IB · SL · Biology

2 hours 22 questions

Structured Questions

Inheritance

Genetic Inheritance & Genetic Crossing / Inheritance: Terminology / Inheriting Alleles / Sex Determination / Pedigree Charts / Continuous Variation: Skills

Easy (9 questions)	/47
Medium (5 questions)	/38
Hard (8 questions)	/51
Total Marks	**/136**

Scan here to return to the course
or visit savemyexams.com

Easy Questions

1 (a) During the process of fertilisation, haploid sperm and egg cells fuse together to form a diploid zygote.

Define the term 'haploid'.

.....

(1 mark)

(b) There are certain advantages to cells being diploid.

List **two** advantages of cells containing two sets of chromosomes.

.....

.....

(2 marks)

(c) A couple is expecting a child and wondering which sex the baby will be.

The following genetic diagram shows the sex chromosomes present in the gametes of both parents.

Gametes	X	X
X		
Y		

Calculate the percentage chance of the baby being a girl by completing the genetic diagram.

Show your working.

.....

.....

.....

(3 marks)

(d) One of the genes carried on the X chromosome codes for a protein called factor VIII.

State the role of this protein in humans.

.....

(1 mark)

2 Define the term **genotype**.

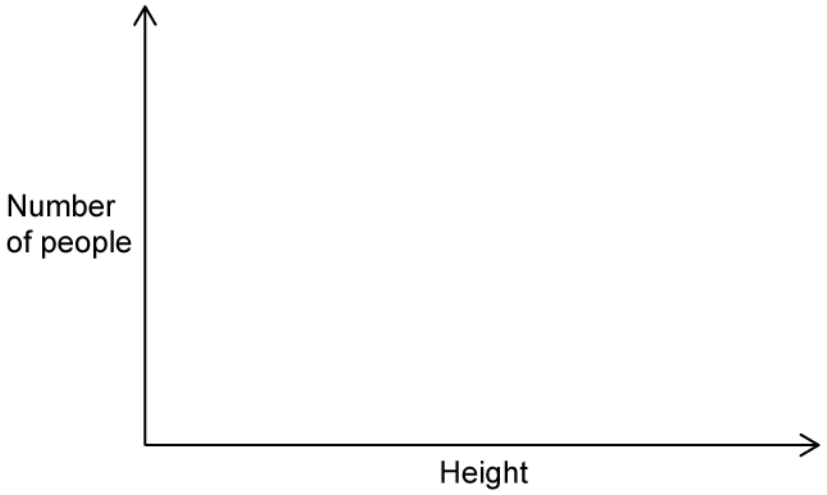
.....

(1 mark)

3 (a) A group of 1000 people were chosen at random and surveyed as part of a population study. The participants were asked about their characteristics.

One characteristic that was surveyed was the participants' height measurements.

Sketch a graph in the space below to predict the distribution of height values in the population sample.



(2 marks)

(b) Name the type of variation shown in the example in part a).

(1 mark)

(c) Another characteristic that was surveyed was hair colour.

It was found that most individuals had black, brown, blonde, or red hair, but a small number of individuals had hair colours like pink, blue and green.

Describe the factors that can cause variation in hair colour.

(2 marks)

(d) Some characteristics are coded for by several genes that work in combination to produce the phenotype.

State the scientific term used for this type of characteristic.

(1 mark)

4 Outline the causes of variation in living organisms.

(5 marks)

5 (a) Huntington's disease is a disease caused by a dominant allele.

State what is meant by the term **dominant**, in the context of alleles.

.....

(1 mark)

(b) Gregor Mendel conducted experiments that established the basis of modern genetics.

(i) State the type of organism that Mendel used in his studies.

[1]

(ii) State why the organism you named in part (i) was a good choice for Mendel's experiments.

[2]

.....

.....

.....

(3 marks)

(c) In snapdragon plants, a cross between a red and white flowered plant results in pink flowered offspring due to codominance of alleles.

In the species that Mendel used for his experiments, a cross between a red-flowered plant and a white-flowered plant, did not result in any pink flowered plants in the next generation.

Suggest why.

.....

.....

(2 marks)

6 In a genetic diagram where **H** denotes the dominant allele responsible for causing Huntington's disease, and **h** denotes the recessive allele, state:

(i) the meaning of the genotype **Hh**

[1]

(ii) the phenotype that **Hh** will display

[1]

(1 mark)

7 (a) The diploid number of a species of rodent is 64.

