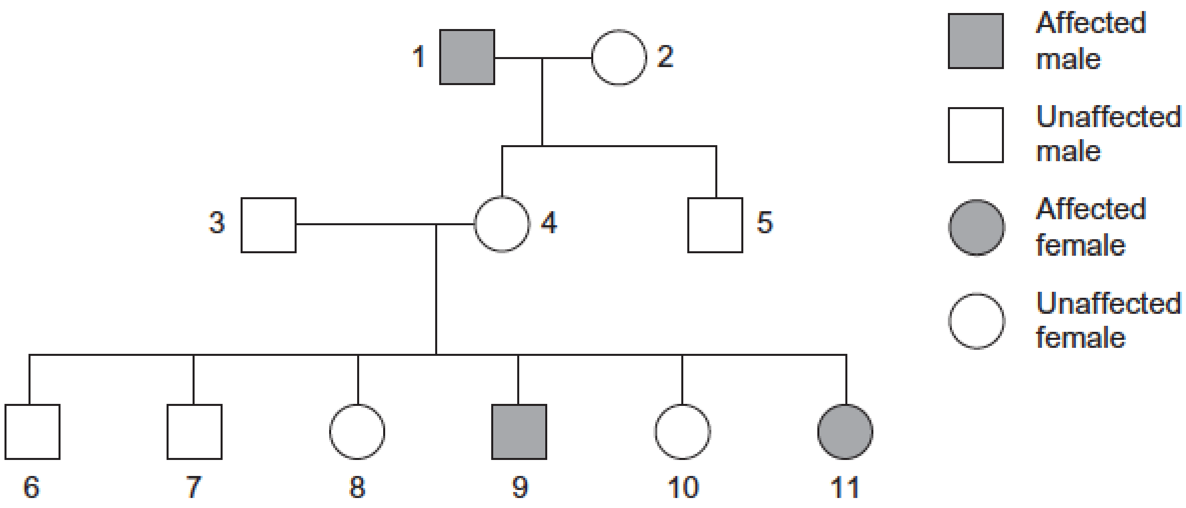
(2)

(b) Tay-Sachs disease is a human inherited disorder. Sufferers of this disease often die during childhood. The allele for Tay-Sachs disease **t,** is recessive to allele **T**, present in unaffected individuals. The diagram shows the inheritance of Tay-Sachs in one family.



(i) Explain **one** piece of evidence from the diagram which proves that the allele for Tay-Sachs disease is recessive.

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(2)

(ii) Explain **one** piece of evidence from the diagram which proves that the allele for Tay-Sachs disease is **not** on the X chromosome.

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(2)

(c) (i) In a human population, one in every 1000 children born had Tay-Sachs disease. Use the Hardy-Weinberg equation to calculate the percentage of this population you would expect to be heterozygous for this gene. Show your working.

Answer = ____________________ %

(3)

(ii) The actual percentage of heterozygotes is likely to be lower in future generations than the answer to part (c)(i). Explain why.

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(1)

(Total 10 marks)

Q11.

Researchers investigated some characteristics of people from different parts of England. In the north of England they selected 200 people and recorded their phenotypes for three different characteristics.

Their results are shown in the figure below.

Phenotype produced by dominant allele	**Number of people**	**Phenotype produced by recessive allele**	**Number of people**
Tongue roller	131	Non-tongue roller	58
Right-handed	182	Left-handed	14
Straight thumb	142	Hitch-hiker thumb	50

(a) Calculate the ratio of straight thumb to hitch-hiker thumb in this study.

Ratio = ____________________

(1)

(b) The numbers for the tongue rolling and thumb characteristics do not add up to 200. For each characteristic suggest **one** reason why the numbers do **not** add up to 200.

Tongue rolling ____

____

____

Thumb ____

____

(2)

(c) One student looked at the researchers' results and concluded that 91% of people in the UK are right-handed.
Do you agree with this conclusion? Give reasons for your answer.

