eduresourceza.com

Downloaded from eduresourceza.com

GENETICS AND INHERITANCE

1. Concepts in Inheritance

1.5 The table below shows the autosomes and sex chromosomes of human egg and sperm cells.

EGG (23)	SPERM (23)	ZYGOTE (46)	SEX OF CHILD
22 + X	22 + X	(a)	(c)
22 + X	22 + Y	(b)	(d)

1.5.1 Write down the letters **(a)** and **(b)** and next to each the autosomes and sex chromosomes that complete the table above. (2)

1.5.2 Write down the letters **(c)** and **(d)** and next to each the sex of the child that completes the table above. (2)

1.5.3 A woman has three children, all of whom are boys. What is the probability of her fourth child being a girl? Explain your answer. (3)
(7)

1.5
1.5.1 (a) 44XX✓
(b) 44XY✓ (2)

1.5.2 (c) Girl✓/female
(d) Boy✓/male (2)

1.5.3 50% ✓ /equal chance that the fourth child would be a boy or a girl
Half of all the sperm of the father carry the X chromosome✓ and half of all the sperm carry the Y chromosome✓

(Answer might be given in a Punnett square/line diagram) (3)
(7)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.4 Explain:

3.4.1 The principle of dominance (3)
3.4.2 Mendel's law of segregation (3)
[30]

3.4

3.4.1 In a heterozygous condition✓ the dominant allele expresses itself in the phenotype✓, masking the effect of the recessive allele✓

OR

When two individuals with pure breeding✓contrasting characteristics ✓ are crossed,the F_1-generation all display the dominant✓characteristic (3)

3.4.2 Each characteristic is regulated by two alleles✓/factors which separate✓ during meiosis so that each gamete contains only one of the alleles✓/factors (3)
(6)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2. Monohybrid Crosses

2.4 In cats the allele for short hair is dominant **(H)** to the allele for long hair **(h)**.

A short-haired cat that is heterozygous is crossed with a long-haired cat. Use a genetic cross to determine the percentage chance of the offspring being heterozygous for hair length. (6)

2.4 **P**$_1$/parent Phenotype: short-haired x long-haired ✓
Genotype: Hh x hh ✓
Meiosis
G/gametes H, h x h, h ✓

Fertilisation

F$_1$/offspring Genotype: Hh ; Hh ; hh; hh ✓
Phenotype: 2 short-haired cats, 2 long-haired cats ✓

***50% chance of heterozygous offspring** ✓
Parents and offspring ✓/P$_1$ and F$_1$
Meiosis and fertilisation ✓

(Any 5 + ***1 compulsory mark**)

OR

P$_1$/parent Phenotype: short hair x long hair ✓
Genotype: Hh x hh ✓
Meiosis
G/gametes H, h x h, h ✓

Fertilisation

Gamete	H	h
h	Hh	hh
h	Hh	hh
1 mark for correct gametes 1 mark for correct genotypes		

F$_1$/offspring Genotype: Hh ; Hh ; hh ; hh ✓
Phenotype: 2 short-haired cats, 2 long-haired cats ✓

***50% chance of heterozygous offspring**
Parents and offspring ✓/P$_1$ and F$_1$
Meiosis and fertilisation ✓ (Any 5 + ***1 compulsory mark**) (6

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.2 In dogs rough hair (**H**) is dominant to smooth hair (**h**). A heterozygous rough-haired dog is mated with a smooth-haired dog.

Represent a genetic cross to show the phenotypic ratio of the puppies. **(6)**

2.2.

P_1	Phenotype	Rough hair	x	Smooth hair✓
	Genotype	Hh	x	hh✓
Meiosis				
	G/gametes	H h	x	h h✓
Fertilisation				
F_1	Genotype	Hh Hh		hh hh ✓
	Phenotypic ratio	1 rough hair : 1 smooth hair ✓		

P_1 and F_1✓
Meiosis and fertilisation✓ Any 6

OR

P_1	Phenotype	Rough hair	x	Smooth hair✓
	Genotype	Hh	x	hh✓

Meiosis

Fertilisation

Gametes	H	h
h	Hh	hh
h	Hh	hh

1 mark for correct gametes
1 mark for correct genotypes

F_1	Phenotypic ratio	1 rough hair : 1 smooth hair ✓

P_1 and F_1✓ **(6)**
Meiosis and fertilisation✓ Any 6

2.2 A grey (**G**) male rabbit was mated with an albino (**g**) female rabbit. The entire F_1 generation was grey.

Use a genetic cross to show the phenotypic ratio of their offspring if one of the males of the F_1 generation was mated with an albino female. **(7)**

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.2

P_2	Phenotype	Grey male	x	Albino female✓
	Genotype	Gg	x	gg✓
Meiosis				
	G/gametes	G, g	x	g, g✓
Fertilisation				
F_2	Genotype	Gg; Gg; gg; gg ✓		
	Phenotype	2 grey rabbits : 2 albino rabbits ✓		

Phenotypic ratio of offspring is *1 : 1✓
P_2 and
F_2✓
Meiosis and fertilisation✓

***1 compulsory** + any 6

OR

P_2	Phenotype	Grey male	x	Albino female✓
	Genotype	Gg	x	gg✓
Meiosis				
Fertilisation				

Gametes	G	g
g	Gg	gg
g	Gg	gg

1 mark for correct gametes
1 mark for correct genotypes

F_2	Phenotype	2 grey rabbits : 2 albino rabbits ✓

Phenotypic ratio of offspring is *1 : 1✓
P_2 and
F_2✓ **(7)**
Meiosis and fertilisation✓

***1 compulsory** + any 6

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.1 In rabbits, black fur is produced by the allele (**B**) and white fur by the allele (**b**).

The table below shows the genotypes of some rabbits.

RABBIT	GENOTYPE
1	BB
2	Bb
3	bb

2.1.1 What is the phenotype:

(a) Produced by the recessive allele (1)

(b) Of rabbit **2** (1)

2.1.2 Give the NUMBER only (**1**, **2** or **3**) of the rabbit(s) that is/are:

(a) Pure-bred

(b) Homozygous dominant (3)

2.1.3 Use a genetic cross to show the percentage chance of rabbits **1** and **3** having offspring with white fur. (6)
(11)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.1	2.1.1	(a)	White✓fur	(1)
		(b)	Black✓fur	(1)
	2.1.2	(a)	1✓ and 3✓ ***(Mark first TWO only)***	(2)
		(b)	1✓ ***(Mark first ONE only)***	(1)

2.1.3

P_1	Phenotype	Black	X	White✓	
	Genotype	BB	X	bb✓	
Meiosis					
	G/gametes	B, B	X	b, b✓	
Fertilisation					
F_1	Genotype	Bb;	Bb,	Bb;	Bb ✓
	Phenotype	All black ***0✓%white**			

P_1 and F_1✓
Meiosis and fertilisation✓

(*compulsory mark + 5)

OR

P_1	Phenotype	Black	X	White✓
	Genotype	BB	X	bb✓

Meiosis

Fertilisation

Gametes	B	B
b	Bb	Bb
b	Bb	Bb

1 mark for correct gametes
1 mark for correct genotypes

F_1	Phenotype	All black ***0✓% white**

P_1 and F_1✓
Meiosis and fertilisation✓

(* compulsory mark + 5) (6)
(11)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.2 In rabbits the dominant allele (**B**) produces black fur and the recessive allele (**b**) produces white fur. Study the genotypes of four rabbits.

Rabbit	**1**	**2**	**3**	**4**
Genotype	BB	Bb	Bb	bb

2.2.1 Give the phenotypes of:

(a) Rabbit **2** (1)

(b) Rabbit **4** (1)

2.2.2 State the genotypic ratio that is shown in the table above. (2)

2.2.3 If rabbits **1** and **4** were mated together and had 12 offspring, how many of these would you expect to be black? (1)

2.2.4 Rabbit **3** was allowed to breed with rabbit **4**. Use a genetic cross to show the possible phenotypes and genotypes of the F1 generation for fur colour. (6)

2.2 2.2.1 (a) Black ✓fur (1)

(b) White ✓fur (1)

2.2.2 1BB :2Bb :1 bb ✓✓ (2)

2.2.3 12 ✓ (1)

2.2.4 **P_1** Phenotype Black X White ✓

Genotype Bb X Bb ✓

Meiosis

G/gametes B, b X I^B, i

Fertilisation

F_1 Genotype Bb Bb; bb bb ✓*

Phenotype Black white✓*

P_1 and F_1 ✓

Meiosis and fertilisation ✓

OR

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

OR

P_1	Phenotype	Black	X	White ✓
	Genotype	Bb	X	bb ✓

Meiosis

Fertilisation

Gametes	B	b
b	Bb	bb
b	Bb	bb

1 mark for correct gametes
1 mark for correct genotypes ✓*

F_1 Phenotype Black , white ✓*

P_1 and F_1 ✓

Meiosis and fertilisation ✓

*(compulsory 2 + any 4) (6)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.1 In rabbits the dominant allele (B) produces black fur and the recessive allele (b) produces white fur. Study the table below showing the genotypes of four rabbits.

RABBIT	1	2	3	4
GENOTYPE	BB	Bb	Bb	bb

3.1.1 What are the phenotypes for rabbits **2** and **4**, respectively? (2)

3.1.2 State the genotypic ratio that is shown in the table above. (1)

3.1.3 If rabbits **1** and **4** mated and had 18 offspring, how many of these would you expect to be black? (1)

3.1.4 Rabbit **2** was allowed to mate with rabbit **4**.

Represent a genetic cross to show the possible phenotypes and the genotypes of the F_1 generation for fur colour. (6)
(10)

3.1
3.1.1 2 - Black✓
4 - White✓ (2)

3.1.2 1BB: 2Bb: 1bb✓/ 1:2:1 (1)

3.1.3 18✓/all/100% (1)

3.1.4 **P_1** phenotype Black x White✓
genotype Bb x bb✓

Meiosis

G B, b x b, b ✓

Fertilisation

F_1 genotype Bb Bb bb bb✓

phenotype Black , White✓

OR

gametes	b	b
B	Bb	Bb
b	bb	bb

1 mark for correct gametes
1 mark for correct genotypes

Parents and offspring✓/P_1 & F_1
Meiosis and fertilisation✓ any (6)
(10)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.4 Plants with yellow flowers were crossed with plants having red flowers. All the offspring had orange flowers.

Crosses were then done using different combinations of parental phenotypes to produce the F1 generation. The results are shown in the table below.

Cross Number	Results of the Cross
1	All **red**
2	All **orange**
3	52 **orange** and 51 **red**
4	22 variety **yellow**, 55 **orange**, 24 **red**

1.4.1 Name the type of dominance for flower colour represented by the above information. (1)

1.4.2 Use the letter **Y** for yellow and **R** for red to give the genotype for:

(a) Yellow flowers (1)

(b) Orange flowers (1)

1.4.3 Give the NUMBER of the cross where both parents are:

(a) Heterozygous (1)

(b) Homozygous (1)

(5)

1.4	1.4.1	Incomplete✓ dominance	(1)
	1.4.2	(a) YY✓	(1)
		(b) YR✓	(1)
	1.4.3	(a) 4✓	(1)
		(b) 1✓/2	(1)
			(5)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.1 In the Hedera plant green leaves **(G)** are dominant over variegated leaves (combination of yellow and green) **(g).** A plant which is heterozygous for green leaves is crossed with a plant with variegated leaves.

3.1.1 Write the genotype of the plant with green leaves in the crossing mentioned above. (1)

3.1.2 If the plant in QUESTION 3.1.1 is allowed to undergo self-pollination and 64 offspring are produced, how many plants …

(a) will have variegated leaves? (1)
(b) will be heterozygous for green leaves ? (1)
(c) will be homozygous? (1)
(4)

3.1

3.1.1 Gg ✓ (1)

3.1.2 (a) 16 ✓ (1)

(b) 32✓ (1)

(c) 32✓ (1)
(4)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.2.5 Use the symbols **T** for the normal allele and **t** for the recessive Tay-Sachs allele.

Do a genetic cross to determine the percentage chance of a couple who are both heterozygous for Tay-Sachs, to have a child with this disorder. (6)

2.2.6 Tay-Sachs disorder has a high incidence among a certain population group in Europe. One in every 27 people in this population group has at least one allele for this disorder.

If a sample of 360 000 people in this population group is tested, how many of them do you expect to have the allele for Tay-Sachs? Show all workings. (3)

2.2.5

P_1: Phenotype Normal X Normal✓
Genotype Tt X Tt✓
Meiosis
Gametes: T; t T; t✓
Fertilisation
F_1:

Gametes	T	t
T	TT	Tt
t	Tt	tt

✓

Phenotype: 25% chance to have a child with Tay Sachs ✓

Both P_1 and F_1 ✓
Both meiosis and fertilisation ✓ (Any 6)

OR

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

P_1:	Phenotype	Normal	X	Normal✓
	Genotype	Tt	X	Tt✓

Meiosis

Gametes **T t T t** ✓

Fertilisation

F_1: **T T Tt Tt tt** ✓

Phenotype: 25% chance to have a child with Tay Sachs ✓

Both P_1 and F_1 ✓
Both meiosis and fertilisation ✓ (Any 6)

2.2.6 $\frac{1}{27}$ ✓X $\frac{360\,000}{1}$ ✓= 13✓ **OR** $\frac{360\,000}{27}$ ✓✓= 13✓ (3)

(17)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.6 You have two rose plants, both with pink flowers. You cross them and find that, while most of the offspring are pink, some are red and some are white.

Use a genetic cross to show how breeding two pink flowering plants can result in pink, red and white flowering plants.

Use the letter **R** for the red allele and **W** for the white allele. **(6)**
[40]

2.6 2.6.1

P_1	Phenotype	Pink	x	Pink✓
	Genotype	RW	x	RW✓
Meiosis				
	G/gametes	R, W	x	R, W ✓
Fertilisation				
F_1	Genotype	RR;	RW; RW;	WW ✓
	Phenotype	Red	Pink	White ✓

P_1 and F_1✓
Meiosis and fertilisation✓

Any 6

OR

P_1	Phenotype	Pink	x	Pink ✓
	Genotype	RW	x	RW ✓

Meiosis

Fertilisation

Gametes	R	W
R	RR	RW
W	RW	WW

1 mark for correct gametes
1 mark for correct genotypes

F_1 Phenotype Red : Pink : White ✓

P_1 and
F_1✓
Meiosis and fertilisation✓ **(6)**

Any 6 **[40]**

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

4.1 In an experiment to show co-dominance, cows with white fur (W) were crossed with bulls with red fur (R). All the offspring of the F_1-generation have roan fur (RW). A roan fur consists of patches of white and patches of red fur. Roan cows and roan bulls were crossed and the results are given below.

Genotype	RR	RW	WW
Number of offspring	120	240	120

4.1.1 Give the ratio of the different phenotypes shown in the above table. (2)

4.1.2 Use the information in the table above to draw a pie-chart showing the proportions of the different genotypes. (7)

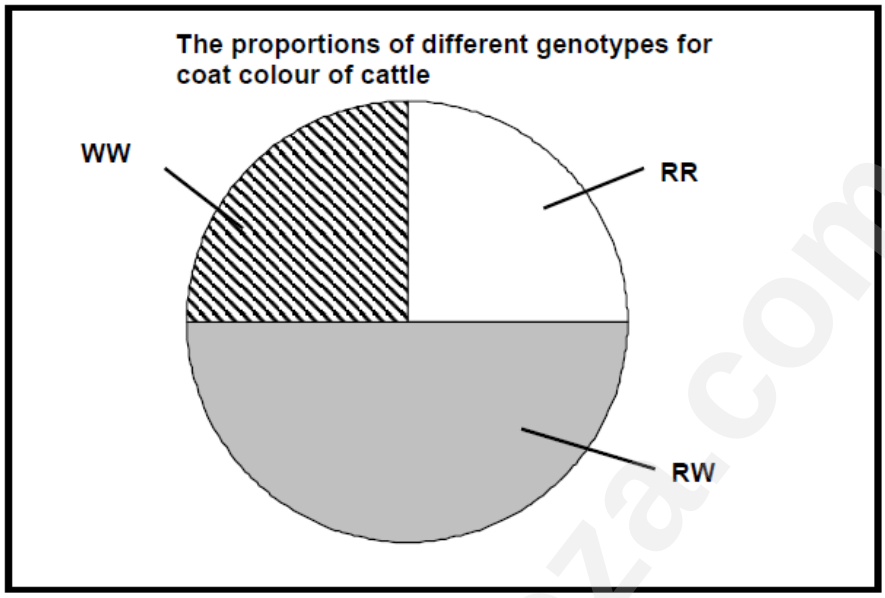
4.1.3 Explain why the cows and bulls with genotype RW have roan fur and not only red or only white fur. (3)
(12)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

4.1.1 1 : 2 : 1✓ ✓ (2)

4.1.2



Rubric for the mark allocation of the pie chart

Correct type of graph	1
Caption	1
Correct proportions of slices	1: 1 correct slice 2: 2 to 3 correct slices
Label / key for each slice	1 mark for each label

NOTE: If the wrong type of graph is drawn: marks will be lost for "correct type of graph" as well as for drawing the slices in correct proportions. (7)

4.1.3 Both alleles✓ for fur colour are equally dominant✓ and therefore both are expressed in the phenotype✓

OR

Neither of the alleles✓ for red or white colour are dominant over each other✓ and therefore no one colour alone is expressed/ masked in the phenotype✓ (3)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.3 A farmer has an orchard of apple trees. Each apple produced expressed red and yellow colour equally (red-yellow apples). To extend his apple orchard, the farmer collected seeds from the red-yellow apples and grew them.