The table below has been incorrectly completed; some of the numbers in the second column are correct, while others are not.

Cell Type	Number of chromosomes
Zygote	64
Sperm cell	64
Muscle cell	32
Fur-producing cell	16

Complete the table below with correct numbers in the second column.

Cell Type	Number of chromosomes
Zygote	
Sperm cell	
Muscle cell	
Fur-producing cell	

(2 marks)

(b) A genetic cross is performed between two heterozygous parents with the genotype Qq.

Complete the Punnett grid for this cross.

	Q	q
Q		
q		

(2 marks)

(c) When writing out genetic crosses by hand, which of the following pairs of letters is the best choice for denoting the dominant and recessive alleles?

Give a reason for your answer.

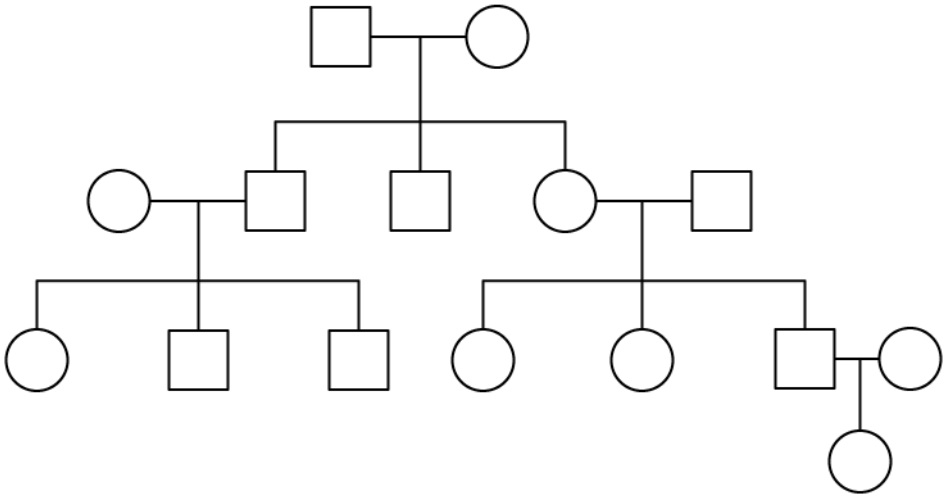
- Cc
- Oo
- Hh
- Vv

(2 marks)

(d) State the name used to describe different alleles of the same gene, that have a combined effect on the phenotype of the organism.

(1 mark)

8 (a) A pedigree chart is shown below.



(i) State the number of generations shown in the pedigree chart.

[1]

(ii) State the numbers of males and females shown in the pedigree chart.

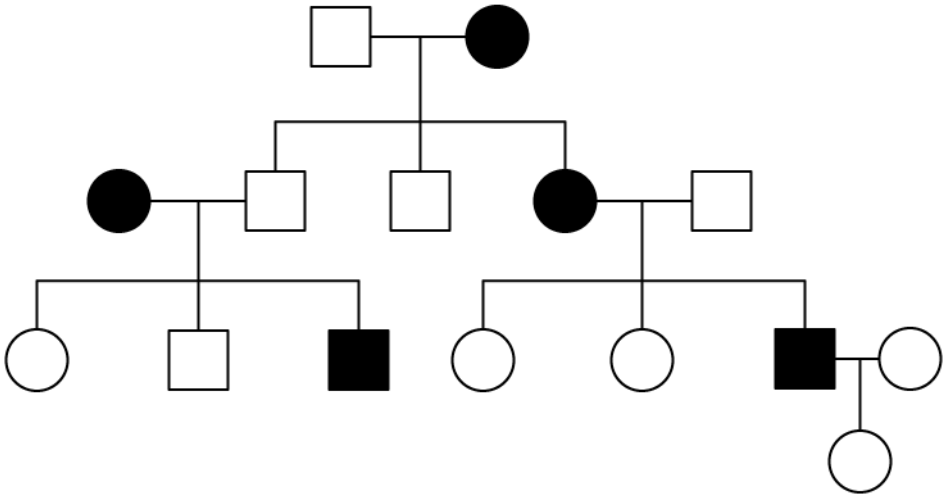
[1]

.....

.....