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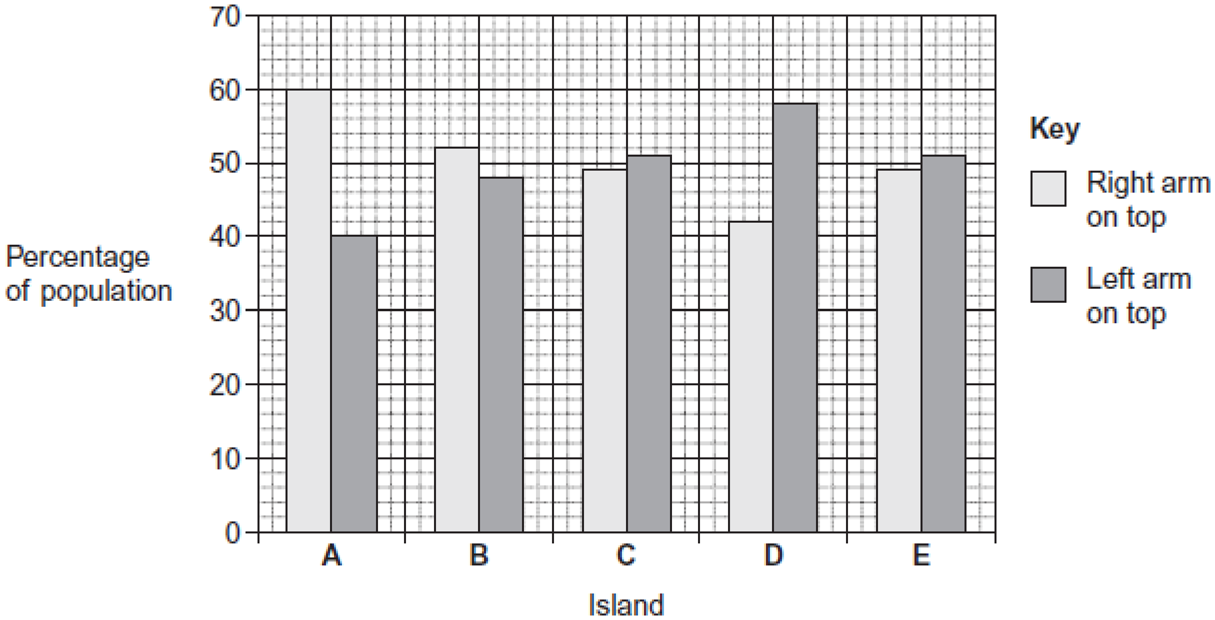
(2)
(Total 5 marks)

Q12.

When most people fold their arms, they either always have their left arm on top, **L**, or always have their right arm on top, **R**. A geneticist investigated this characteristic on five small islands, **A, B, C, D** and **E**.

Her results are shown in **Figure 1**.

Figure 1



On one of the islands she recorded the arm-folding characteristics of parents and their children.

These results are shown in **Figure 2**.

Figure 2

Arm-folding of parents	Arm-folding of the children / %

	Right arm on top, R	Left arm on top, L
R and **R**	41	59
R and **L**	45	55
L and **L**	44	56

The geneticist concluded that arm-folding is not determined by a single gene with a dominant allele and a recessive allele.

(a) The geneticist investigated arm-folding on five small islands.

(i) Use information from **Figure 1** to describe the results she obtained.

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(2)

(ii) Suggest advantages of using island populations in this investigation.

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(2)

(b) The geneticist concluded that arm-folding is **not** determined by a single gene with a dominant allele and a recessive allele.

Use information from **Figure 2** to explain why she reached this conclusion.

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(Extra space)___

(3)

(c) In another study, the geneticist investigated arm-folding in genetically identical twins.
Data from this study supported her conclusion from the island study.

Suggest the evidence she found that supported her conclusion.

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(1)
(Total 8 marks)

Q13.