When the new trees matured, he found that some of the trees produced red apples (**R**), others produced yellow apples (**Y**) and the rest produced apples that were red-yellow.

3.3.1 Use a genetic cross to explain his results in the F_1 generation. (6)

3.3.2 What proportion of apples in the F_1 generation will be red-yellow apples? (1)

3.3.3 The farmer saw that the red-yellow apples sell the best. Name the phenotypes of the trees that he should cross in the future in order to ensure that any new trees will definitely produce only red-yellow apples. (2)
(9)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.3 3.3.1

P_1	phenotype	red-yellow	X	red-yellow✓
	genotype	RY	X	RY✓

Meiosis

G/gametes R, Y X R, Y✓

Fertilisation

F_1 genotype RR, RY, RY, YY✓

phenotype	red apples	red-yellow apples	yellow✓ apples

P_1 and F_1✓
Meiosis and fertilisation✓ (Any 6)

OR

P_1	phenotype	red-yellow	X	red-yellow✓
	genotype	RY	X	RY✓

Meiosis

Fertilisation

Gametes	R	Y
R	RR	RY
Y	RY	YY

1 mark for correct gametes
1 mark for correct genotypes

F_1 genotype RR, RY, RY, YY✓

phenotype	red apples	red-yellow apples	yellow✓ apples

P_1 and F_1✓
Meiosis and fertilisation✓ (Any 6) (6)

3.3.2 50%✓/half (1)

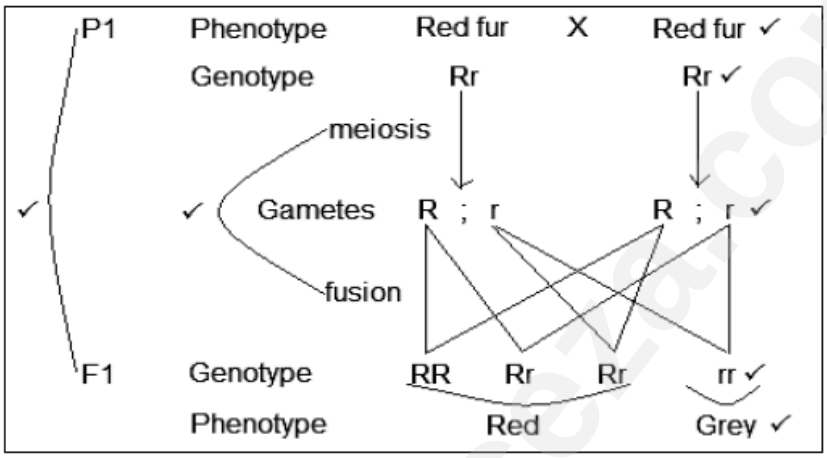
3.3.3 A tree with red apples✓ should be crossed with a tree that produces yellow apples✓ (2)
(9)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.1 In mice, the allele for red fur colour (R) is dominant over the allele for grey fur colour (r). It also happens that all embryos, which are homozygous for the dominant factor, will always die before birth. If a colony of heterozygous mice were inbred to produce 300 young living mice, how many of these offspring would be likely to have red fur and how many will have grey fur? Use a genetic diagram to show how you arrived at your answer. (7)

3.1



Individuals with RR will die before birth:
Phenotypic ratio is therefore 2 red fur : 1 grey fur
(rather than 3 red fur : 1 grey fur)
Therefore: 200 / two thirds of the population has red fur
100 *✓/ one third of the population has grey fur
Any 6 points from diagram plus 1 compulsory point for the answer above (*) (7)

4.2 There are red-flowered, white-flowered and pink-flowered varieties in a certain plant. The results of two crosses are shown in the table below.

Crosses	Number of plants of each colour		
	Red	Pink	White
Red x white	0	115	0
Pink x pink	40	80	40

Using the symbols **R** (red) and **W** (white) for the alleles for flower colour, represent a genetic cross to explain the results in the table for the cross between two pink-flowered plants. **(6)**

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

4.2 **P_1** phenotype Pink x Pink✓
genotype RW x RW✓

Meiosis

Gametes R, W x R, W ✓

Fertilisation

F_1 genotype RR RW RW WW✓

phenotype **1 Red** **2 Pink** **1 White**✓*

Parents/P_1 and offspring/F_1✓
Meiosis and fertilisation✓

*** 1 Compulsory mark + any 5 other (6)**

OR

P_1 phenotype Pink x Pink✓
genotype RW x RW✓

Meiosis

Gametes

Fertilisation

gametes	R	W
R	RR	RW
W	RW	WW

1 mark for correct gametes
1 mark for correct genotypes

F_1 phenotype **1 Red** **2 Pink** **1 White**✓*

Parents/P_1 and offspring/F_1✓
Meiosis and fertilisation✓

*** 1 Compulsory mark + any 5 other (6)**

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

4.2 The table below shows the results obtained by first crossing a pure-bred black furred mouse with a brown furred mouse. The gene for black fur is dominant over the gene for brown fur. The F_1 generation was used as parents (consisting of 4 breeding pairs) of the F_2 generation.

	Number of black mice	Number of brown mice
Parents	1	1
F_1 generation	8	0
F_2 generation		
Offspring of 1st breeding pair	8	0
Offspring of 2nd breeding pair	7	1
Offspring of 3rd breeding pair	5	3
Offspring of 4th breeding pair	4	4

4.2.1 From the data, calculate the phenotypic ratio of the mice with black fur and the mice with brown fur in the F_2 generation. Show ALL your workings. (2)

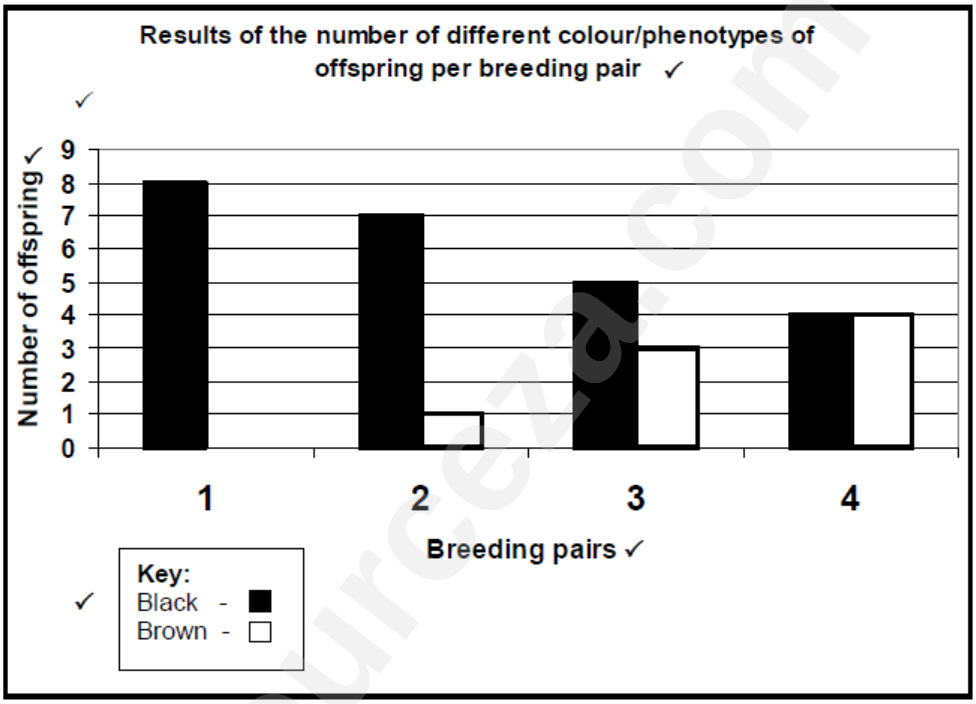
4.2.2 Suggest why it is better to use the four sets of offspring to calculate the ratio rather than using only one set. (2)

4.2.3 Draw bar graphs on the same system of axes to represent the phenotypic results of the F_2 generation offspring of each breeding pair shown in the table above. (9)
(13)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

4.2	4.2.1	24 : 8✓(accept different correct working) = 3 : 1✓	(2)
	4.2.2	To increase the reliability of theresults✓✓ **OR** Reduces chances of errors✓✓ any	(2)
	4.2.3		

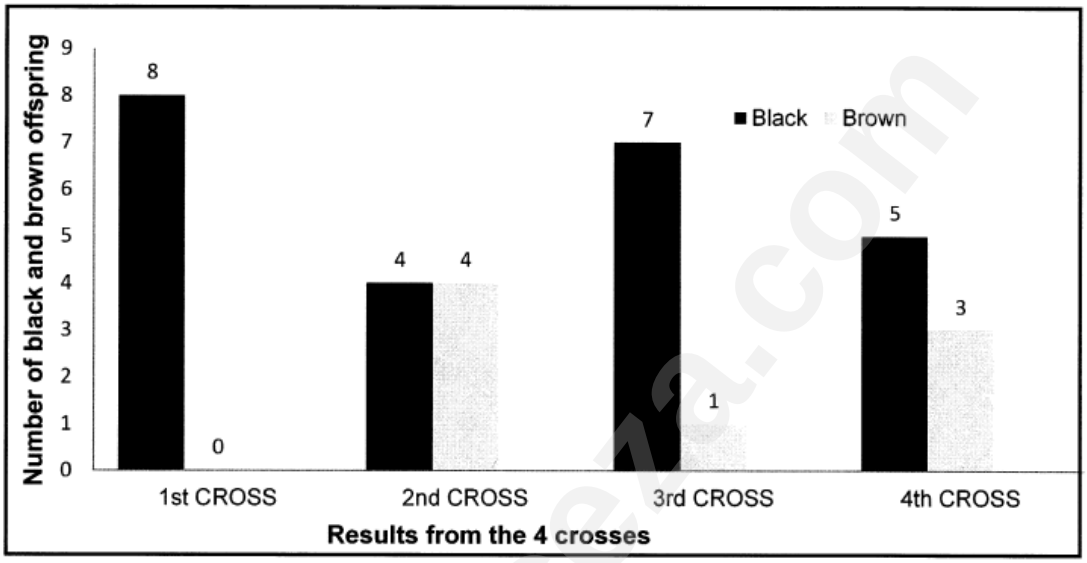


T✓
D ✓✓

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.5 A learner wanted to determine the genotypes of his breeding pair of mice. Black fur colour is dominant to brown fur colour in mice. His black male was crossed four times with his brown female. The results of the crosses are shown in the following graph.



1.5.1 Supply the graph with a suitable heading. (2)

1.5.2 Give the dependent variable in this investigation. (1)

1.5.3 From the graph, determine the ratio between all the black and brown offspring. Show all calculations. (2)

1.5.4 What conclusion can be made from this investigation? (2)

1.5.5 Why did the learner do four crosses? (1)

(8)

Downloaded from eduresourceza.com

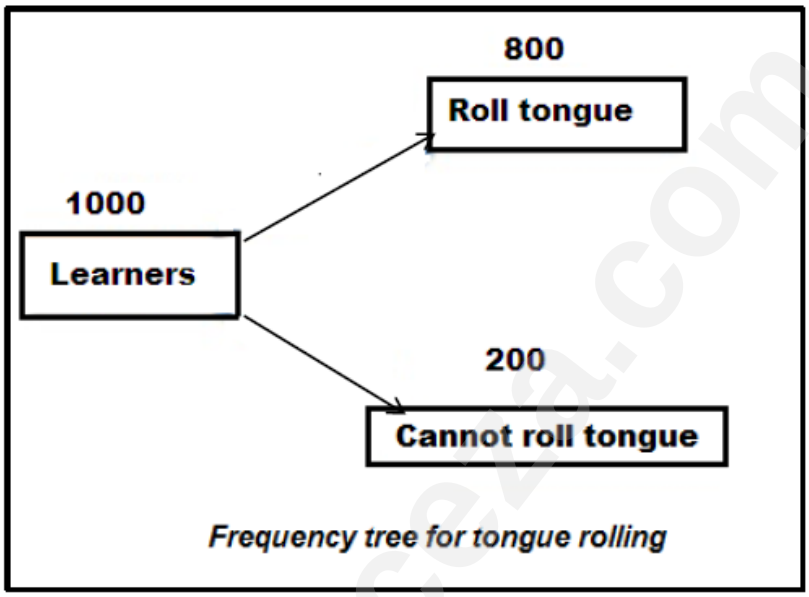
Downloaded from eduresourceza.com

1.5.1	The **number of black and brown offspring**✓ from **4 crosses**✓ between a breeding pair of mice/ black male and brown female	(2)
1.5.2	Number of black and brown offspring✓	(1)
1.5.3	Black : Brown 24 : 8✓ 3 : 1✓	(2)
1.5.4	The black male is heterozygous✓ and the brown female is homozygous✓	(2)
1.5.5	To increase the reliability✓ of the investigation	(1)
		(8)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.3 A class of Grade 11 learners conducted an investigation to determine the frequency of dominant and recessive characteristics in their school. The characteristic investigated was the ability to roll one's tongue.
The results obtained were recorded in the frequency tree as shown below.



Frequency tree for tongue rolling

2.3.1 Based on the results obtained from this investigation, which characteristic is dominant? (1)

2.3.2 List THREE steps that the learners need to follow while planning this investigation. (3)

2.3.3 Use the data given in the frequency tree to plot a bar graph. (6)

2.3.4 Would you classify the ability to roll one's tongue as continuous or discontinuous variation? (1)

2.3.5 Explain your answer to QUESTION 2.3.4. (2)

Downloaded from eduresourceza.com

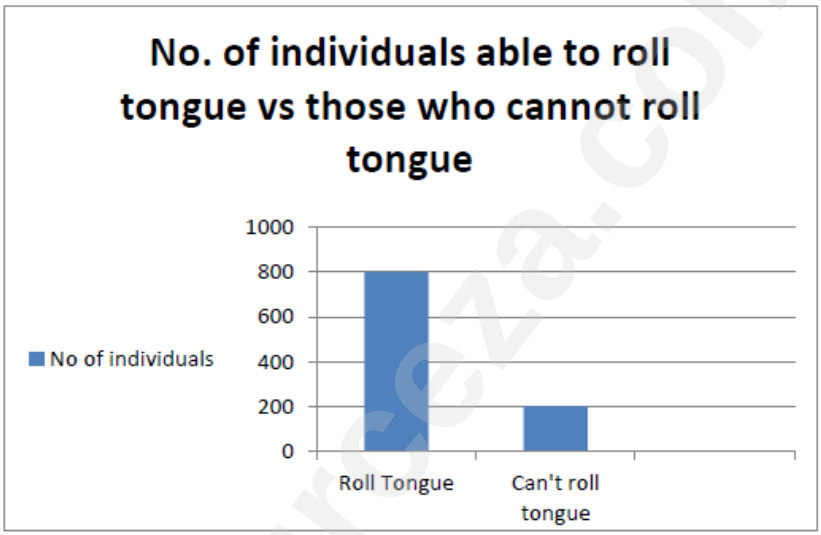
Downloaded from eduresourceza.com

2.3 2.3.1 Ability to roll the tongue ✓ (1)

2.3.2
- Ask the permission from the participants and the school principal to conduct the investigation. ✓
- Determine the sample size. ✓
- Decide on how data will be recorded. ✓
- Decide on data capturers to collect data. ✓

(*Mark first THREE only*) (Any 3 x 1) (3)

2.3.3



Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

Mark allocation of the graph

Criterion	Elaboration	Mark
Type of graph (T)	Bar graph drawn	1
Caption (C)	Includes both variables: number of individuals/able or unable to roll tongue	1
X-axis	Equal width of bars AND correct label	1
Y-axis	Appropriate scale AND correct label	
Plotting (P)	1 bar plotted correctly	1
	2 bars plotted correctly	2

NOTE:
If a line graph is drawn –marks will be **awarded** for the 'title and label for X-axis and Y-axis' only.
If a histogram is drawn – marks will be **lost** for the 'type of graph and correct scale' only. (6)

2.3.4 Discontinuous ✓ (1)

2.3.5 There is no range of different phenotypes for tongue rolling ✓/ there are no intermediates between phenotypes, either one can roll their tongue or they cannot. ✓ (2)

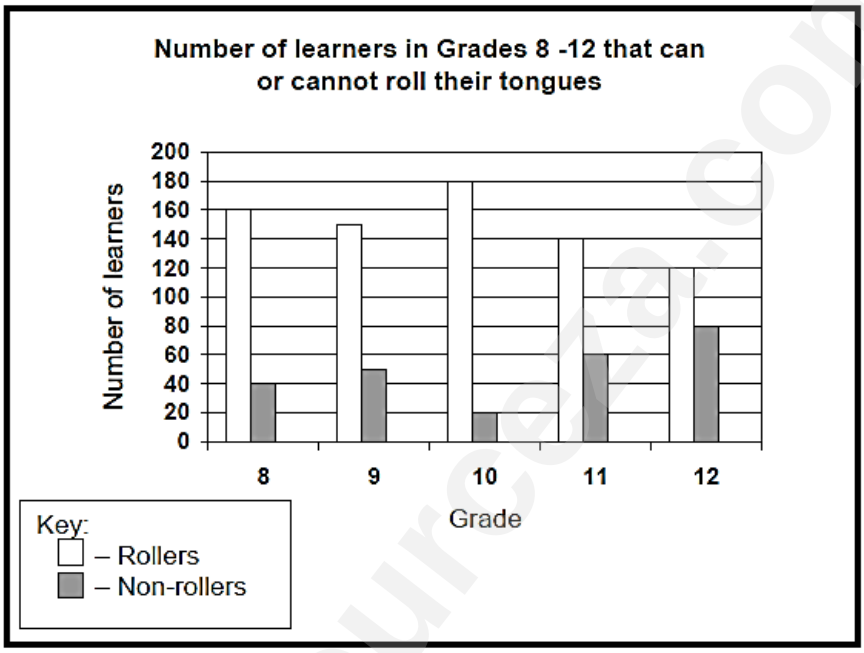
Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.1 Some people have the ability to roll their tongue (rollers) while other people cannot roll their tongues (non-rollers).