(2 marks)

(b) The pedigree chart from part (a) can be adapted with shading as follows:

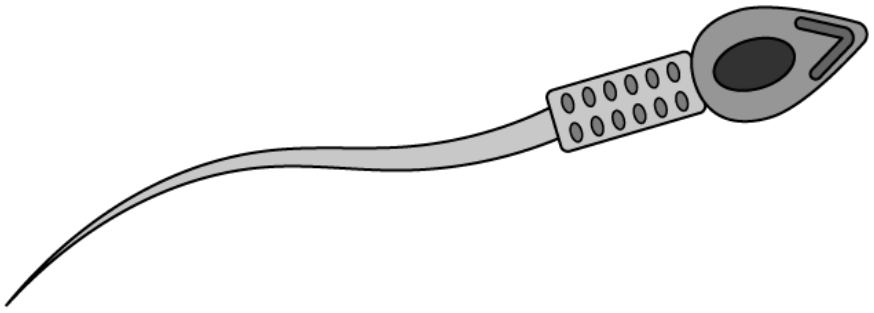


Suggest a meaning for the shaded squares and circles.

.....

(1 mark)

(c) A sperm cell is shown below.



(i) Label the diagram with an **X** to show the position of mitochondria in this cell.

[1]

(ii) State the purpose of the mitochondria in a sperm cell.

[1]

.....

.....

(2 marks)

(d) Define the term sex linkage.

.....

.....

(2 marks)

9 (a) State the differences between the terms phenotype and genotype.

Give **one** example of **each**.

(4 marks)

(b) 8000 offspring were produced from a cross between two heterozygous parents, Hh and Hh.

Calculate how many of these offspring would have the genotype hh. Show your working.

(3 marks)

Medium Questions

1 (a) Contrast continuous and discontinuous variation.

(4 marks)

(b) Describe sex linkage.

(3 marks)

2 (a) Human red blood cells can be categorised into different blood groups based on the structure of a surface glycoprotein (antigen). The ABO blood groups are controlled by a single gene with multiple alleles (A, B, O). The table below shows all the genotypes for all the possible blood groups.

Phenotype	Genotype
Blood Group A	I^AI^A I^Ai
Blood Group B	I^BI^B I^Bi
Blood Group AB	I^AI^B
Blood Group O	ii

A child has blood group AB and their father has blood group A.

Identify the possible phenotypes of the mother.

.....

.....

(2 marks)

(b) Suggest which pattern of inheritance is exhibited in the AB blood group.

.....

(1 mark)

(c) A man with normal colour vision wishes to start a family with his partner who is a carrier of the allele for colour-blindness. They wanted to work out the probability of having a child with colour-blindness.

Using the following symbols:

X^B = an X chromosome carrying the normal allele for colour vision
X^b = an X chromosome carrying the allele for colour blindness

(i) Identify all the possible genotypes for female and male offspring.