The fruit fly is a useful organism for studying genetic crosses. Female fruit flies are approximately 2.5 mm long. Males are smaller and possess a distinct black patch on their bodies. Females lay up to 400 eggs which develop into adults in 7 to 14 days. Fruit flies will survive and breed in small flasks containing a simple nutrient medium consisting mainly of sugars.

(a) Use this information to explain **two** reasons why the fruit fly is a useful organism for studying genetic crosses.

1. ___

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2. ___

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(2)

(b) Male fruit flies have the sex chromosomes XY and the females have XX. In the fruit fly, a gene for eye colour is carried on the X chromosome. The allele for red eyes, **R**, is dominant to the allele for white eyes, **r**. The genetic diagram shows a cross between two fruit flies.

(i) Complete the genetic diagram for this cross.

Phenotypes of parents	red-eyed female		white-eyed male
Genotype of parents	___	×	___
Gametes	___and___		___and___
Phenotypes of offspring	red-eyed females	and	red-eyed males
Genotype of offspring	___		___

(3)

(ii) The number of red-eyed females and red-eyed males in the offspring was counted. The observed ratio of red-eyed females to red-eyed males was similar to, but not the same as, the expected ratio. Suggest **one** reason why observed ratios are often **not** the same as expected ratios.

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(1)

(c) Male fruit flies are more likely than female fruit flies to show a phenotype produced by a recessive allele carried on the X chromosome. Explain why.

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(2)
(Total 8 marks)

Q14.

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.

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(1)

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

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(1)

(c) A cross between two pink-shelled snails produced only pink-shelled and yellow-shelled snails. 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 is controlled 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 ____________________ %

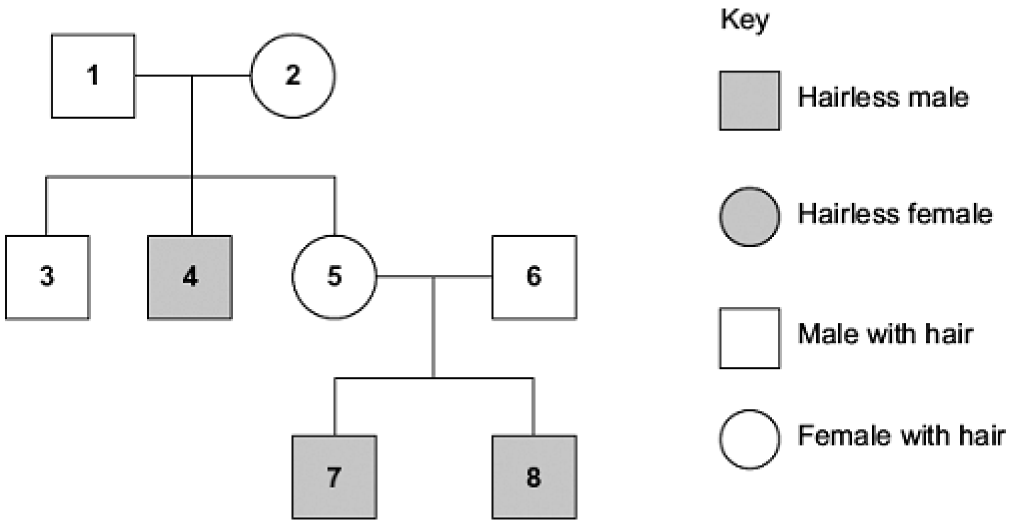
(3)

(Total 8 marks)

Q15.

A single gene controls the presence of hair on the skin of cattle. The gene is carried on the X chromosome. Its dominant allele causes hair to be present on the skin and its recessive allele causes hairlessness.

The diagram shows the pattern of inheritance of these alleles in a group of cattle.



(a) Use evidence from the diagram to explain

(i) that hairlessness is caused by a recessive allele

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(2)

(ii) that hairlessness is caused by a gene on the X chromosome.

____

____

(1)

(b) What is the probability of the next calf born to animals **5** and **6** being hairless? Complete the genetic diagram to show how you arrived at your answer.