A Grade 12 learner wanted to determine the frequency of learners in the school that could roll their tongues.

She went to each grade in the school and counted the number of rollers and non-rollers. She presented her results in the graph below.



3.1.1 State a hypothesis for this investigation. (2)

3.1.2 Which grade had the most learners that could roll their tongues? (1)

3.1.3 Use the data in the graph to draw a table that shows the results she obtained. (7)

3.1.4 Calculate the ratio of rollers to non-rollers. Show ALL working. (4)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.1

3.1.1 Most✓ learners in the school can roll their tongue✓

OR

Most✓ learners cannot roll their tongue✓

OR

Equal✓ number of rollers and non-rollers✓

OR

Difference✓ in the number of rollers and non-rollers✓

OR

Tongue rolling occurs✓/does not occur among the learners✓ (2)

3.1.2 Grade 10✓ (1)

3.1.3 The number of rollers and non-rollers in the different grades

Grade	Rollers	Non-rollers
8	160	40
9	150	50
10	180	20
11	140	60
12	120	80

OR

The number of rollers and non-rollers in the different grades

Grade	8	9	10	11	12
Rollers	160	150	180	140	120
Non-rollers	40	50	20	60	80

Caption✓
Correct column headings✓
Correct row headings✓
Data in table: 5 rows correct✓✓✓
3 to 4 rows correct✓✓
1 to 2 rows correct✓
Drawing of table✓ (7)

3.1.4 160 + 150 + 180 + 140 + 120 = 750✓
40 + 50 + 20 + 60 + 80 = 250✓
750 ÷✓ 250 **OR** 750/250✓
OR 750✓ ÷✓ 250✓

3 : 1✓ / 75% : 25% / ¾ : ¼ **OR** 1 non-roller: 3 rollers (4)
(14)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.2 A learner investigated the frequency of certain dominant and recessive characteristics in his class.

His hypothesis was:
There will be more learners with dominant characteristics than learners with recessive ones.

He used 10 boys and 10 girls to investigate the following characteristics. He collected the data over a two weeks period.

Characteristic	Dominant	Recessive
Tongue rolling	roller	non roller
Number of fingers	five fingers	six fingers
Hair	curly hair	straight hair
Earlobe attachment	free earlobe	attached earlobe

The results of the investigation are shown in the table below:

Tongue roll	NO	6 Fingers	5 Fingers	Curly	Straight	Free earlobe	Attached earlobe
✓✓			✓✓✓		✓		
✓			✓		✓✓✓	✓✓✓	✓
✓✓✓	✓		✓✓	✓	✓	✓	
✓			✓✓✓✓		✓	✓✓✓	
✓✓	✓		✓		✓✓✓	✓✓✓	
✓✓✓			✓	✓✓	✓✓	✓	
✓	✓		✓✓✓✓✓		✓✓✓	✓✓✓	
✓	✓	✓	✓✓		✓	✓	
✓	✓			✓	✓	✓✓	✓✓

3.2.1 Process the results of the investigation and tabulate the findings neatly. (5)

3.2.2 Which TWO processes occur during meiosis to make it possible for a child to inherit different genes from parents? (2)

3.2.3 Which characteristic shows the largest difference between dominant and recessive alleles? (1)

3.2.4 Explain if this learner's hypothesis can be accepted or rejected? (2)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.2

3.2.1 **Table showing the different characteristics and the number of learners** H ✓

C✓

R✓

Characteristic	Number Dominant	Number Recessive	Total
Tongue Rolling	15	05	20
Number of fingers	19	01	20
Type of hair	04	16	20
Type of earlobe	17	03	20

V✓ ✓

Mark allocation: Heading =1
Column headings =1
Row headings =1
Correct values (1-8) =1
All correct =2 (5)

3.2.2 Crossing over✓ **and** random arrangement of homologous chromosomes at the equator. ✓ (2)

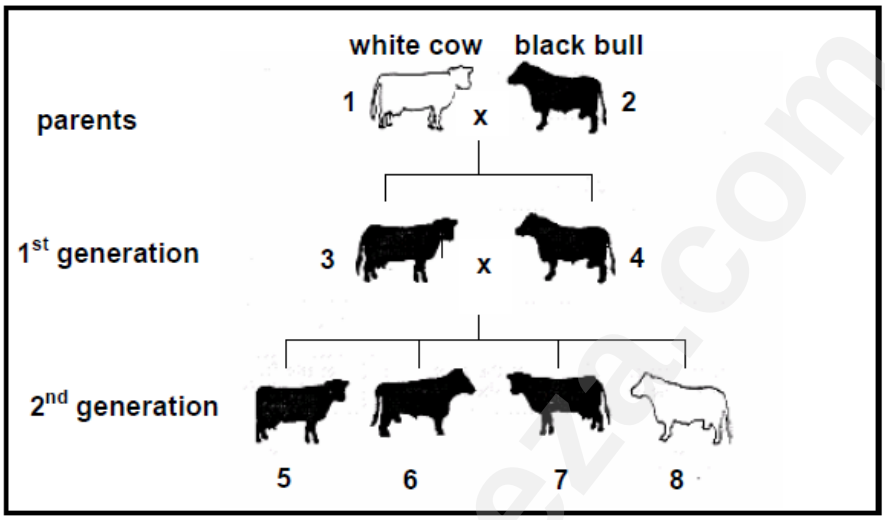
3.2.3 Number of fingers✓/5 or 6 (1)

3.2.4 Accepted✓ because the dominant trait is more✓ in the case given (2)
(10)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.4 The diagram below shows the offspring of crosses between a pure-bred black coat bull and a pure-bred white coat cow. The coat colours of the offspring of the first and second generations are also shown. Coat colour is controlled by two alleles, one for black and one for white coat colour.



1.4.1 Use the letters **B** and **b** and state which gene is responsible for the following:

(a) Black coat colour (1)

(b) White coat colour (1)

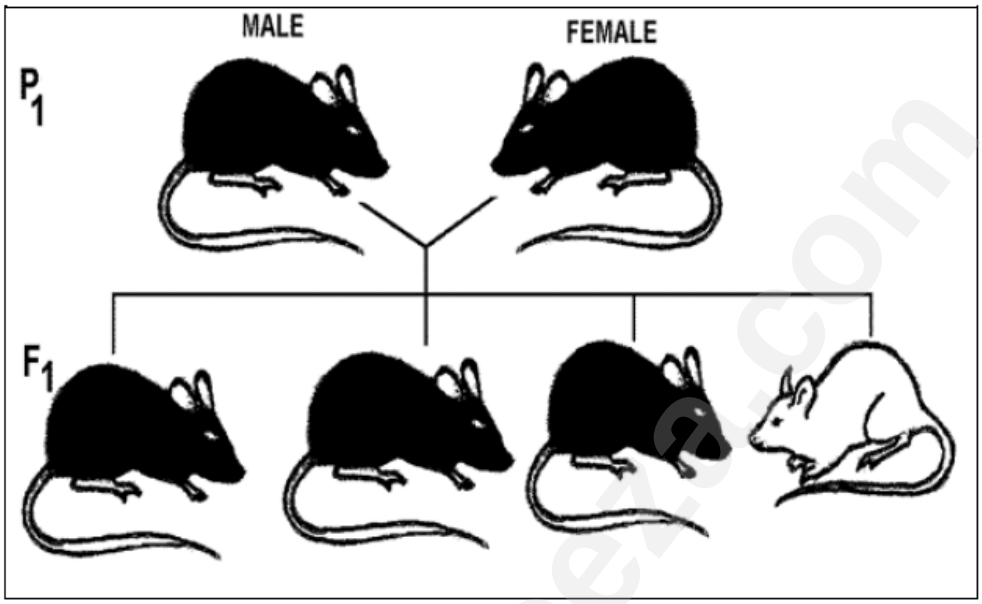
1.4.2 Which animal(s) (**1** to **8**) in the diagram **must be** homozygous for coat colour? (3)
(5)

1.4	1.4.1	(a) B✓	(1)
		(b) b✓	(1)
	1.4.2	1✓ 2✓ 8✓	(3)
		(Mark first THREE only)	**(5)**

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.1 The diagram below shows a genetic cross between two black mice. Study the diagram and answer the following questions. Use the symbols **B** and **b** for the alleles of fur colour.



3.1.1 Give the genotype of the male and the female parents respectively. (2)

3.1.2 What percentage of the F_1 generation is recessive? Show your working. (2)

3.1.3 What is the phenotype ratio of the F_1 generation? (1)

3.1.4 By using a genetic crossing diagram, show the possible genotypes and phenotypes of a cross between the white mouse in the F_1 generation and the female parent in the P_1 generation. (7)

Downloaded from eduresourceza.com

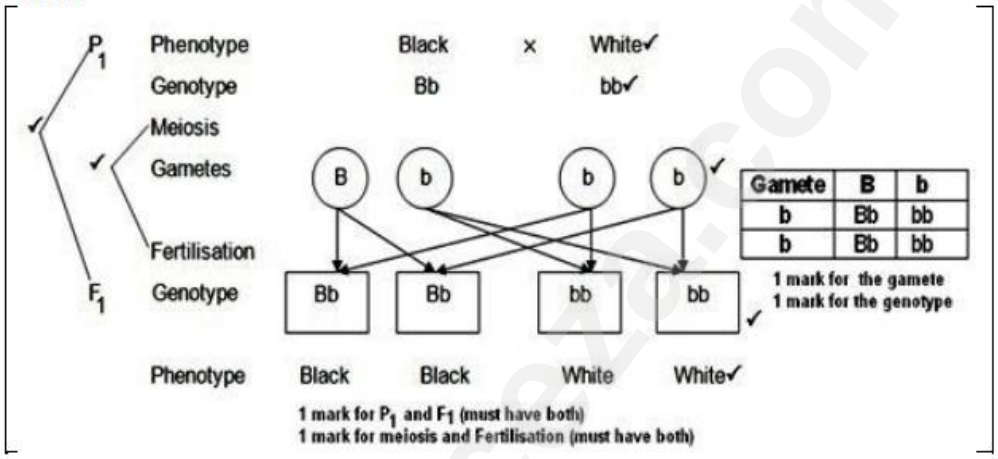
Downloaded from eduresourceza.com

3.1 3.1.1 Male parent **Bb** ✓
Female parent **Bb** ✓ (2)

3.1.2 $\frac{1}{4} \times 100$✓ $= 25\%$ ✓ (2)

3.1.3 3:1✓ (1)

3.1.4

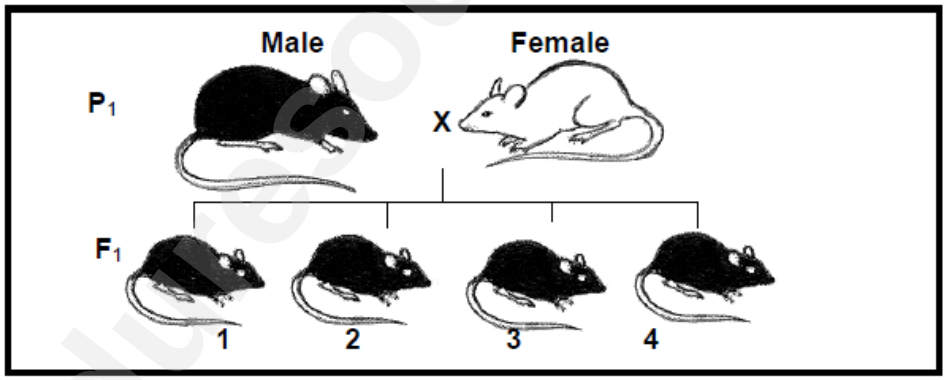


Gamete	B	b
b	Bb	bb
b	Bb	bb

1 mark for the gamete
1 mark for the genotype

(7)

4.3 The diagram below shows a crossing between a homozygous black mouse and a homozygous white mouse. The F_1-generation was all black.



Use the symbols **B** and **b** for the alleles of fur colour and show diagrammatically a genetic cross between mouse **1** and mouse **3** to show the possible genotypes and phenotypes of the next generation (F_2). **(7)**

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

4.3

P_2 phenotype Black x Black✓
genotype Bb x Bb✓

Meiosis

Gametes B, b x B, b ✓

Fertilisation

OR

gametes	B	b
B	BB	Bb
b	Bb	bb

1 mark for correct gametes
1 mark for correct genotypes

F_2 genotype BB Bb Bb bb✓

phenotype Black and White✓

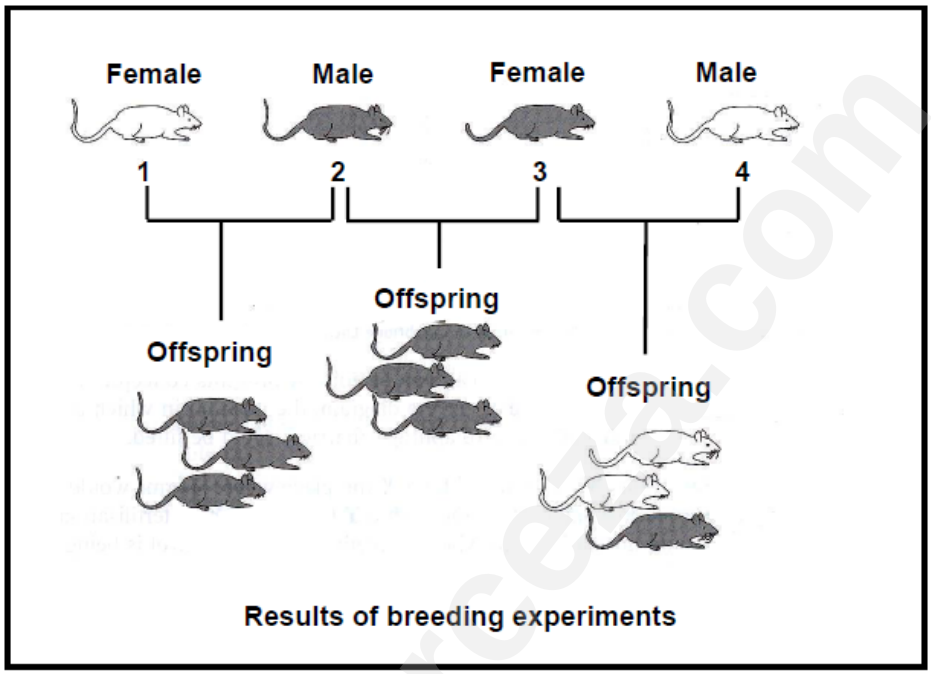
Parents and offspring✓/P_2 & F_2
Meiosis and fertilisation✓

(7)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.3 Study the diagrams below that show breeding experiments on mice. A single pair of alleles showing complete dominance controls coat colour (white or grey) in these mice.