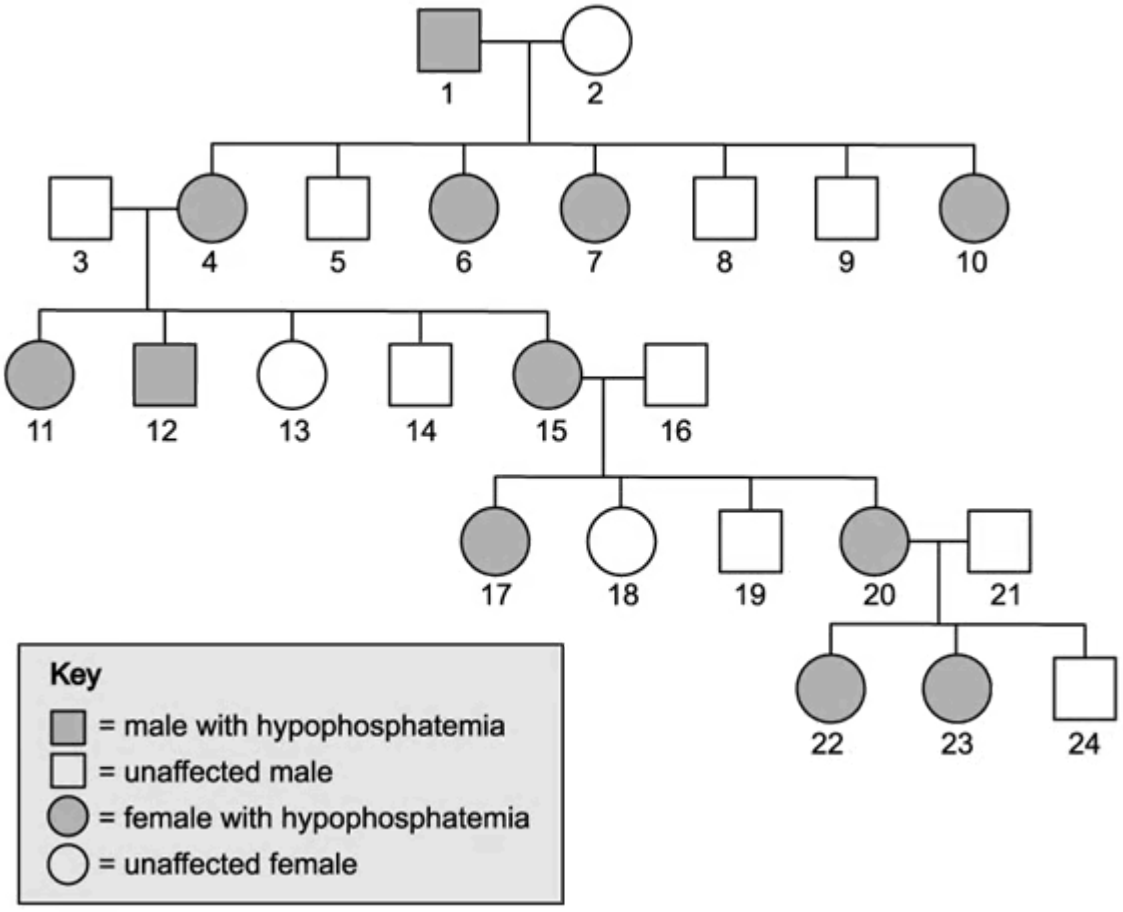
(ii) Predict the probability of having a child with colour-blindness.

.....

(3 marks)

3 (a) Hypophosphatemia is a sex-linked inherited condition which results in abnormally low levels of phosphate in the blood which can cause the disease rickets. It is caused by a dominant allele.

The diagram below shows the inheritance of hypophosphatemia in one family.



State the evidence that suggests that hypophosphatemia is a sex-linked, dominant inherited disease.

.....

.....

(2 marks)

(b) Using the following symbols,

X^H = an X chromosome carrying the allele for hypophosphatemia
X^h = an X chromosome carrying the normal allele
Y = a Y chromosome

Identify all the possible genotypes of each of the following persons from the diagram in part (a):

1 :

4 :

5 :

13 :

(2 marks)

(c) Person 20, from the diagram in part (a), is pregnant for the fourth time. As the family has a history of hypophosphatemia, a test was carried out to discover the sex of the embryo.

Describe what possible observations of the chromosomes would be expected when determining the sex of an embryo.

(2 marks)

(d) State the probability that the child Person 20 is pregnant with will be a male with hypophosphatemia.

Explain your answer by drawing a genetic diagram, using the following symbols:

X^H = an X chromosome carrying the allele for hypophosphatemia

X^h = an X chromosome carrying the normal allele

Y = a Y chromosome

(4 marks)

4 (a) A horticulturist investigated the inheritance of flower colour in *Camellia japonica*, a widely cultivated ornamental plant commonly known as Japanese camellia.The horticulturist crossed a homozygous parent with red flowers and a homozygous parent with white flowers. All of the F1 generation had the same colour flowers. Using the following symbols:

C^R = Red flowers
C^W = White flowers

Sketch a genetic diagram / Punnett square to deduce all the genotypes in this cross

(2 marks)

(b) Each of the F1 generation plants had flowers that were patterned red and white. The horticulturist undertook a self-cross with these F1 hybrids.

(i) State all the possible phenotypes of the F2 hybrids

(ii) Deduce the probability of obtaining a white flower.

(2 marks)

(c) Describe, with a reason, what pattern of inheritance is exhibited in the horticulturist's experiment.

(3 marks)

5 (a) FG syndrome is a recessive disorder that can cause a characteristic facial appearance, developmental delays and hyperactivity. FG syndrome is a rare X-linked genetic disorder that occurs almost exclusively in males, it is caused by a mutation in the *MED12* gene on the X chromosome.