Phenotypes of parents	Female with hair	Male with hair
Genotypes of parents	____________	____________
Gametes	____________	____________
Genotypes of offspring	____________________	
Phenotypes of offspring	____________________	
Probability of next calf being hairless	____________________	

(4)

(Total 7 marks)

Q16.

A breeder crossed a black male cat with a black female cat on a number of occasions. The female cat produced 8 black kittens and 4 white kittens.

(a) (i) Explain the evidence that the allele for white fur is recessive.

____

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(1)

(ii) Predict the likely ratio of colours of kittens born to a cross between **this** black male and a white female.

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(1)

(b) The gene controlling coat colour has three alleles. The allele **B** gives black fur, the allele **b** gives chocolate fur and the allele **b^i** gives cinnamon fur.

- Allele **B** is dominant to both allele **b** and **b^i**.
- Allele **b** is dominant to allele **b^i**.

(i) Complete the table to show the phenotypes of cats with each of the genotypes shown.

Genotype	**Phenotype**
Bb^i	
bb^i	
Bb	

(1)

(ii) A chocolate male was crossed several times with a black female.

They produced

- 11 black kittens
- 2 chocolate kittens
- 5 cinnamon kittens.

Using the symbols in part (b), complete the genetic diagram to show the results of this cross.

Parental phenotypes Chocolate male Black female

Parental genotypes ____________ ____________

Gametes ____________ ____________

Offspring genotypes _________ _________ _________

Offspring phenotypes Black Chocolate Cinnamon

(3)

(iii) The breeder had expected equal numbers of chocolate and cinnamon kittens from the cross between the chocolate male and black female. Explain why the actual numbers were different from those expected.

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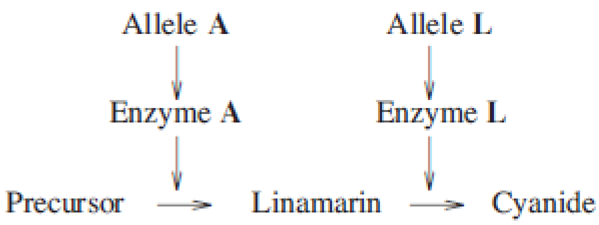
(1)

(iv) The breeder wanted to produce a population of cats that would all have chocolate fur. Is this possible? Explain your answer.

(2)
(Total 9 marks)

Q17.

Cyanide is a poisonous substance. Cyanogenic clover plants produce cyanide when their tissues are damaged. The ability to produce cyanide is controlled by genes at loci on two different chromosomes. The dominant allele, **A**, of one gene controls the production of an enzyme which converts a precursor to linamarin. The dominant allele, **L**, of the second gene controls the production of an enzyme which converts linamarin to cyanide. This is summarised in the diagram.



(a) Acyanogenic clover plants cannot produce cyanide. Explain why a plant with the genotype **aaLl** cannot produce cyanide.

(1)

(b) A clover plant has the genotype **AaLl**.

(i) Give the genotypes of the male gametes which this plant can produce.

(1)

(ii) Explain how meiosis results in this plant producing gametes with these genotypes.

(2)

(c) Two plants, heterozygous for both of these pairs of alleles, were crossed. What proportion of the plants produced from this cross would you expect to be acyanogenic but able to produce linamarin? Use a genetic diagram to explain your answer.

(3)

In an investigation, cyanogenic and acyanogenic plants were grown together in pots. Slugs were placed in each pot and records were kept of the number of leaves damaged by the feeding of the slugs over a period of 7 days. The results are shown in **Table 1**.

Table 1

	Undamaged	**Damaged**
Cyanogenic plants	160	120
Acyanogenic plants	88	192

(d) A x^2 test was carried out on the results.

(i) Suggest the null hypothesis that was tested.

(1)

(ii) x^2 was calculated. When this value was looked up in a table, it was found to correspond to a probability of less than 0.05. What conclusion can you draw from this?