Results of breeding experiments

2.3.1 Which sex chromosomes would be present in the gametes of mouse **2** and mouse **3** respectively? (2)

2.3.2 If mice **3** and **4** had a second set of offspring, what is the percentage chance that the first mouse born would be female? (1)

2.3.3 Which of the parent mice (**1**, **2**, **3** or **4**) is likely to be homozygous dominant for coat colour? (1)

2.3.4 State why mouse **3** can only be heterozygous for coat colour. (2)
(6)

2.3
2.3.1 Mouse 2 - X and Y/XY✓
Mouse 3 - X only/XX✓ (2)

2.3.2 50%✓ (1)

2.3.3 Mouse 2✓ (1)

2.3.4 A cross between mouse 3 and mouse 4✓produced some offspring with white✓/recessive coat colour and white colour will only show up if both parents have at least one recessive gene✓/
and 3 was dark therefore it must have been heterozygous any (2)
(6)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3. Sex-linked Inheritance

3.3 Haemophilia is a genetic disorder caused by a recessive allele on the X chromosome.

A haemophiliac female marries a normal male. Explain why all their sons will be haemophiliacs. **(4)**

3.3
- An individual inherits one allele from each parent✓
- The Y chromosome was inherited from the father✓
- and the recessive allele/X^h was inherited from the mother✓
- since the mother has two recessive alleles✓/X^h X^h
- A son only needs to get one recessive allele to be haemophiliac✓since the
- Y-chromosome does not carry any allele to mask the haemophilia allele✓

Any 4 **(4)**

2.4 Haemophilia is a sex-linked disorder that causes excessive bleeding due to a lack of the blood clotting protein. The recessive allele responsible for this disorder is represented by X^h.

2.4.1 Show by means of a genetic cross the possible genotypes and phenotypes of the parents and children if a man suffering from haemophilia and a woman who is a carrier of this disorder decide to have children. (6)

2.4.2 Explain why this disorder affects mostly males in a family. (3)
(9)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.4 2.4.1

P_1	Phenotype	Haemophilia	x	Carrier✓
	Genotype	X^hY	x	X^HX^h✓

Meiosis

G/Gametes X^h , Y x X^H , X^h✓

Fertilisation

F_1 Genotype $X^H X^h$, $X^h X^h$, X^HY, $X^h Y$ ✓

Phenotype 25% boys normal: 25% boys haemophilia
25% girls haemophilia: 25% girls carriers✓

P_1 and F_1✓
Meiosis and fertilisation✓ (Any 6)

OR

P_1	Phenotype	Haemophilia	x	Carrier✓
	Genotype	X^hY	x	X^HX^h✓

Meiosis

Fertilisation

Gametes	X^h	Y
X^H	$X^H X^h$	X^HY
X^h	$X^h X^h$	$X^h Y$

1 mark for correct gametes
1 mark for correct genotype

F_1 Phenotype 25% boys normal: 25% boys haemophilia:
25% girls haemophilia: 25% girl carriers✓

P_1 and F_1✓
Meiosis and fertilisation✓ (Any 6) (6)

2.4.2
- The allele for the trait is carried on the X-chromosome✓
- Males only have one X-chromosome✓
- A male therefor only needs one recessive allele✓to have haemophilia
- A female must have two recessive alleles to have haemophilia✓

(Any 3) (3)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.1 Haemophilia is a sex-linked disease caused by the presence of a recessive allele (X^h). A normal father and heterozygous mother have children.

2.1.1 Represent a genetic cross to determine the possible genotypes and phenotypes of the children of the parents mentioned in QUESTION 2.1. (6)

2.1.2 What are the chances of the parents having a child that will be a haemophiliac male? (2)

2.1.3 Explain why the father is not a carrier for haemophilia. (2)
(10)

2.1 2.1.1

		Father		Mother
P$_1$/parent	*phenotype*	Normal	*x*	Normal✓
	genotype	X^HY	*x*	X^HX^h ✓

Meiosis

G/gametes X^H , Y *x* X^H , X^h✓

✓ ✓

Fertilisation

OR

Gametes	X^H	X^h
X^H	$X^H X^H$	$X^H X^h$
Y	X^HY	$X^h Y$

1 mark for correct gametes
1 mark for correct genotypes

F$_1$/offspring
genotype $X^H X^H$, $X^H X^h$, $X^H Y$, $X^h Y$ ✓
phenotype 2 normal daughters, 1 normal son, 1 son with haemophilia✓

Max (6)

2.1.2 25✓% ✓chance /1✓ out of 4✓/ ¼✓✓ (2)

2.1.3 The male has only one X chromosome ✓ Y chromosome does not have the allele for this trait ✓

OR

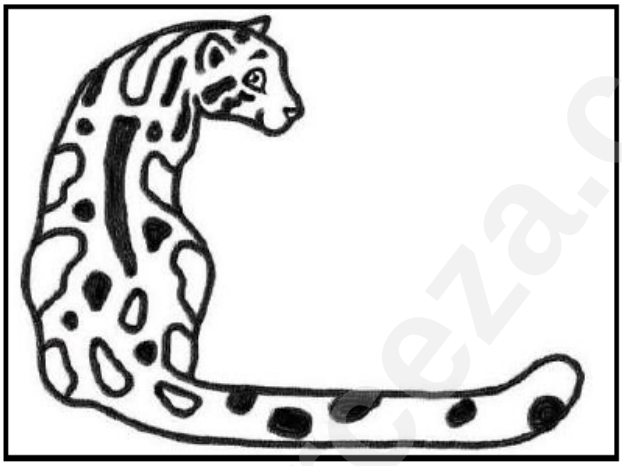
If he had 'h' he would be a sufferer✓, therefore he must have had 'H'✓.

Max (2)
(10)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.2 Clouded leopards (Neofelis nebulosa) are a medium-sized, endangered species of cat, living in the very wet cloud forests of Central America. The normal spots (X^N, pictured here) are a result of a dominant, sex-linked allele and that dark spots are the result of a recessive allele.
A biologist crossed a male with dark spots and a female with normal spots. She had four cubs; two are male and two female. One of each of the male and female cubs have normal spots and one each have dark spots.



2.2.1 What is the genotype of the mother? (2)

2.2.2 The biologist crosses the female cub that is heterozygous for normal spots, with a male that also has normal spots. Using a genetic cross determine how many of each phenotype will be found in the cubs, assuming that 4 cubs are born and two are males and two are females. (6)

2.2.3 Calculate the percentage of dark spotted males among the offspring. SHOW ALL WORKING. (2)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.2 2.2.1 X^NX^n ✓✓

2.2.2 **P**$_1$/parent phenotype Normal spotted male x Normal spotted female ✓

genotype $X^N Y$ x $X^N X^n$ ✓

Meiosis

G/gametes X^N , Y x X^N ; X^n ✓

Fertilisation

F$_1$/offspring genotype $X^N X^N$; $X^N X^n$; $X^N Y$; $X^n Y$ ✓

phenotype 2 Normal spotted females, 1 normal spotted male and 1 dark spotted male ✓

Parents and offspring ✓/P$_1$ and F$_1$

Meiosis and fertilisation ✓ (Any 6 x 1)

OR

P$_1$/parent phenotype Normal spotted male x Normal spotted female ✓

genotype $X^N Y$ x $X^N X^n$ ✓

Meiosis

G/gametes X^N , Y x X^N ; X^n ✓

Fertilisation

Gametes	X^N	Y
X^N	$X^N X^N$	$X^N Y$
X^n	$X^N X^n$	$X^n Y$

1 mark for correct gametes
1 mark for correct genotypes

F$_1$/offspring phenotype 2 Normal spotted females, 1 normal spotted male and 1dark spotted male ✓

Parents and offspring ✓/P$_1$ and F$_1$

Meiosis and fertilisation ✓ (Any 6 x 1) (6)

2.2.3 (¼ x 100) ✓= 25% ✓ (2)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.5 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.

2.5.1 Use the information above to explain TWO reasons why the fruit fly is a useful organism for studying genetic crosses. (4)

2.5.2 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**). A white eyed male is crossed with a homozygous red eyed female. Use a genetic cross to show the **F_1** offspring. (6)

2.5.3 Explain why male fruit flies are more likely than female fruit flies to show a phenotype produced by a recessive allele. (2)

2.5 2.5.1 Large number of eggs produce ✓, therefore improves reliability ✓
simple nutrient medium ✓ therefore reduces costs ✓
markings on male/size of female ✓therefore easy to identify ✓
short generation time ✓ therefore results obtained quickly ✓
(Any 2 x 2) (4)

2.5.2

P1	Phenotype	White eyed male	X	Red eyed female
	Genotype	$X^r Y$	X	$X^R X^R$ ✓
✓	Meiosis			
✓	Gametes	X^r ; Y		X^R ; X^R ✓
	Fertilisation			
F1	Genotype	$X^P X^r$; $X^R X^r$; $X^R Y$; $X^R Y$ ✓		

Phenotype: 2 Red eyed females and 2 Red eyed males ✓ (6)

2.5.3 Males have one allele ✓(not chromosome), so only one recessive allele will show the phenotype, ✓ but females need two recessive alleles to show in the phenotype. ✓ (Any 2 x 1) (2)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.3 Study the genotypes and phenotypes below that show how the alleles for colour-blindness are inherited. X and Y represent sex chromosomes. Carriers do not suffer from colour-blindness, but can pass the allele for colour-blindness onto their children.

Name of person	Genotype	Phenotype
Sarah	$X^B X^B$	Female with normal sight
Beauty	$X^B X^b$	Carrier female
Leonie	$X^b X^b$	Colour-blind female
Paul	$X^B Y$	Male with normal sight
Sam	$X^b Y$	Colour-blind male

2.3.1 Is colour-blindness caused by a dominant or recessive allele? (1)

2.3.2 Explain why Sam is colour-blind even though he carries only one allele for colour-blindness. (2)

2.3.3 Use a genetic diagram to determine the possible genotypes and phenotypes of children produced by a female with normal sight crossed with a colour-blind male. (6)
(9)

2.3 2.3.1 Recessive allele (1)

2.3.2 Being male, Sam has only one X chromosome√ or XY.
Y recessive allele do not carry this characteristic√.
Therefore one recessive allele is enough for him to have the condition√ any 2 (2)

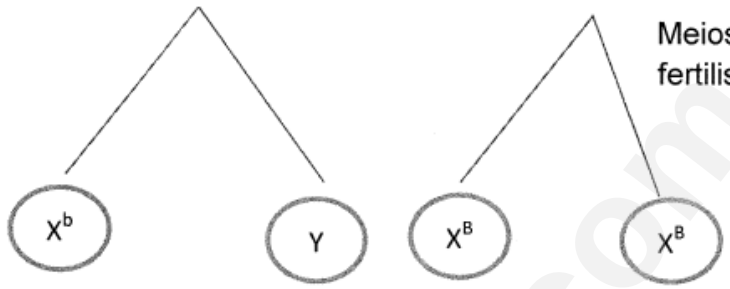
Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.3.3 P_1 Paul Sarah

genotype $X^b Y$ √ $X^B X^B$ P_1 and F_1√

Meiosis: Meiosis and fertilisation√



√

Fertilisation:

F_1: $X^B X^b$ √ $X^B Y$√

Normal sight (carrier) daughter √ Normal sight son √ any 6 (6)

(9)

3.3 The inheritance of fur colour in cats is sex-linked. The tortoise-shell colour of cats is a combination of black and orange fur. The allele for black fur is represented by $\mathbf{X^B}$ and the allele for orange fur is represented by $\mathbf{X^O}$. A female cat with a tortoise-shell colour mates with an orange male cat.

HINT: The sex chromosomes/gonosomes in cats are the same as in humans.

3.3.1 Use the symbols $\mathbf{X^B}$, $\mathbf{X^O}$ and **Y** to represent a genetic cross of the mating stated above. Also indicate the proportion of the F_1 phenotypes. (7)

3.3.2 Explain why the male kittens can never have the tortoise-shell colour. (2)

3.3.3 Explain why the female kittens can have the tortoise-shell colour. (2)

(11)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.3.1 P_1/parent phenotype: tortoise-shell female x orange male✓

genotype: X^BX^O x X^OY ✓

✓ ✓ *Meiosis*

G/gametes X^B, X^O x X^O, Y✓

Fertilisation

F_1/offspring genotype X^BX^O, X^BY, X^OX^O; X^OY✓

phenotype 1 tortoise-shell female, 1 black male, 1 orange female and 1 orange male✓✓

(1 mark for gender and 1 mark for fur colour with correct proportion)

OR

P_1/parent phenotype: tortoise-shell female x orange male✓

genotype: X^BX^O x X^OY ✓

✓ ✓ *Meiosis*

G/gametes X^B, X^O x X^O, Y✓

Fertilisation

gametes	X^B	X^O
X^O	X^BX^O	X^OX^O
Y	X^BY	X^OY

F_1/offspring genotype X^BX^O, X^BY, X^OX^O & X^OY✓

phenotype 1 tortoise-shell female, 1 black male, 1 orange female and 1 orange male✓✓

(1 mark for gender and 1 mark for fur colour with correct proportion) (7)

3.3.2 Because fur colour is sex linked and only carried by the X chromosome✓ male kittens cannot have turtoise-shell colour because their Y chromosome does not carry any allele ✓for fur colour (2)

3.3.3 Because the gene for fur colour is sex linked and only carried by the X chromosome ✓ female cats with the allele combination X^BX^O ✓ will have the turtoise-shell colour (2)

(11)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

4. Blood grouping

3.2 Human blood groups are controlled by multiple alleles.

3.2.1 How many alleles control blood groups? (1)

3.2.2 Which TWO alleles are codominant in the inheritance of blood groups? (2)

3.2.3 A man is heterozygous for blood group A and marries a woman who has blood group O. Use a genetic cross to show the phenotypic ratio of their offspring. (7)
(10)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.2	3.2.1	Three✓/3				(1)
	3.2.2	I^A✓ and I^B✓ **(MARK FIRST TWO ONLY)**				(2)
	3.2.3	**P_1**	Phenotype	Blood group A	x	Blood group O✓
			Genotype	I^Ai	x	ii✓
		Meiosis				
			G/gametes	I^A, i	x	i, i✓
		Fertilisation				
		F_1	Genotype	I^Ai; I^Ai;		ii; ii ✓
			Phenotype	2 blood group A : 2 blood group O✓ Phenotypic ratio is **1 : 1***✓		
		P_1 and F_1✓ Meiosis and fertilisation✓				
						***1 compulsory mark** + Any 6
				OR		
		P_1	Phenotype	Blood group A	x	Blood group O✓
			Genotype	I^Ai	x	ii✓
		Meiosis				
		Fertilisation				

Gametes	I^A	i
i	I^Ai	ii
i	I^Ai	ii

1 mark for correct gametes
1 mark for correct genotypes

		F_1	Phenotype	2 blood group A : 2 blood group O✓ Phenotypic ratio is **1 : 1***✓		
		P_1 and F_1✓ Meiosis and fertilisation✓				(7) **(10)**
						***1 compulsory mark** + Any 6

3.2 A man has blood type **AB** and his sister has blood type **O**.

Determine the genotypes and phenotypes of their parents by doing a genetic cross. **(6)**

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.2

P_1	Phenotype	Blood type A	x	Blood type B✓*
	Genotype	I^Ai	x	I^Bi✓*
Meiosis				
	G/gametes	I^A, i	x	I^B, i ✓
Fertilisation				
F_1	Genotype	I^AI^B;	I^A i;	I^Bi ii✓
	Phenotype	Blood type AB		Blood type O ✓

P_1 and F_1✓
Meiosis and fertilisation✓

OR

P_1	Phenotype	Blood type A	x	Blood type B✓*
	Genotype	I^Ai	x	I^Bi✓*

Meiosis

Fertilisation

Gametes	I^A	i
I^B	I^AI^B	I^Bi
i	I^A i	ii

1 mark for correct gametes
1 mark for correct genotypes

F_1 Phenotype Blood type AB and Blood type O ✓

P_1 and
F_1✓
Meiosis and fertilisation✓ **(6)**

*compulsory 2 + any 4

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.4 Human blood groups are controlled by multiple alleles.

3.4.1 Name ALL the alleles that control human blood groups. (3)

3.4.2 How many of the alleles named in QUESTION 3.4.1 can any individual inherit? (1)

3.4.3 Give a reason for your answer to QUESTION 3.4.2. (2)

3.4.4 A man has blood group **A** and his wife has blood group **B**. Their first child has blood group **AB** and the second child has blood group **O**.

What can one conclude about the blood groups of their future children? (3)
(9)

3.4	3.4.1	I^A✓, I^B✓, i✓	(3)
	3.4.2	2✓	(1)
	3.4.3	- Any individual inherits one allele✓ - from each parent✓	(2)
	3.4.4	- Each child✓ - has an equal✓/25% chance of having - any blood group✓/ A, B, AB, or O.	(3) **(9)**

2.3 Humans have different blood groups which are coded for by a number of alleles.

Mary has the genotype I^Ai and her son Joseph has blood type AB.

2.3.1 How many alleles code for blood groups? (1)

2.3.2 Give:

(a) Mary's blood group (1)

(b) Joseph's genotype (1)

(c) All the possible genotypes of Joseph's father (3)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.3	2.3.1		3 ✓	(1)
	2.3.2	(a)	Blood group A ✓	(1)
		(b)	I^AI^B ✓	(1)
		(c)	I^AI^B ✓ I^BI^B ✓ I^Bi ✓	(3)

2.3 Mr and Mrs Phonela are concerned that their baby girl does not appear to resemble either of them. They suspect that the baby they were given at the hospital was not theirs. Mr Phonela is blood type **AB**, Mrs Phonela is blood type **B** and the baby they were given is blood type **O**.