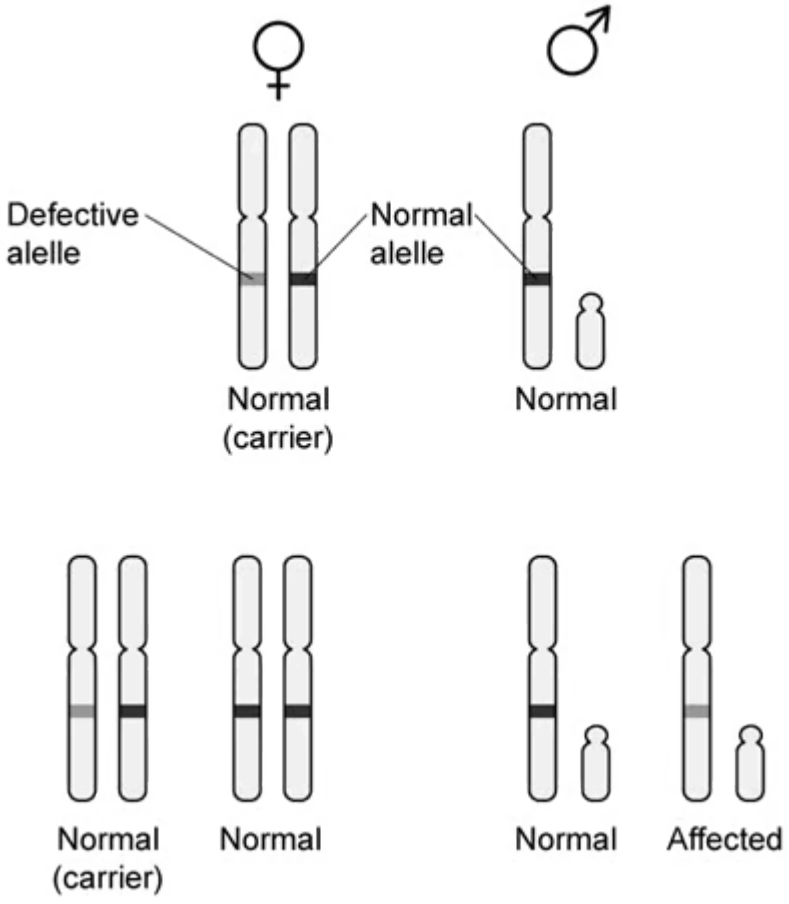
Suggest why FG syndrome occurs almost exclusively in males.

.....

.....

(2 marks)

(b) The diagram below shows the familial inheritance of an X-linked recessive disease.



Describe the patterns of inheritance that hold true for X-linked conditions.

.....

.....

(3 marks)

(c) Haemophilia is due to a sex-linked recessive gene X^h whereas the normal gene is X^H. A haemophiliac man and a woman, who does not have haemophilia, have two children. Their first child is male and has haemophilia.

Deduce what this tells us about the mother.

(1 mark)

(d) Their second child is female.

Deduce, with a reason, the probability that their daughter will also have haemophilia.

(2 marks)

Hard Questions

1 Outline the inheritance of colour-blindness.

(7 marks)

2 Human eggs and sperm cells are very different in size to each other.

Explain why, despite this size difference, both contribute equally to the genetic composition of a zygote.

(1 mark)

3 (a) Explain why knowledge of blood groups is of critical importance when planning a blood transfusion.

(2 marks)

(b) A man of blood group **AB** and a woman of blood group **B** have four children together.

- One child is blood group **AB**
- One child is blood group **A**
- Two children are blood group **B**

Assuming that the genotypes of the four children are representative of the expected genotype ratios, deduce the mother's and father's genotypes under the A, B, O blood grouping system.

(3 marks)

(c) Using your knowledge of the A, B, O blood grouping system, suggest why people of blood group O are sought-after as blood donors.

(2 marks)

(d) As stated in part (c), group O blood is highly valued for transfusions into other patients.

Explain the main **disadvantage** of a person having group O blood.

(2 marks)

4 (a) Chickens can produce pigmentation in their feathers to make them white, black or speckled, as shown in the diagram below.

White feathers | Black feathers | Speckled feathers

Homozygous white-feathered chickens can be crossed with homozygous black-feathered chickens to produce speckled offspring. This occurs via codominance.