(3)

A second investigation was carried out in a field of grass which had been undisturbed for many years. **Table 2** shows the population density of slugs and the numbers of cyanogenic and acyanogenic clover plants at various places in the field.

Table 2

Population density of slugs	**Number of acyanogenic clover plants per m²**	**Number of cyanogenic clover plants per m²**
Very low	26	10
Low	17	26
High	0	10
Very high	0	5

(e) Explain the proportions of the two types of clover plant in different parts of the field.

(Extra space)

(4)
(Total 15 marks)

Q18.

(a) Meiosis results in cells that have the haploid number of chromosomes and show genetic variation. Explain how.

(6)

(b) In mice, two genes affecting coat colour are on different chromosomes.
One gene controls whether there is any black pigment in the hairs. The dominant allele of this gene, **B**, results in black fur. The recessive allele, **b**, results in white fur. The second gene controls banding of the fur. The dominant allele, **A**, causes a yellow band to develop on each hair. The resulting coat colour is called agouti. The recessive allele, **a**, results in hairs with no bands on them. This gene has no effect on mice with white fur; white mice do not develop bands, even if they have the **A** allele.

Breeders performed many crosses in which agouti mice were crossed with white mice, homozygous for both genes. They expected agouti, black and white mice in the offspring in a 1 : 1 : 2 ratio.

(i) Complete the genetic diagram to show how this ratio of phenotypes would be produced.

Parental phenotypes Agouti White

Parental genotypes

Gamete genotypes

Offspring genotypes

Offspring phenotypes

(4)

(ii) The actual numbers of offspring with each phenotype were

Agouti	34
Black	35
White	51

The x^2 test can be used to test the hypothesis that there is no significant difference between these results and the expected 1 : 1 : 2 ratio. Complete the table to calculate the value of x^2 for these results.

Colour of offspring	**Observed (O)**	**Expected (E)**	**(O - E)**	**(O - E)²**	$\frac{(O-E)^2}{E}$
Agouti	34				
Black	35				
White	51				
			$\sum \frac{(O-E)^2}{E} =$		

(2)

(iii) The table shows values for x^2 at different levels of probability and for different degrees of freedom.

Degrees of freedom	**Probability, p**				
	0.2	**0.1**	**0.05**	**0.02**	**0.01**
1	1.64	2.71	3.84	5.41	6.64
2	3.22	4.61	5.99	7.82	9.21
3	4.64	6.25	7.82	9.84	11.35
4	5.99	7.78	9.49	11.67	13.28
5	7.29	9.24	11.07	13.39	15.09

What should the breeders conclude about the significance of their results? Explain your answer.

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(3)
(Total 15 marks)

Q19.

(a) The guinea pig, *Cavia porcellus*, is a small mammal. Complete the table to show the classification of the guinea pig.

Kingdom	
	Chordata
	Mammalia
	Rodentia
Family	Caviidae
Genus	
Species	

(2)

(b) In South America, there are several species of guinea pig. They are thought to have arisen by sympatric speciation.
Explain how sympatric speciation may have occurred.

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(3)

(c) In guinea pigs, hair length and hair colour are controlled by two genes on different chromosomes. The hair may be either long or short and its colour either black or brown.

A male guinea pig and a female guinea pig both had short, black hair. The male was homozygous for hair length, and the female was homozygous for hair colour. Repeated crossings of these two guinea pigs resulted in offspring of four different genotypes, all of which had short, black hair.

Complete the genetic diagram to explain these results. Write in the box the symbols you will use to represent the alleles.

Allele for short hair = ________	Allele for long hair = ________
Allele for black hair = ________	Allele for brown hair = ________

	Male	Female
Parental phenotypes	Short, black hair	Short, black hair
Parental	______________	______________

genotypes

Gamete genotypes ______________ ______________

Offspring genotypes ______________________________

Offspring phenotypes Short, black hair

(4)

(d) In another investigation, the same female guinea pig was twice mated with another male which had long, brown hair. Of the 14 offspring, 10 had short, black hair and 4 had long, black hair. The investigators expected equal numbers of offspring with these two phenotypes. They used a χ^2 test to determine whether the observed results fitted the expected 1:1 ratio.