2.3.1 Give the possible genotypes of:

(a) Mrs Phonela (2)

(b) The baby girl (1)

2.3.2 Explain why the baby girl with blood type **O** cannot be Mr and Mrs Phonela's daughter. (3)

2.3.3 Explain why the use of blood type for paternity testing is not conclusive. (2)

2.3.4 Using your knowledge of sex chromosomes, explain why the sex of a child is determined by the male gamete. (5)
(13)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.3 2.3.1 (a) I^BI^B✓ of I^Bi✓ (2)
(b) ii✓ (1)

2.3.2
- The baby inherited one allele for type O blood/i from each parent✓ since
- her genotype is ii✓
- Mr Phonela does not have an allele for O blood/i✓ (3)

2.3.3 Blood type can be used to exclude a particular man✓ as the parent but it cannot confirm that a particular man is the father✓
Since a large portion of the population have the same blood type✓
(Any 2) (2)

2.3.4
- Normal females have two X✓ chromosomes
- Normal males have one X and one Y✓
- The female always provides X in the egg✓
- If an egg cell is fertilized by an X bearing sperm✓ a female/girl✓is formed
- If an egg is fertilized by a Y bearing sperm✓
- a male/boy✓ is formed (Any 5)

OR

Gametes		male gamete✓	
		X	Y
female gamete✓	X	XX✓	XY✓

2 XX : 2 XY
Female ✓ Male✓ (Any 5) (5)
(13)

2.4 Use a genetic cross to show the possible blood types of the offspring of a cross between individuals who are type AB and type O. (Blood type O is recessive) (6)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.4

P1	Phenotype	Blood group AB	X	Blood group O ✓
	Genotype	I^AI^B	X	ii ✓
	Meiosis			
	Gametes	I^A I^B	X	i i ✓
	Fertilisation			

	i	i
I^A	I^Ai	I^Ai
I^B	I^Bi	I^Bi

✓ ✓

F1	Genotype	I^Ai	I^Bi ✓
	Phenotype	Blood group A	Blood group B ✓

(Any 6) (6)

1.3 THREE babies (**X**, **Y** and **Z**) from three different sets of parents were born in a hospital. TWO of the babies were accidentally swopped. Blood groups of the parents were used to establish which baby belonged to which set of parents.

The blood groups of the parents and the babies are shown in the table below.

PARENTS	BABIES	BLOOD GROUPS OF PARENTS AND BABIES		
		Mother	Father	Baby
Mr and Mrs Pule	X	B	A	A
Mr and Mrs Chaka	Y	AB	B	O
Mr and Mrs Tau	Z	O	B	AB

1.3.1 Which TWO babies (from **X**, **Y** and **Z**) were swopped? (2)

1.3.2 Give the surnames of the biological parents of the two babies that were swopped. Write the correct surnames of the parents next to the letter (**X**, **Y** or **Z**). (2)

1.3.3 Give the possible genotype(s) of Mr Pule that could have produced baby **X**. (2)
(6)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.3	1.3.1	Y✓and Z✓ ***(Mark first TWO only)***	(2)
	1.3.2	Y – Tau✓ Z – Chaka✓	(2)
	1.3.3	I^AI^A✓ I^Ai✓ ***(Any order)***	(2) **(6)**

2.5 Three babies (**S**, **T** and **U**) from three different sets of parents were born in a hospital. TWO of the babies were accidentally swopped. Blood groups of the parents were used to establish which baby belonged to which set of parents.

The blood groups of the parents and the babies are shown in the table below.

	BABIES	BLOOD GROUPS OF PARENTS AND BABIES		
		Mother	Father	Baby
Mr and Mrs Khumalo	S	B	A	A
Mr and Mrs Molefe	T	AB	B	O
Mr and Mrs Dube	U	O	B	AB

2.5.1 Which TWO babies (from **S**, **T** and **U**) were swopped? (2)

2.5.2 Give the possible genotype(s) of Mr Khumalo that could have produced baby **S**. (2)
(4)
[40]

2.5	2.5.1	T ✓and U✓	(2)
	2.5.2	I^AI^A✓ I^Ai✓ (Any order)	(2) **(4)** **[40]**

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.5 Three babies (**X**, **Y** and **Z**) from three different sets of parents were born in a hospital. TWO of the babies were accidentally swopped. Blood groups of the parents were used to determine which baby belonged to which set of parents.

The blood groups of the parents and the babies they were given are shown in the table below.

	BABIES	BLOOD GROUPS OF PARENTS AND BABIES		
		Mother	Father	Baby
Mr and Mrs Muko	X	B	A	A
Mr and Mrs Zifo	Y	AB	B	O
Mr and Mrs Bata	Z	O	B	AB

2.5.1 Of the alleles that code for blood groups, which alleles are codominant? (2)

2.5.2 Which TWO babies (from **X**, **Y** and **Z**) were swopped? (2)

2.5.3 Assume that Mr Muko is heterozygous for blood group A.
Give the possible genotype of Mrs Muko that will result in baby **X**. (2)
[40]

2.5 2.5.1 I^A ✓and I^B ✓ (2)

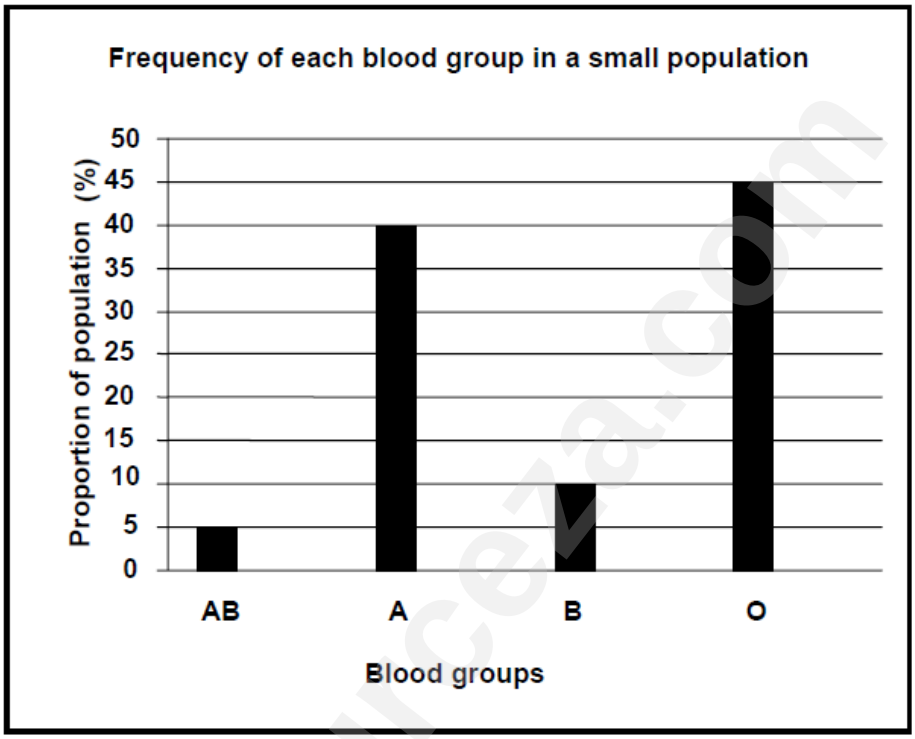
2.5.2 Baby **Y** ✓ and **Z** ✓ (2)

2.5.3 I^Ai ✓✓ (2)
[40]

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.2 The graph below shows the results of an investigation into the frequency of blood groups in a small human population.



2.2.1 Which blood group has the lowest frequency in the population investigated? (1)

2.2.2 How many times more often would you find people with blood group **A** compared to blood group **B** in this portion of a human population? (1)

2.2.3 Which allele is the least frequent in this population? (1)

2.2.4 Explain your answer to QUESTION 2.2.3. (2)

2.2.5 Explain why most people in this population have blood group O. (3)
(8)

Downloaded from eduresourceza.com

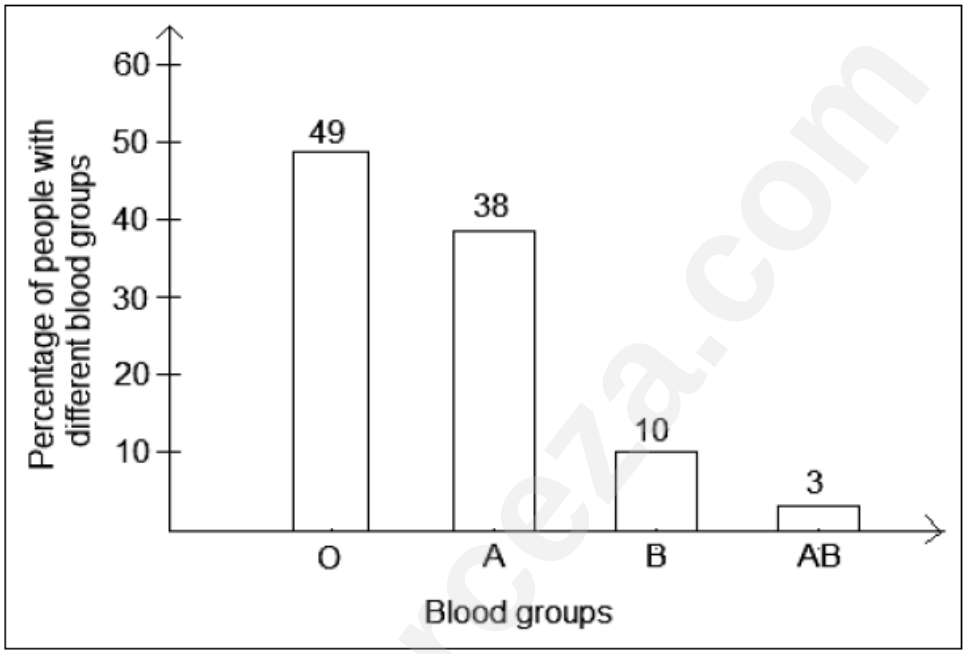
Downloaded from eduresourceza.com

2.2		
2.2.1	AB✓	(1)
2.2.2	4✓/four	(1)
2.2.3	I^B✓ /B	(1)
2.2.4	People from blood groups AB and B✓ possess the B allele and since people with blood group AB and B together are less frequent than A or O✓ the B allele is the least frequent	(2)
2.2.5	Many people that are of blood groups A and B✓ might be heterozygous✓/ I^Ai and I^Bi many offspring could end up with ii combination✓ **OR** Since the proportion of the population with O type is the greatest✓ the possibility of reproduction✓ between individuals with O group is greater and many offspring could end up with O blood group✓	(3)
		(8)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.2 Blood groups in humans are controlled by multiple alleles. As a result, there are four possible blood groups: A, AB, B and O. Study the graph below which shows the percentage of people that have different blood group and then answer the questions that follow.



3.2.1 Explain what is meant by *multiple alleles*. (2)

3.2.2 Which blood group is the least common in the human population? (1)

3.2.3 Recent population statistics show that KwaZulu-Natal has a human population of approximately 9,2 million. Calculate the number of people who will have blood group O in KwaZulu-Natal. (2)

3.2 3.2.1 There are more than two alleles ✓ possible at the one locus. ✓ (2)

3.2.2 AB ✓ (1)

3.2.3

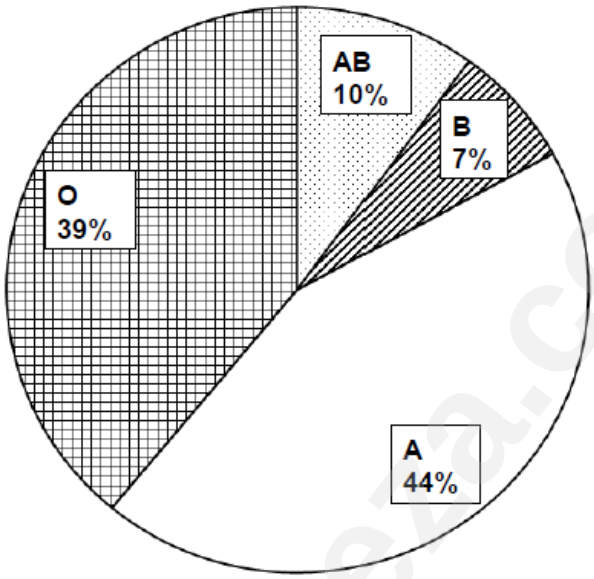
$$\left(\frac{49}{100} \times \frac{9\,200\,000}{1}\right) ✓ = 4\,508\,000 ✓ \text{ people}$$

(2)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.4 A group of learners conducted an investigation to determine which blood type is most common in humans. They recorded the blood types of the 20 learners in their class. The results are represented in the pie chart below.



Pie chart showing the percentage of different blood types in a sample group of people

2.4.1 State TWO planning steps that should be considered before carrying out this investigation. (2)

2.4.2 According to Statistics South Africa, the total population in South Africa is estimated to be 54,96 million in 2016. Use the learners results to determine how many of the South African population are likely to have blood group **B**. (2)

2.4.3 The frequency of each blood group worldwide is shown in the table below.

Blood Type	Worldwide Frequency (%)
O	45
A	40
B	11
AB	4

[Adapted from: www.inspired-self-help-shortcuts.com]

The learners expected their results to correspond with the results in the table above but they do not. Explain why the results of the learner's investigation are not very reliable. (2)
(6)

2.5 Use a genetic diagram to illustrate how a father with blood group A and a mother with blood group B could have four children, each with a different blood group. **(6)**

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.4

2.4.1
- Get permission from all stakeholders✓
- Design a record sheet✓
- Set a date/time✓
- Arrange a venue✓
- Determine the composition of the sample✓/participants
- Ensure that the learners know their blood groups✓/have a means to determine blood groups of learners

(Mark first TWO only) (Any 2) (2)

2.4.2

$\frac{7}{100}$ X 54,96 million ✓= 3,85✓/3,9 million

OR

$\frac{7}{100}$ X 54 960 000 ✓= 3 847 200✓

(2)

2.4.3 The sample that was used was very small✓ and is therefore not representative of the world population✓ (2)

(6)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.5

P_1	Phenotype	Blood group A	x	Blood group B✓
	Genotype	I^Ai	x	I^Bi✓
Meiosis				
	G/gametes	I^A, i	x	I^B, i✓
Fertilisation				
F_1	Genotype	I^AI^B; I^Ai; I^Bi; ii ✓		
	Phenotype	AB : A : B : O ✓		

P_1 and F_1✓
Meiosis and fertilisation✓

Any 6

OR

P_1	Phenotype	Blood group A	x	Blood group B✓
	Genotype	I^Ai	x	I^Bi✓

Meiosis

Fertilisation

Gametes	I^A	i
I^B	I^AI^B	I^Bi
i	I^Ai	ii

1 mark for correct gametes
1 mark for correct genotypes

F_1 Phenotype AB : A : B : O ✓

P_1 and F_1✓
Meiosis and fertilisation✓

Any 6

(6)

(10)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.1 The table below shows the percentage of the populations with different blood groups for two countries.