Construct a Punnett grid to show the results of two of the speckled offspring being crossed. Use your Punnett grid to deduce the ratios of the various phenotypes that would come out of the cross.

(4 marks)

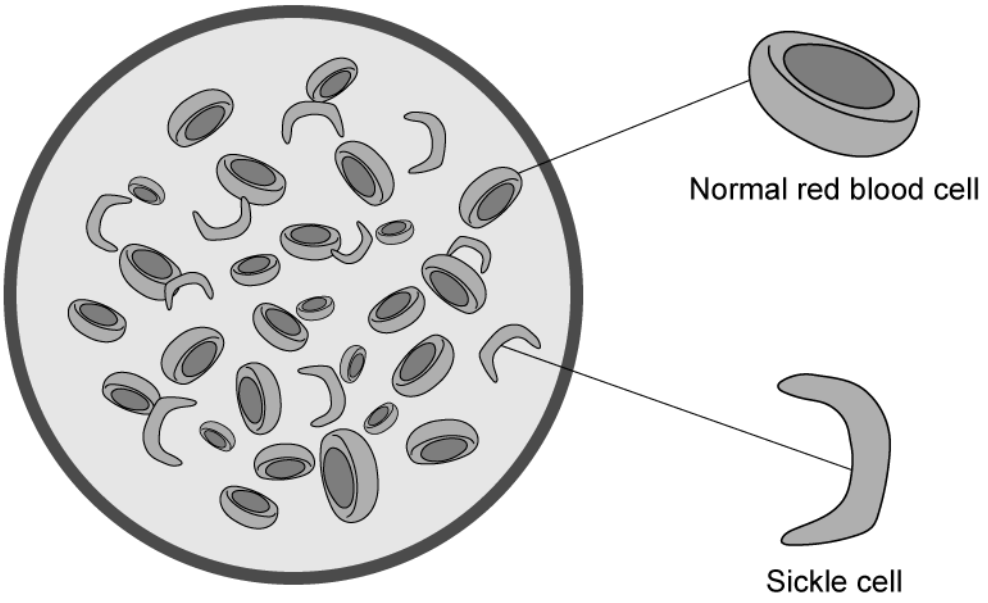
(b) Explain why the traits shown in part (a) are referred to as *codominant*.

(2 marks)

(c) The genetic disease sickle cell anaemia is caused by a faulty allele of the beta-globin gene, needed for the production of functional haemoglobin in red blood cells.

The faulty allele causes red blood cells to adopt a sickle shape when oxygen availability is low, as opposed to the conventional biconcave disc structure, as shown below. Sickle

cells cause considerable suffering including severe cramping pains in fingers and toes, and general fatigue.



The following table gives information about the condition in its various forms.

Genotype	Disease manifestation
Homozygous dominant	No disease All red blood cells are biconcave discs
Heterozygous	Mild symptoms at worst Mixture of biconcave discs and sickle-shaped cells at low oxygen levels
Homozygous recessive	Severe disease All red blood cells sickle-shaped at low oxygen levels, considerable suffering

Use the information above to explain why the condition is regarded as codominant.

.....

.....