Give a suitable null hypothesis for the investigation.

____

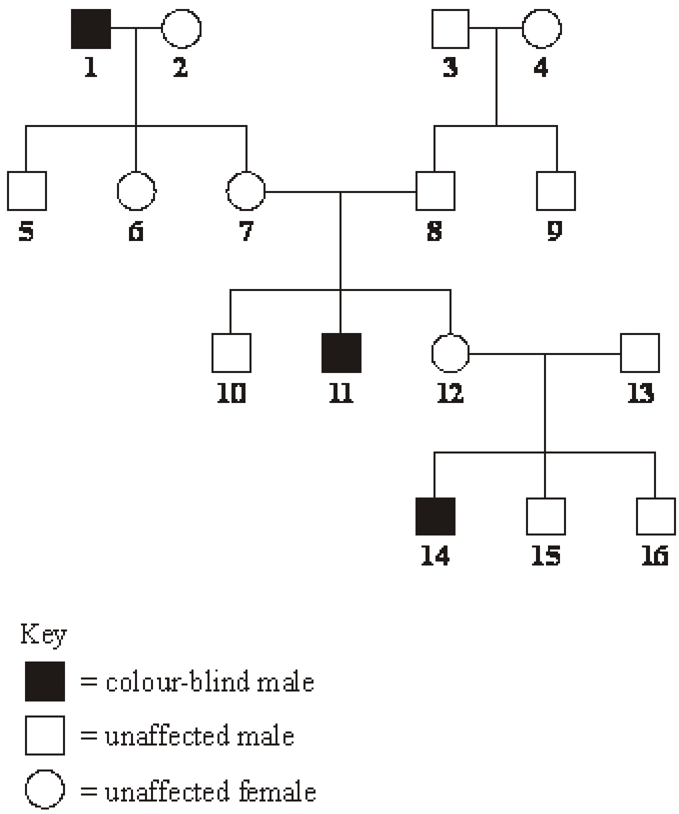
____

(1)

(Total 10 marks)

Q20.

Red-green colour blindness is caused by a mutation in the gene coding for one of the opsin proteins which are needed for colour vision. The diagram shows the inheritance of red-green colour blindness in one family.



Person **12** is pregnant with her fourth child. What is the probability that this child will be a male with red-green colour blindness? Explain your answer by drawing a genetic diagram. Use the following symbols

X^R = an X chromosome carrying an allele for normal colour vision

X^r= an X chromosome carrying an allele for red-green colour blindness

Y = a Y chromosome

Probability = ____________________

(Total 4 marks)

Q21.

Human ABO blood groups are determined by the presence or absence of two antigens (A and B) on the plasma membrane of the red blood cells. The inheritance of these blood groups is controlled by three alleles:

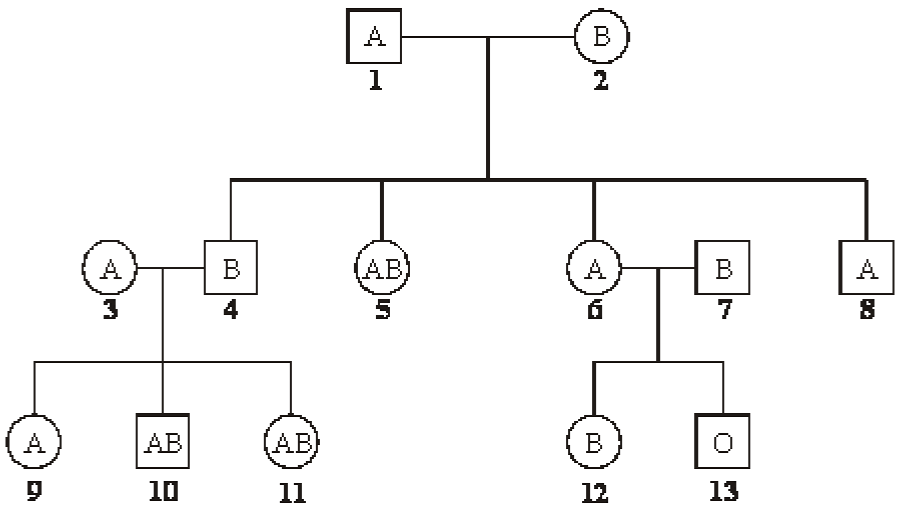
I^A – determines the production of antigen A