BLOOD GROUP	PERCENTAGE OF POPULATION	
	COUNTRY Q	COUNTRY R
O	40	20
A	10	35
B	45	40
AB	5	5

3.1.1 Which blood group shows the greatest percentage difference between the two countries? (1)

3.1.2 The population size of country **Q** is 5 million people.

Calculate the number of people who have blood group **O**. Show ALL your working. (3)

3.1.3 Explain how the inheritance of blood group **AB** is an example of co-dominance. (2)

3.1.4 Explain why blood groups are considered an example of discontinuous variation. (2)

3.1.5 In the inheritance of blood groups, give the:

(a) Recessive allele (1)

(b) Phenotype of an individual who is homozygous recessive (1)

3.1 3.1.1 Blood group A✓ (1)

3.1.2 $\frac{40}{100}$ ✓ x $\frac{5\ 000\ 000}{1}$ ✓
= 2 000 000✓/2 million (3)

3.1.3 - The alleles I^A and I^B✓
- are equally dominant✓ (2)

3.1.4 - When phenotypes fit into separate or distinct categories✓
- with no intermediate phenotypes✓ (2)

3.1.5 (a) i✓ (1)
(b) Blood group O✓ (1)
(10)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

4.1 The table below shows the percentage distribution of blood groups in a province in South Africa.

BLOOD GROUPS			
A	B	AB	O
35	15	10	40

4.1.1 How many genes control the blood groups shown above? (1)

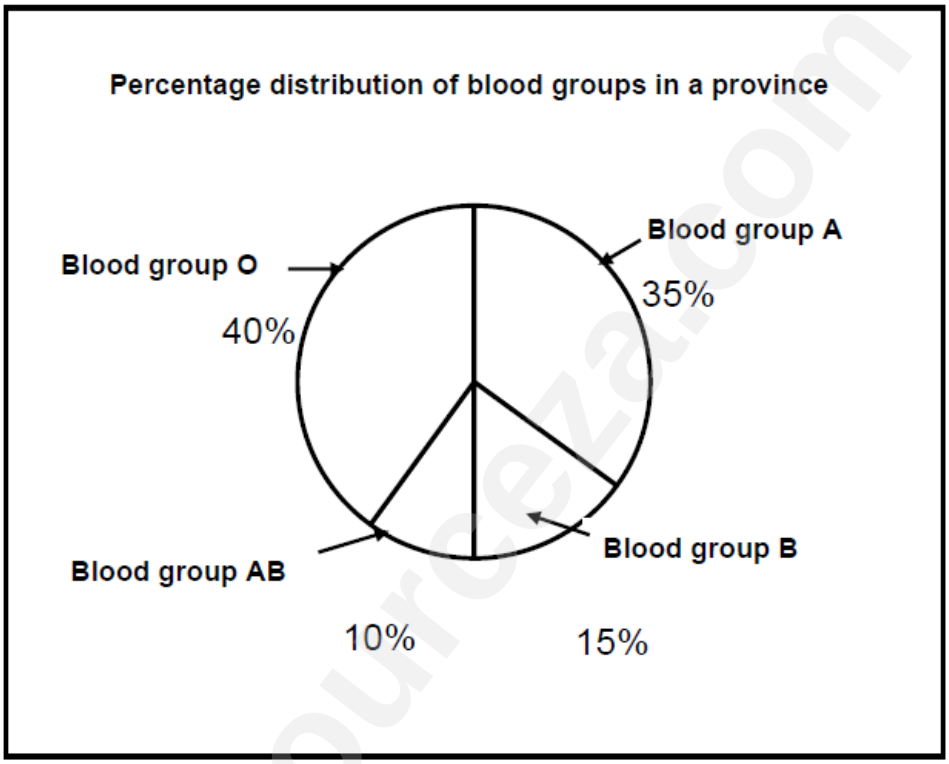
4.1.2 Explain how it is genetically possible to have four blood groups in a population. (2)

4.1.3 Draw a pie chart using the information in the table above. Show ALL calculations. (8)
(11)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

4.1	4.1.1	One✓	(1)
	4.1.2	Blood groups are controlled by three alleles✓/ I^A, I^B, I which when in combination provide four phenotypes✓/A, AB, B, O.	(2)
	4.1.3		



Blood group A: $\frac{35}{100} \times \frac{360}{1}$
$= 126^\circ$

Blood group B: $\frac{15}{100} \times \frac{360}{1}$
$= 54^\circ$

Blood group AB: $\frac{10}{100} \times \frac{360}{1}$
$= 36^\circ$

Blood group O: $\frac{40}{100} \times \frac{360}{1}$
$= 144^\circ$

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

Rubric for the mark allocation of the calculations

Marks	Calculations
1	1–3 correct
2	4 correct

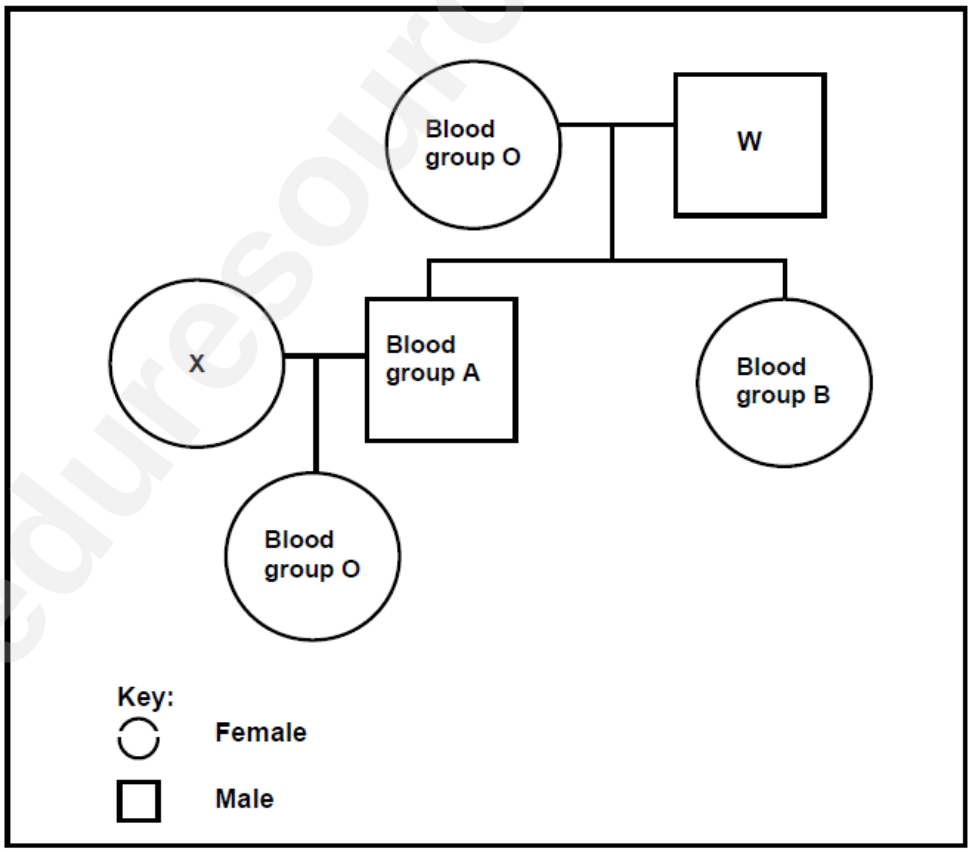
Rubric for the mark allocation of the pie chart

Caption	1
Correct proportion of slices	1: 1–2 correct 2: 3–4 correct
Label / key for each slice	1: 1 correct label 2: 2 correct label 3: 3–4 correct labels

(8)

1.5 It is possible to trace the inheritance of characteristics such as blood groups and genetic disorders over a number of generations.

1.5.1 The pedigree diagram below shows the blood groups of individuals of a family. The blood groups are indicated inside the circle or the square. The blood groups of individuals **W** and **X** are not indicated.



Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

Write down ALL the possible genotypes of individuals:

(a) **W**

(b) **X** (8)

1.5.2 Haemophilia is a blood-clotting disorder. Explain why mainly males suffer from this disorder. (4)
(12)

1.5
1.5.1
(a) I^AI^B ✓✓/ AB (2)

(b) I^Ai✓✓/ I^AI^o/ AO

I^Bi✓✓/I^BI^o/ BO

ii✓✓/I^oI^o/ OO (6)

1.5.2 It is a sex-linked✓disease
caused by a recessive allele✓
carried on the X✓ chromosome
Males need only one recessive allele✓to have the disease because they have XY combination/Y chromosome has no alleles/H for clotting while females have to have both recessive alleles✓ to have haemophilia because they have an XX combination any (4)
(12)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

5. Dihybrid Crosses

1.5 In peas, round seed shape (R) is dominant to wrinkled seed shape (r), and yellow seed colour (Y) is dominant to green seed colour (y). A pea plant which is homozygous round seed and has green seed colour is crossed with a pea plant that is heterozygous round seed shape and heterozygous yellow seed colour. The cross is represented in a punnet square below:

Gametes	RY	Ry	rY	ry
Ry	RRYy	RRyy	RrYy	Rryy
Ry	RRYy	RRyy	RrYy	Rryy
Ry	RRYy	RRyy	RrYy	Rryy
Ry	RRYy	RRyy	RrYy	Rryy

1.5.1 What is the percentage chances of the offspring being:

(a) Homozygous for round seed (1)

(b) Heterozygous for both seed shape and colour (1)

1.5.2 Give the gametes that resulted in the following offspring:

(a) RRyy (1)

(b) RrYy (1)

1.5.3 Give the phenotype for offspring Rryy. (1)

1.5.4 Give the phenotype ratio of offspring from the cross. (1)

1.5 1.5.1 (a) 8/16 = ½ = 50% ✓

(b) 4/16 = ¼ = 25% ✓ (1)

1.5.2 (a) Ry ✓ (1)

(b) Ry, ry ✓ (1)

1.5.3 (e) Round and green ✓ (1)

1.5.4 8 Round yellow : 8 Round green = 1 : 1 ✓ (1)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.5 In fruit flies, the characteristic for body colour is either grey colour or black colour. A second characteristic is normal wings or vestigial wings. Vestigial wings are crumpled and therefore prevent flies from flying properly.

1.5.1 In a cross between a fly that is homozygous dominant for both traits and a fly that is homozygous recessive for both traits, all the offspring are grey with normal wings. Identify the ...

(a) dominant trait for body colour. (1)

(b) recessive trait for wing type. (1)

1.5.2 This is a cross describing two characteristics. What type of cross does it represent? (1)

1.5.3 Use the letters (**B**) for body colour and (**W**) for wings.

A fly is heterozygous for both traits. Give the ...

(a) genotype of the fly. (1)

(b) phenotype of the fly. (1)

(c) possible genotypes of the gametes that this fly can produce. (2)
(7)

1.5	1.5.1	(a) grey ✓	(1)
		(b) vestigial✓	(1)
	1.5.2	Dihybrid ✓	(1)
	1.5.3	(a) BbWw ✓	(1)
		(b) grey-bodied, normal wings✓	(1)
		(c) BW Bw bW bw ✓✓ (All four must be correct to get the marks.)	(2)
			(7)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.4 In tomato plants the allele for red fruit **(R)** is dominant over the allele for yellow fruit **(r)**. The allele for tallness **(T)** is dominant over the allele for shortness **(t)**.

Plant **A**, which is heterozygous for red fruit and homozygous tall, was crossed with Plant **B**, which has yellow fruit and is short.

1.4.1 Write down the genotype of:

(a) Plant **A** (1)

(b) Plant **B** (1)

1.4.2 Write down ALL the possible genotypes of the gametes of plant **A**. (2)

1.4.3 Name the phenotype of an offspring having the genotype:

(a) Rrtt (1)

(b) RrTt (1)

1.4.4 Plant **B** was then crossed with another plant (Plant **C**) and all the offspring had red fruit and were tall.

Use this information to write down the genotype of Plant **C**. (2)
(8)

1.4	1.4.1	(a) RrTT✓	(1)
		(b) rrtt✓	(1)
	1.4.2	RT✓ rT✓	(2)
	1.4.3	(a) Red fruit, short✓	(1)
		(b) Red fruit, tall✓	(1)
	1.4.4	RRTT✓✓	(2)
			(8)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.4 About 70% of people get a bitter taste when a substance called PTC is placed on their tongue. They are referred to as 'tasters'. All other people are unable to taste PTC and are referred to as 'taste-blind'. The 'taster' allele is dominant and the 'taste-blind' allele is recessive.

Also in humans, normal skin pigmentation is dominant to the albino condition (no pigmentation).

The letters in the key below must be used to represent the alleles for the different characteristics above.

Key:

T – taster
t – taste-blind
N – normal skin pigmentation
n – no skin pigmentation (albino)

A man who is heterozygous for both tasting PTC and skin pigmentation marries a woman who is taste-blind for PTC and is an albino.

1.4.1 State why the example above represents a dihybrid cross. (1)

1.4.2 Write down:

(a) The genotype of the woman (1)

(b) ALL the possible gametes of the man (2)

1.4.3 The man and woman have a child whose genotype is **ttNn**. What is the child's phenotype? (2)

1.4.4 A man and a woman are only able to produce children with the genotype **TtNn**. The woman's genotype is **ttnn**. State the only possible genotype of the man. (2)
(8)

1.4 1.4.1 Two characteristics✓ are involved in the cross (1)
1.4.2 (a) ttnn✓ (1)
(b) TN; Tn; tN; tn✓✓
1 – 3 correct ✓
all 4 correct ✓✓ (2)

1.4.3 Taste-blind✓ and normal skin pigmentation✓ (2)

1.4.4 TTNN✓✓ (2)
(8)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.4 In a certain type of pigeons it was found that **red eye** colour **(R)** is dominant over **black eye** colour **(r)**, while **grey tail** feathers **(G)** were dominant over **white tail** feathers **(g)**.

A pigeon breeder crosses a homozygous female with red eyes and grey tail feathers with a homozygous male with black eyes and white tail feathers.

1.4.1 Name the genotype of the:

(a) Female pigeon (1)
(b) Male pigeon (1)

1.4.2 Name the genotypes of the gametes of the female. (2)

1.4.3 State the phenotype of an offspring having the genotype:

(a) rrGg (1)
(b) RrGg (1)
(6)

1.4	1.4.1	(a)	RRGG✓	(1)
		(b)	rrgg✓	(1)
	1.4.2		RG, RG, RG, RG✓✓/all RG /RG	(2)
	1.4.3	(a)	Black eye, grey tail feathers ✓	(1)
		(b)	Red eye, grey tail feathers✓	(1)
				(6)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.4 In rabbits, grey hair is dominant to white hair and black eyes are dominant to red eyes. These letters below represent the genotypes of some rabbits:

GG – Grey hair	BB – Black eyes
Gg – Grey hair	Bb – Black eyes
gg – White hair	bb – Red eyes

1.4.1 What are the phenotypes of the rabbits that have the following genotypes?

(a) Ggbb (1)
(b) ggBB (1)
(c) ggbb (1)
(d) GgBb (1)

1.4.2 A male rabbit with the genotype GGbb is crossed with a female rabbit with the genotype ggBb. The punnet square is set out below:

	Gb	**Gb**	**Gb**	**Gb**
gB	GgBb	GgBb	GgBb	GgBb
gb	Ggbb	Ggbb	Ggbb	Ggbb
gB	GgBb	GgBb	GgBb	GgBb
gb	Ggbb	Ggbb	Ggbb	Ggbb

How many out of the 16 offspring have:

(a) Grey fur and black eyes (1)
(b) Grey fur and red eyes (1)
(c) White fur and black eyes (1)
(d) White fur and red eyes (1)

1.4 1.4.1 (a) Grey hair with red eyes ✓
(b) White hair with black eyes ✓
(c) White hair with red eyes ✓
(d) Grey hair with black eyes ✓ (4)

1.4.2 (a) 8 ✓
(b) 8 ✓
(c) 0 ✓
(d) 0 ✓ (4)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.4 The size and colour of unripe fruit in a plant species is genetically controlled. The allele for small fruit (**b**) is recessive to the allele for big fruit (**B**). The allele for yellow fruit colour (**g**) is recessive to the allele for green fruit (**G**).

1.4.1 State:

(a) The phenotype of the plant with the genotype **BbGg** (2)

(b) ALL possible genotypes of the gametes produced by the plant mentioned in QUESTION 1.4.1(a) (2)

1.4.2 In a cross between two plants with genotypes **BBGG** and **bbgg** what percentage of the offspring will be homozygous for both characteristics? (2)
(6)

1.4	1.4.1	(a) Big✓ and green✓ fruit	(2)
		(b) BG, Bg, bG, bg✓✓	(2)
	1.4.2	0✓ %✓	(2)
			(6)

1.4 Mendel observed some characteristics of the pea plant (*Pisum sativum)* which he suggested were controlled by inherited factors. He conducted a series of experiments in which he crossed pea plants with contrasting phenotypes to obtain the offspring of the F_1 generation. At first his crosses were simple and involved only one pair of characteristics.

Mendel counted the number of offspring showing each of the variations.

His results are shown in the table below.

PLANT PART	CHARACTERISTIC	P_1 GENERATION	F_1 GENERATION
Seed	Seed texture	Round x wrinkled	All round
	Seed colour	Yellow x green	All yellow
Pod	Pod texture	Full x constricted	All full
	Pod colour	Green x yellow	All green
Flowers	Flower colour	Violet x white	All violet
Stem	Location of flower on stem	Axial x terminal	All axial
	Height of stem	Tall x short	All tall

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.4.1 Give the term for:

(a) The *inherited factors* that Mendel referred to (1)

(b) A cross involving only ONE characteristic (1)

1.4.2 Name the female structure of the flower where meiosis occurs. (1)

1.4.3 Use the information in the table above to give the NUMBER of EACH of the following:

(a) Characteristics of pods (1)

(b) Alleles for seed characteristics (1)

1.4.4 Give the characteristic that is:

(a) Dominant for flower colour (1)

(b) Recessive for stem height (1)

1.4.5 If the individuals of the $\mathbf{F_1}$ generation are crossed, how many phenotypes for seed colour would be expected in the $\mathbf{F_2}$ generation? (1)
(8)

1.4	1.4.1	(a) Genes✓/alleles	(1)
		(b) Monohybrid✓	(1)
	1.4.2	Ovary✓/gynaecium/pistil/ovule	(1)
	1.4.3	(a) 2✓/Two	(1)
		(b) 4✓/Four	(1)
	1.4.4	(a) Violet✓	(1)
		(b) Short✓	(1)
	1.4.5	2✓/Two	(1)
			(8)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.2 In humans the allele for short fingers (brachydactyly), represented by **B**, is dominant over the allele for normal fingers (**b**). The allele for curly hair (**H**) is dominant over the allele for straight hair (**h**).