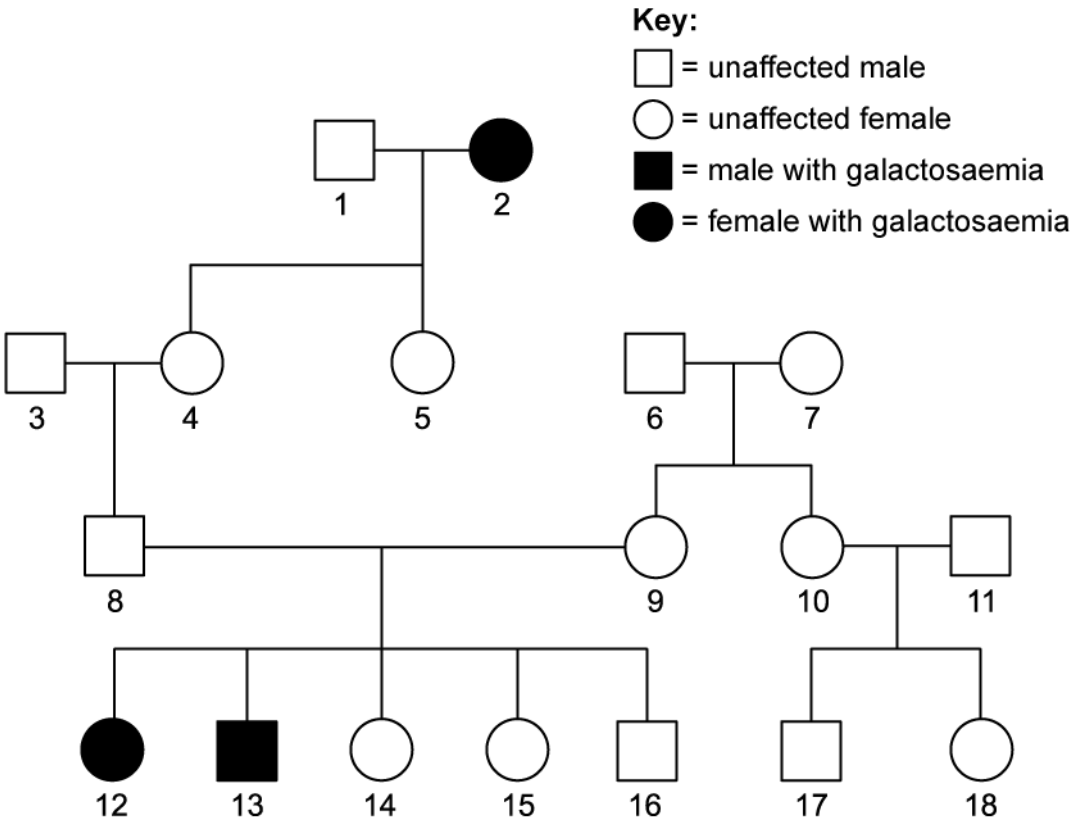
(2 marks)

5 (a) Explain how mutations can have a positive effect on a species.

(2 marks)

(b) Galactosaemia is a condition that prevents sufferers from fully metabolising the sugar galactose.

The pedigree chart below shows part of a family in which galactosaemia is an inherited condition.



Explain how this pedigree chart indicates whether galactosaemia is recessive, sex-linked or both.

(3 marks)

(i) A certain species of flower grows with either red or white petals. The allele for red flowers, **R**, is dominant to the allele for white flowers, **r**.

6 (a) Construct a genetic diagram to predict the outcome of crossing pure-bred red flowers with pure-bred white flowers.

State the genotype and phenotype ratios that would be expected in the F_1 generation.

[3]

(ii) Plants from the F_1 generation were crossed.

Construct a second genetic diagram to predict the outcomes.

State the genotype and phenotype ratios that would be expected in the F_2 generation.

[4]

(7 marks)

(b) Huntington's disease is a genetic condition that affects the brain progressively. Problems with coordination worsen over time and can ultimately cause death by, for example, an inability to swallow or by injuries associated with falling.

(i) Huntington's disease is described as an autosomal dominant disorder.

Explain the term **autosomal dominant**.

[2]

(ii) The mutation in the Huntington's disease allele contains a higher-than-normal number of repeats of a nucleotide sequence coding for a protein called huntingtin.

Suggest the consequence to the protein huntingtin of the extra nucleotide repeats.

[2]

.....

.....

.....

.....

(4 marks)

7 (a) When investigating variation scientists often study sets of twins, both identical and non-identical.

Suggest the advantage of studying twins when investigating variation.

(2 marks)

(b) A scientific study carried out in 2013 investigated whether academic achievement was influenced primarily by genetics or the environment.

11 117 pairs of identical twins participated in the study, which found that around 55% of the outcomes in core GCSE subjects (English, maths, and science) were explained by genetic influence, 25% by shared environmental influences, such as parental support, and the remaining 20% by environmental influences that were not shared between the two twins, such as teacher quality and class grouping.

Using this information, evaluate the statement "intelligence is determined by genetics".

(3 marks)

(c) Twin studies tend to be run using two main assumptions:

- That the identical twins in the study share 100% of their DNA
- That all twins are raised in exactly equal environments at home

Discuss whether it is correct to make these assumptions about twin studies.

(2 marks)

8 *Drosophila melanogaster* is a useful organism to use in studies on inheritance patterns. Female fruit flies can lay up to 400 eggs, which can develop into adults in 7-14 days. They have simple nutrient requirements.

Explain why *Drosophila melanogaster* is a useful organism in studies of inheritance patterns.

.....

.....

.....

(3 marks)