I^B – determines the production of antigen B

I^o – determines the production of no antigen

Alleles I^A and I^B are codominant. Allele I^o is recessive to both.

The pedigree shows the pattern of inheritance of these blood groups in a family over three generations.



(a) (i) How many antigen-determining alleles will be present in a white blood cell? Give a reason for your answer.

____

____

(1)

(ii) Which antigen or antigens will be present on the plasma membranes of red blood cells of individual **5**?

____

(1)

(b) If individuals **6** and **7** were to have another child, what is the probability that this child would be male and blood group A? Explain your answer.

____

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(3)
(Total 5 marks)

Q22.

In fruit flies, the allele for grey body, **G**, is dominant to the allele for ebony body, **g**, and the allele for normal wings, **N**, is dominant to the allele for vestigial wings, **n**. Vestigial-winged flies, heterozygous for grey body colour, were crossed with ebony-bodied flies, heterozygous for normal wings.

Complete the genetic diagram to show the genotypes and phenotypes in this cross.

Parental phenotypes Grey body, vestigial wings Ebony body, normal wings

Parental genotypes ________________ ________________

Gamete genotypes ________________ ________________

Offspring genotypes

____

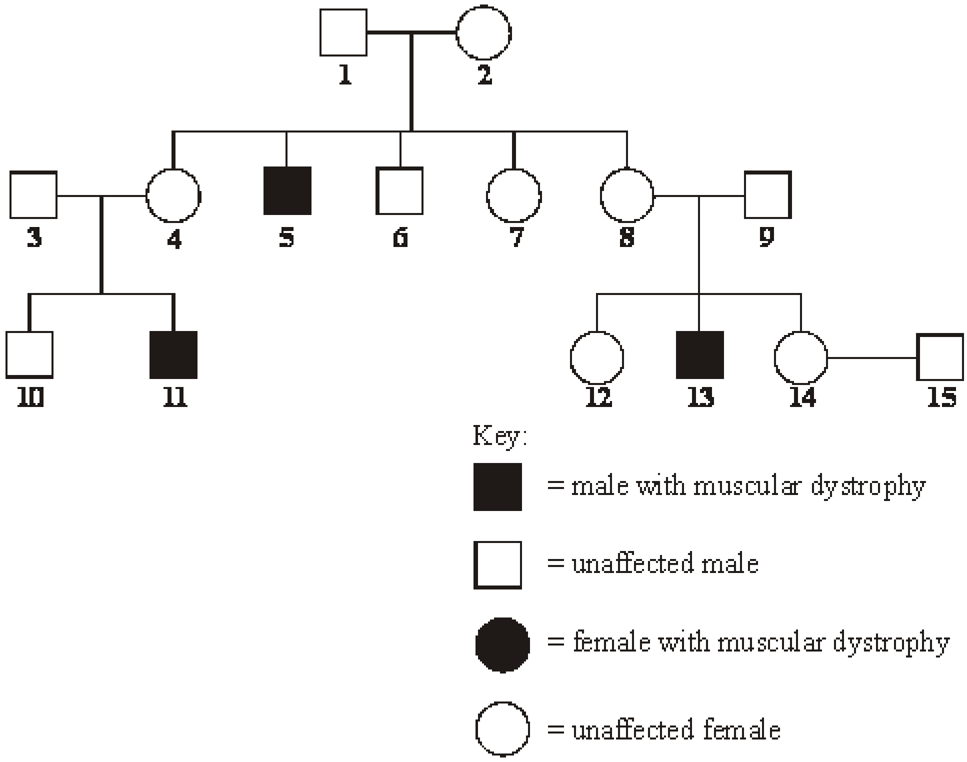
Offspring phenotypes

____

(Total 4 marks)

Q23.