Andrew, with genotype **Bbhh**, married Susan, with genotype **bbHh**.

2.2.1 State how the phenotypes of Andrew and Susan differ from each other. (2)

2.2.2 Give ALL the possible genotypes of the gametes produced by Andrew. (2)
(4)

2.2	2.2.1	- Andrew has short fingers while Susan has normal fingers✓ - Andrew has straight hair while Susan has curly hair✓	(2)
	2.2.2	Bh✓, bh✓	(2) **(4)**

2.5 In a certain species of plant, *Acer rubrum* (red maple), tallness (T) is dominant over shortness (t) and red (R) fruit colour is dominant over yellow (r) fruit colour.

2.5.1 A plant that is homozygous for both tallness and red fruit colour, is crossed with a plant homozygous for both shortness and yellow fruit colour.

List the phenotypes and genotypes of

(i) P_1 generation. (2)
(ii) F_1 generation. (2)

2.5.2 If the F_1 generation in QUESTION 2.5.1 was interbred, what are the chances of the offspring being short with yellow fruit? (2)

2.5.3 State Mendel's principle of segregation. (2)
(8)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.5	2.5.1	(i)	P_1 Phenotype: Tall, red fruit colour and short, yellow fruit colour✓	
			P_1 Genotype: TTRR and ttrr✓	(2)
		(ii)	F_1 Genotype: TtRr✓	
			F_1 Phenotype: Tall, red fruit colour✓	(2)
	2.5.2		$\frac{1}{16}$ / 6%✓✓	(2)
	2.5.3		The two alleles controlling a given characteristic ✓, separate and go to different gametes during meiosis✓.	(2)
				(8)

2.3 In fruit flies, normal wing is controlled by a dominant allele (**N**) and short wing is controlled by a recessive allele (**n**).

In addition, grey body colour is controlled by a dominant allele (**G**) and black body colour is controlled by a recessive allele (**g**).

A male fruit fly that is homozygous for both normal wings and grey body colour is mated with a female fruit fly that is heterozygous for wing length and that has a black body.

2.3.1 Give the genotypes of the:

(a) Male fly (1)

(b) Female fly (1)

(c) Possible gametes produced by the female fly (1)

2.3.2 The male fruit fly is then mated with a second female. The genotype of all the offspring is **NnGg.**

What was the genotype of the second female fruit fly? (2)
(5)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.3	2.3.1	(a) NNGG✓	(1)
		(b) Nngg✓	(1)
		(c) Ng; ng✓	(1)
	2.3.2	nngg✓✓	(2)
			(5)

3.1 In rice plants the allele for high yield (**H**) is dominant over the allele for low yield (**h**). The allele for a tall stem (**T**) is dominant over the allele for a short stem (**t**).

There are two varieties of rice plants, **A** and **B**.
The genotype of variety **A** is **HHtt**.
The genotype of variety **B** is **hhTT**.

A plant breeder wants to produce a rice plant variety with a high yield and a short stem.

3.1.1 Give the phenotype of variety **A**. (2)

3.1.2 Give ALL the possible genotypes of the gametes of variety **B**. (1)

3.1.3 Give the genotype(s) of the variety the plant breeder wants to produce. (2)

3.1.4 Explain why the plant breeder would want to produce a rice plant with a short stem. (1)

3.1.5 Describe how the plant breeder would be able to produce rice plants with a high yield and short stems only. (2)
(8)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.1	3.1.1	High yield✓ Short stem✓	(2)
	3.1.2	hT✓ ***(Mark first ONE only)***	(1)
	3.1.3	HHtt✓, Hhtt✓ (*Mark first TWO only*)	(2)
	3.1.4	Does not break easily in windy conditions✓/to carry a bigger yield/ easier to harvest Any	(1)
	3.1.5	The plant breeder must cross✓ plants of variety A (HHtt) with plants of variety A✓(HHtt)	(2) **(8)**

3.1 In guinea pigs black fur is due to a dominant gene **B**, and white fur due to a recessive gene **b**. Short fur is due to a dominant gene **S**, and long fur due to a recessive gene **s**. A breeder did the following crossing: **BbSs** x **bbss**.

3.1.1 Using a genetic cross, determine the phenotype of the parents and the possible genotypes of the offspring. (6)

3.1.2 Give the phenotype and ratio of the offspring. (2)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.1 3.1.1 P1 Phenotype Black short fur x White long fur ✓

Genotype BbSs x bbss

Meiosis

Gametes BS ; Bs ; bS ; bs x bs ; bs ; bs ; bs ✓ (OR only one bs)

Fertilisation

F1

Gametes	BS	Bs	bS	bs
bs	BbSs	Bbss	bbSs	bbss
bs	BbSs	Bbss	bbSs	bbss
bs	BbSs	Bbss	bbSs	bbss
bs	BbSs	Bbss	bbSs	bbss

✓✓ (6)

3.1.2 Phenotype: 1 black short fur ; 1 black long fur ✓
1 white short fur ; 1 white long fur ✓ (2)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.6 Coat colour in mice is controlled by two alleles, black (**B**) and grey (**b**). Tail length is controlled by two alleles, long (**T**) and short (**t**).

The Punnett square below shows a part of the cross between two mice. Genotype **(i)** has been left out.

Parent 1

Parent 2

Gametes	BT	Bt	bT	bt
Bt	BBTt	BBtt	BbTt	Bbtt
Bt	BBTt	BBtt	BbTt	Bbtt
Bt	BBTt	BBtt	(i)	Bbtt
Bt	BBTt	BBtt	BbTt	Bbtt

1.6.1 Give the:

(a) Genotype of parent **1** (2)

(b) Phenotype of parent **2** (2)

(c) Genotype of offspring **(i)** (1)

1.6.2 What percentage of the offspring above is grey with short tails? (1)

1.6.3 State the genotypes of TWO gametes from the table above that will result in offspring that are heterozygous for both traits, if fertilisation occurs. (2)
(8)

1.6 1.6.1 (a) BbTt✓✓ (2)

(b) Black coat✓ short tail✓ (2)

(c) BbTt✓ (1)

1.6.2 0✓% (1)

1.6.3 Bt✓ bT✓
(MARK FIRST TWO ONLY) (2)
(8)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.1 The leaf colour in a plant is controlled by two alleles, green (**G**) and yellow (**g**). Thorns on plant stems are controlled by two alleles, presence of thorns (**T**) and no thorns (**t**).

Two plants with the genotypes **GGTT** and **ggtt** were crossed. Their offspring were then left to pollinate each other.

The table below shows the possible genotypes of the offspring of the second generation. Genotypes **(i)** and **(ii)** have been left out.

Gametes	**GT**	**Gt**	**gT**	**gt**
GT	GGTT	GGTt	GgTT	GgTt
Gt	GGTt	GGtt	**(i)…**	Ggtt
gT	GgTT	GgTt	ggTT	ggTt
gt	GgTt	Ggtt	ggTt	**(ii)…**

2.1.1 Give the:

(a) Genotype of **(i)** (1)

(b) Phenotype of **(ii)** (2)

2.1.2 List the FOUR genotypes of the offspring of the second generation that would be phenotypically different from the original pair of parents. (4)
(7)

2.1 2.1.1 (a) GgTt✓ (1)

(b) Yellow✓ leaves no thorns✓ (2)

2.1.2 GGtt✓
Ggtt✓
ggTT✓
ggTt✓
(Mark first FOUR only) (4)
(7)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.7 In a dihybrid cross, a plant homozygous for tallness and coloured flowers was crossed with a pure breeding short plant which had white flowers. The alleles for tall plants (T) and coloured flowers (D) are dominant.

2.7.1 Use the letters T, t, D and d to show a genetic cross between a tall plant with coloured flowers and a short plant with white flowers. (6)

2.7.2 If the F_1-generation is self-pollinated, four different kinds of plants were produced in the F_2-generation as shown below.

		♂ gametes			
		TD	Td	tD	td
♀ gametes	TD	TTDD	TTDd	TtDD	TtDd
	Td	TTDd	TTdd	TtDd	Ttdd
	tD	TtDD	TtDd	ttDD	ttDd
	td	TtDd	Ttdd	ttDt	ttdd

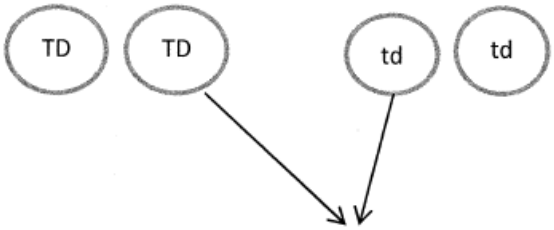
Use the punnet diagram above to determine the phenotypic ratio of the F_2-generation. (2)
(8)

2.7 2.7.1 P_1-phenotype Tall coloured Short white√

P_1 and F_1√

P_1 genotype: TTDD × ttdd√

Meiosis:



√

Meiosis and fertilisation√

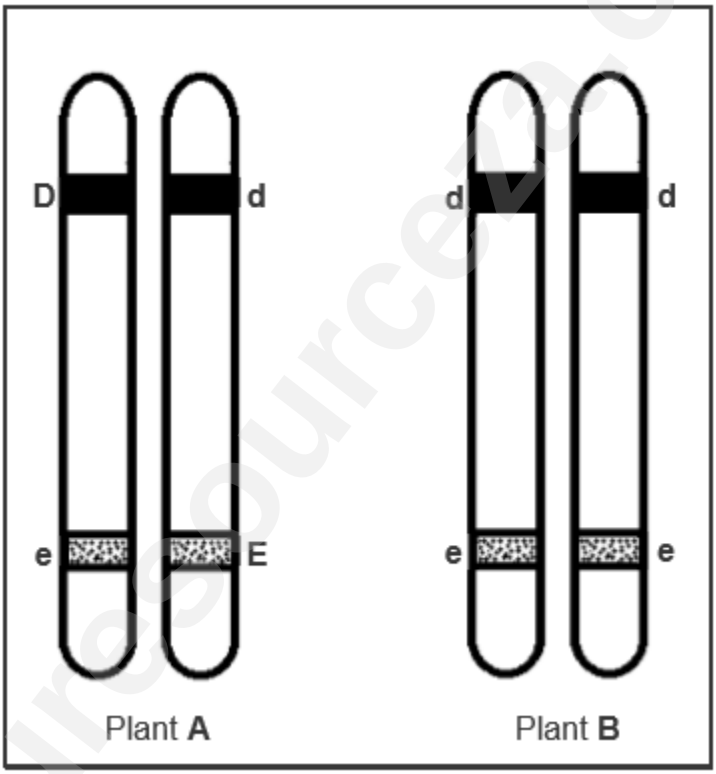
Fertilisation:
F_1-genotypes: TtDd √
F_1-phenotypes: All tall plants with coloured flowers√ (6)

2.7.2 9 : 3 : 3 : 1√√ (2)
(8)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.2 In a certain type of plant, the genes that determine the shape of the pollen grains and the colour of the flowers are linked on the same chromosome. The pollen grains could either be long (**D**) or round (**d**) and the flowers could either be purple (**E**) or red (**e**). The diagram below represents the arrangement of linked genes on the chromosomes in plants **A** and **B**.
In a dihybrid investigation, plant **A** is crossed with plant **B**.



Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.2.1 From the above diagram, determine the genotype and phenotype of:

(a) Plant **A** (2)

(b) Plant **B** (2)

2.2.2 How many gametes with different genotypes can possibly be produced by: (Assume that there is no crossing over in meiosis when the gametes are formed.)

(a) Plant **A** (1)

(b) Plant **B** (1)

2.2.3 What are the genotypes of the gametes produced in:

(a) Plant **A** (2)

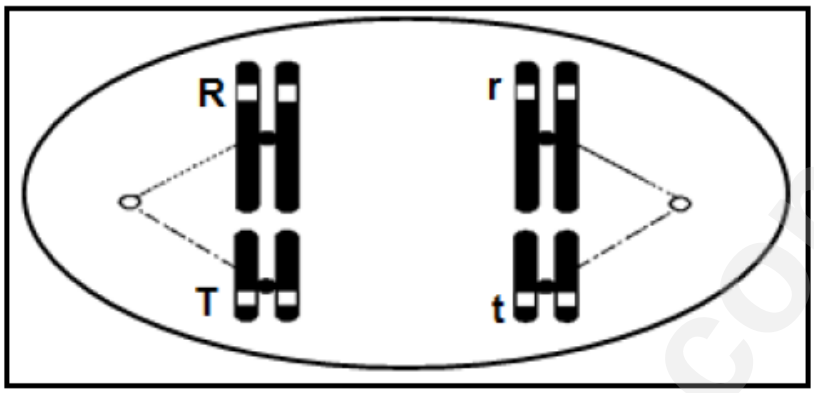
(b) Plant **B** (1)

2.2	2.2.1	(a)	Plant **A** – Genotype: DdEe ✓; Phenotype: Long purple ✓	(2)
		(b)	Plant **B** – Genotype: ddee ✓; Phenotype: Round red ✓	(2)
	2.2.2	(a)	Plant **A** – 4 ✓ types	(1)
		(b)	Plant **B** – 1 ✓ type	(1)
	2.2.3	(a)	DE; De; dE; de ✓✓	(2)
		(b)	de ✓	(1)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.1.5 The diagram below shows some of the alleles during the formation of gametes.



Give the genotype of the:

(a) Individual represented in the diagram (1)

(b) Possible gametes resulting from the arrangement of alleles represented in the diagram (2)
(14)

3.1.5 (a) RrTt✓ (1)

(b) RT, rt✓✓ (2)
(14)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.3 In a plant species two characteristics, flower colour and plant height, were studied. Each of these characteristics has two variations: flowers may be red or white in colour and the plants may be tall or short.

Plants that are heterozygous for flower colour have red flowers and plants that are homozygous recessive for plant height are short.

The alleles for each characteristic are shown in the table below.

CHARACTERISTIC	DOMINANT ALLELE	RECESSIVE ALLELE
Flower colour	F	f
Plant height	H	h

3.3.1 What is the term given for a genetic cross involving two characteristics? (1)

3.3.2 Give the:

(a) Dominant phenotype for flower colour (1)

(b) Recessive phenotype for plant height (1)

(c) Phenotype of a plant that is heterozygous for flower colour and homozygous dominant for plant height (2)

(d) Genotype of a white flowering, short plant (2)

3.3.3 State Mendel's Law of Dominance. (3)
(10)

3.3 3.3.1 Dihybrid✓ cross (1)

3.3.2 (a) Red✓ (1)
(b) Short✓ (1)
(c) Red✓ and Tall✓ (2)
(d) ffhh✓✓ (2)

3.3.3 - When two organisms with pure breeding✓
- contrasting traits✓are crossed
- all the individuals of the F_1 generation will display the dominant trait✓

OR

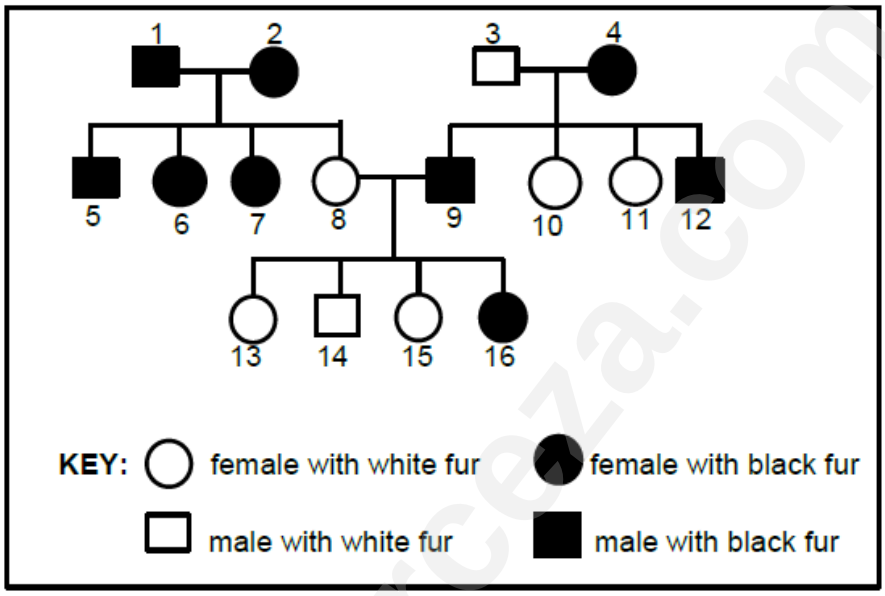
- If an organism is heterozygous✓
- the dominant allele✓
- will determine the phenotype✓ (3)
(10)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

6. Genetic lineages/pedigrees

1.5 Mice may have white fur or black fur. The diagram shows the inheritance of fur colour in mice.



1.5.1 What is this diagram called? (1)

1.5.2 How many sets of parents are represented in this diagram? (1)

1.5.3 Give the phenotype:

(a) Which is dominant (1)

(b) Of individual 9 (1)

1.5.4 Use the letter **A** for the dominant allele and **a** for the recessive allele to give the genotype of:

(a) 8 (1)

(b) 16 (1)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.5	1.5.1	Pedigree ✓ /Genetic lineage diagram		(1)
	1.5.2	3 ✓		(1)
	1.5.3	(a)	Black ✓ fur	(1)
		(b)	Black ✓ fur	(1)
	1.5.4	(a)	aa ✓	(1)
		(b)	Aa✓	(1)

eduresourceza.com

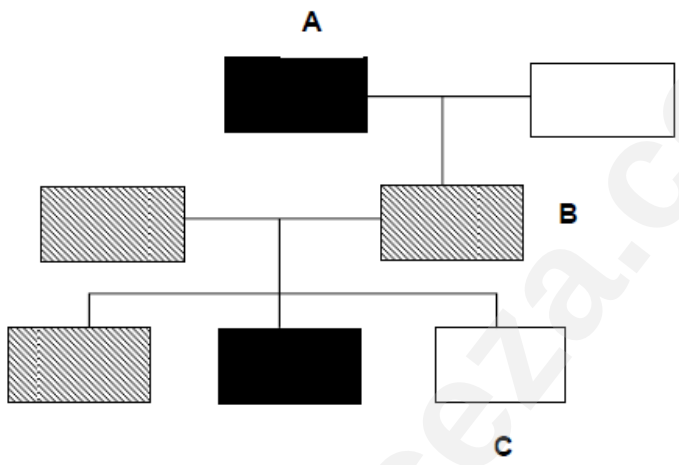
Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.4 Study the pedigree diagram below which shows the inheritance of flower colour in a certain plant over three generations.