Duchenne muscular dystrophy is a sex-linked inherited condition which causes degeneration of muscle tissue. It is caused by a recessive allele. The diagram shows the inheritance of muscular dystrophy in one family.



(a) Give evidence from the diagram which suggests that muscular dystrophy is

(i) sex-linked; ____

____

(1)

(ii) caused by a recessive allele. ______________________________

____

(1)

(b) Using the following symbols,

X^D = an X chromosome carrying the normal allele

X^d = an X chromosome carrying the allele for muscular dystrophy

Y = a Y chromosome

give **all** the possible genotypes of each of the following persons.

5 ____

6 ____

7 ____

8 ____________________

(2)

(c) A blood test shows that person **14** is a carrier of muscular dystrophy. Person **15** has recently married person **14** but as yet they have had no children. What is the probability that their first child will be a male who develops muscular dystrophy?

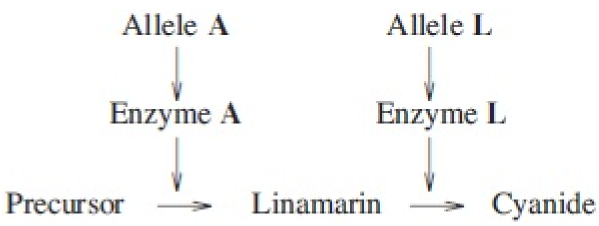
____

(1)

(Total 5 marks)

Q24.

Cyanide is a poisonous substance. Cyanogenic clover plants produce cyanide when their tissues are damaged. The ability to produce cyanide is controlled by genes at loci on two different chromosomes. The dominant allele, **A**, of one gene controls the production of an enzyme which converts a precursor to linamarin. The dominant allele, **L**, of the second gene controls the production of an enzyme which converts linamarin to cyanide. This is summarised in the diagram.



(a) Acyanogenic clover plants cannot produce cyanide. Explain why a plant with the genotype **aaLl** cannot produce cyanide.

____

____

(1)

(b) A clover plant has the genotype **AaLl**.

(i) Give the genotypes of the male gametes which this plant can produce.

____

(1)

(ii) Explain how meiosis results in this plant producing gametes with these genotypes.

____

____

____

____

(2)

(c) Two plants, heterozygous for both of these pairs of alleles, were crossed. What proportion of the plants produced from this cross would you expect to be acyanogenic but able to produce linamarin? Use a genetic diagram to explain your answer.

(3)

In an investigation, cyanogenic and acyanogenic plants were grown together in pots. Slugs were placed in each pot and records were kept of the number of leaves damaged by the feeding of the slugs over a period of 7 days. The results are shown in **Table 1**.

Table 1

	Undamaged	**Damaged**
Cyanogenic plants	160	120
Acyanogenic plants	88	192

(d) A x^2 test was carried out on the results.

(i) Suggest the null hypothesis that was tested.

(1)

(ii) x^2 was calculated. When this value was looked up in a table, it was found to correspond to a probability of less than 0.05. What conclusion can you draw from this?

(3)

A second investigation was carried out in a field of grass which had been undisturbed for many years. **Table 2** shows the population density of slugs and the numbers of cyanogenic and acyanogenic clover plants at various places in the field.

Table 2

Population density of slugs	**Number of acyanogenic clover plants per m^2**	**Number of cyanogenic clover plants per m^2**
Very low	26	10
Low	17	26
High	0	10
Very high	0	5

(e) Explain the proportions of the two types of clover plant in different parts of the field.

___

___

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___

(Extra space) ___

___

(4)

(Total 15 marks)