Use the following symbols for the contrasting alleles:

W – for white colour
R – for red colour



Pedigree diagram showing inheritance of flower colour in a certain type of plant over three generations

KEY:

White flower colour

Red flower colour

Flower with equal distribution of **white** and **red** colour

2.4.1 Name the type of inheritance shown in the pedigree diagram above. (1)

2.4.2 Explain your answer to QUESTION 2.4.1. (3)

2.4.3 Use the symbols **R** and **W** and write down the genotypes of each of the following flowers:

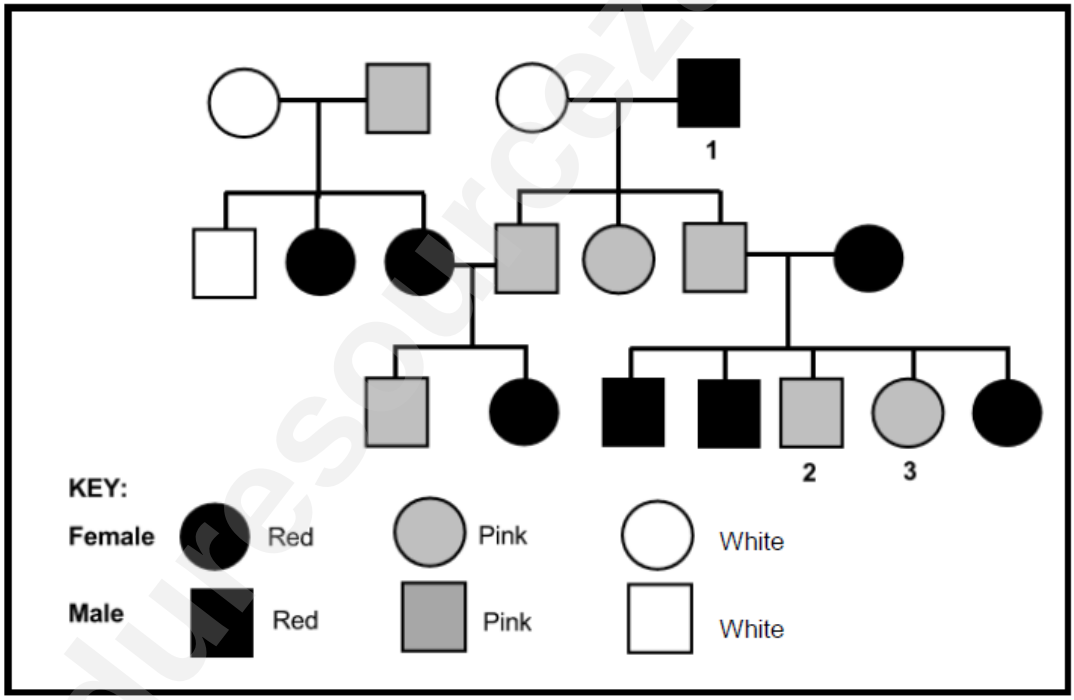
(a) A
(b) B
(c) C (3 x 2) (6)
(10)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.4	2.4.1	Co-dominance✓	(1)
	2.4.2	Both alleles✓ expressed themselves equally✓ in the phenotype✓ of the offspring	(3)
	2.4.3	(a) RR✓✓ (b) RW ✓✓ (c) WW✓✓ (3 x 2)	(6) **(10)**

3.1 The diagram below shows the inheritance of coat colour in pigs through three generations.



Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.1.1 What type of inheritance is shown in the pedigree diagram? (1)

3.1.2 Explain your answer to QUESTION 3.1.1 (2)

3.1.3 Use **R** for the allele for red coat colour and **W** for the allele for white coat colour to give the possible genotype/s of:

(a) Individual **1** (1)

(b) Individual **2** (1)

3.1.4 The pig farmer is interested in breeding pigs with red coats. He has a red-coated male pig that he wishes to use for breeding purposes. He crosses the pig with individual **3**.

Use a genetic cross to show the probability of the piglets being born with red coats. (6)
(11)

3.1 3.1.1 Incomplete dominance ✓ (1)

3.1.2 Some pigs have pink coloured coats / new / third phenotype occurred / neither red nor white in the phenotype is dominant ✓✓ (2)

3.1.3 (a) 1 = RR ✓ (1)

(b) 2 = RW ✓ (1)

3.1.4

P_1 / parent	phenotype	Red coat male	x	Pink female ✓
	genotype	RR	x	RW
	Meiosis			
	G / gametes	R ; R	x	R ; W✓

Fertilisation

F_1 / offspring

genotype: RR ; RW ; RR ; RW✓

phenotype: 2 red : 2 pink✓

***50% or 2 in 4 / 1 in 2 / half✓**

Parents and offspring✓ / P_1 and F_1
Meiosis and fertilisation✓ **Any 5 + 1*(Compulsory)**

OR

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

P_1 / parent	phenotype	Red coat male	x	pink female ✓
	genotype	RR	x	RW ✓
	Meiosis			
	G / gametes	R ; R	x	R ; W ✓

Fertilisation

Gametes	R	R
R	RR	RR
W	RW	RW

✓✓

F_1 / offspring genotype RR ; RR; RW; RW✓

phenotype 2 red : 2 pink✓
***50% or 2 in 4 / 1 in 2 / half✓**

Parents and offspring✓ / P_1 and F_1
Meiosis and fertilisation✓ **Any 5 + 1*(Compulsory)**

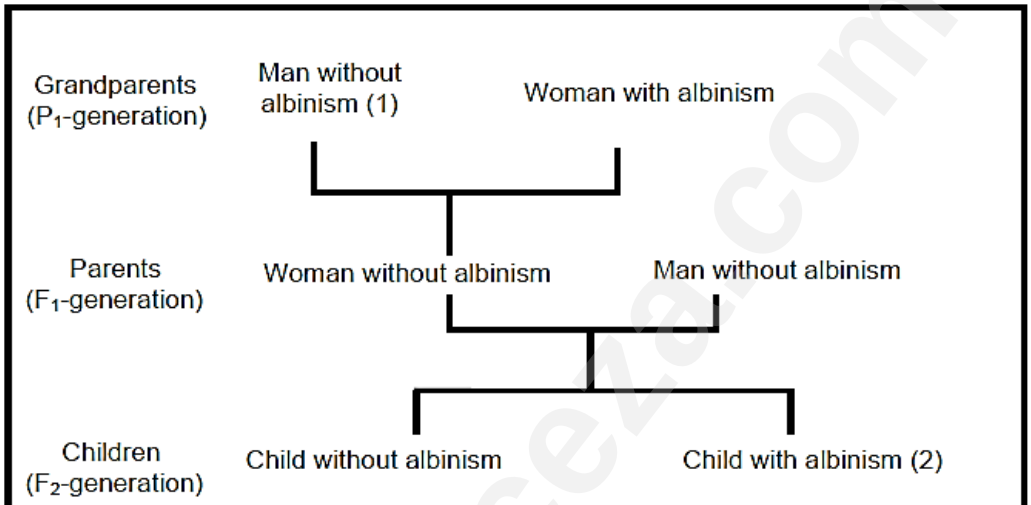
(6)
(11)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.2 People with albinism are unable to produce the dark pigment, melanin, in their skin. This condition is caused when an individual is homozygous recessive for this characteristic.

The family tree below shows the occurrence of albinism over three generations.



Family tree to show the occurrence of albinism

3.2.1 Indicate whether each of the individuals below could be homozygous dominant, homozygous recessive or heterozygous:

(a) 1
(b) 2 (3)

3.2.2 Explain your answer to QUESTION 3.2.1(a). (2)

3.2

3.2.1 (a) homozygous dominant✓and heterozygous✓ (2)

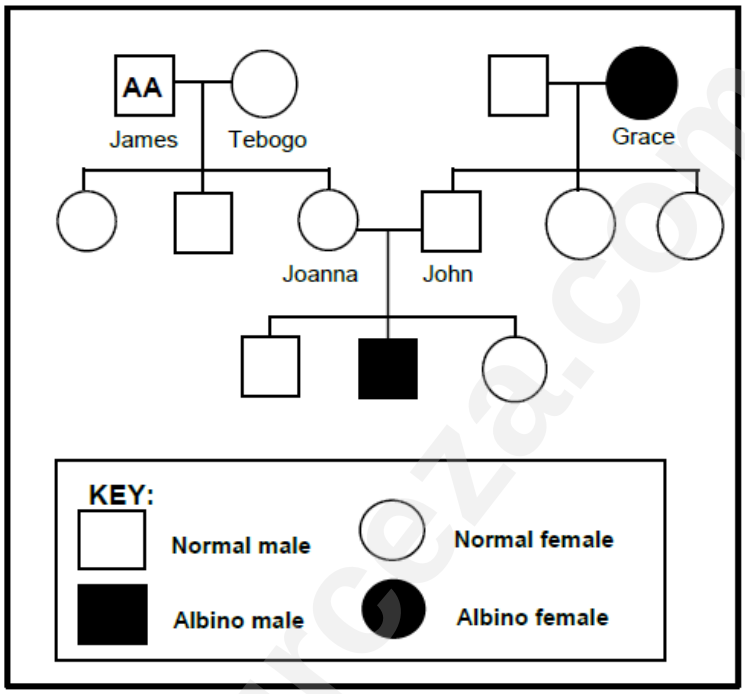
(b) homozygous recessive✓ (1)

3.2.2 Normal is dominant and the dominant condition✓
can show up in either homozygous or heterozygous state✓
OR
To have a normal child ✓ the person (1) must have at least one dominant gene✓/phenotype is normal (2)
(5)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.4 Albinism is an inherited condition caused by a recessive gene mutation. This mutation results in the absence of the protein melanin in the skin. The pedigree diagram below shows the inheritance of albinism in a family. The genotype of James is shown in the diagram.



3.4.1 How many grandsons do James and Tebogo have? (1)

3.4.2 What is:

(a) Grace's phenotype (1)

(b) John's genotype (2)

3.4.3 John and Joanna wish to have another child. What is the percentage chance that the child will:

(a) Be a girl (1)

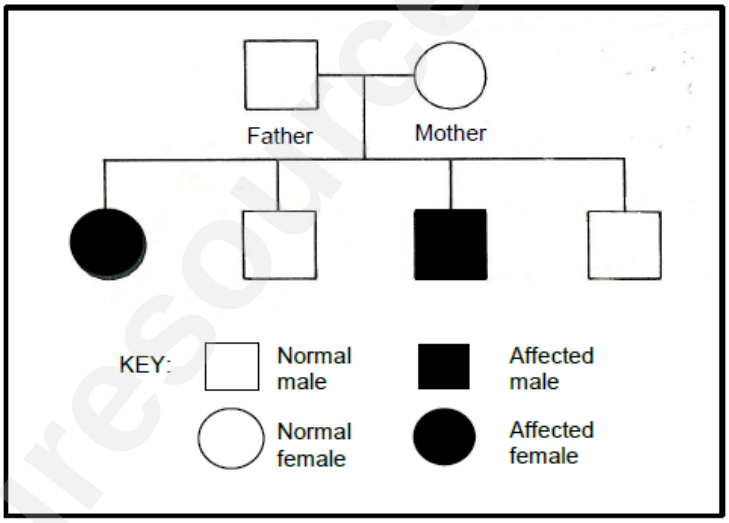
(b) Have albinism (1)
(6)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.4	3.4.1	2✓		(1)
	3.4.2	(a)	Albino female✓	(1)
		(b)	Aa✓✓	(2)
	3.4.3	(a)	50%✓	(1)
		(b)	25%✓	(1) **(6)**

3.5 The pedigree diagram below shows the pattern of inheritance of a certain genetic disorder controlled by a recessive allele. The dominant allele is represented by **N** and the recessive allele by **n**.



3.5.1 Explain why both parents must be heterozygous for this characteristic. (2)

3.5.2 Give the possible genotype(s) of the normal children. (2)

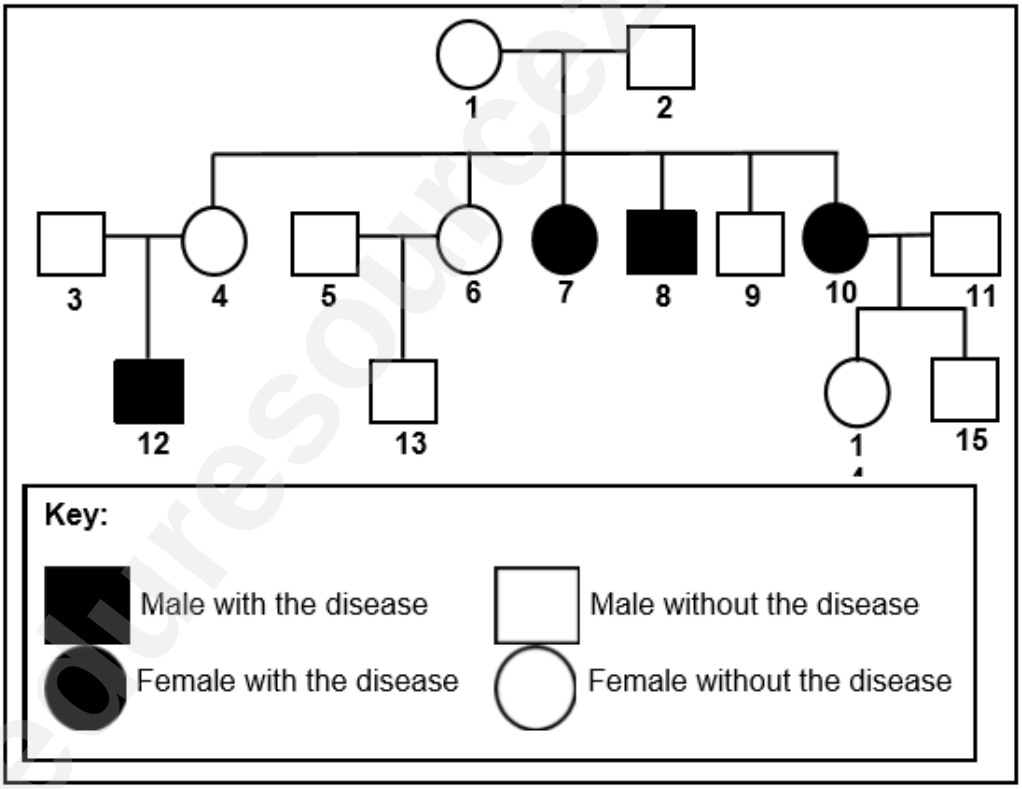
3.5.3 Provide evidence from the pedigree diagram to show that this characteristic is not sex-linked. (2)
(6)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.5	3.5.1	- Because they were normal they must each have one dominant allele✓ - and in order for their children to be affected each parent must have one recessive allele✓	(2)
	3.5.2	NN✓ or Nn✓	(2)
	3.5.3	- The father would have been affected✓ if it was sex-linked - in order for the daughter to be affected✓	(2) **(6)**

3.1 The following diagram shows the inheritance of a particular autosomal disease in humans.



Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.1.1 Name the type of diagram represented above. (1)

3.1.2 Is the disease inherited as a dominant trait or a recessive trait? (1)

3.1.3 Give a reason for your answer in QUESTION 3.1.2. (2)

3.1.4 If **N** represents the dominant allele and **n** the recessive allele. Use these letters to assign the genotype of individual:

(a) **1** (1)

(b) **12** (1)

3.1.5 Suppose individual **11** has no family history of the disease.

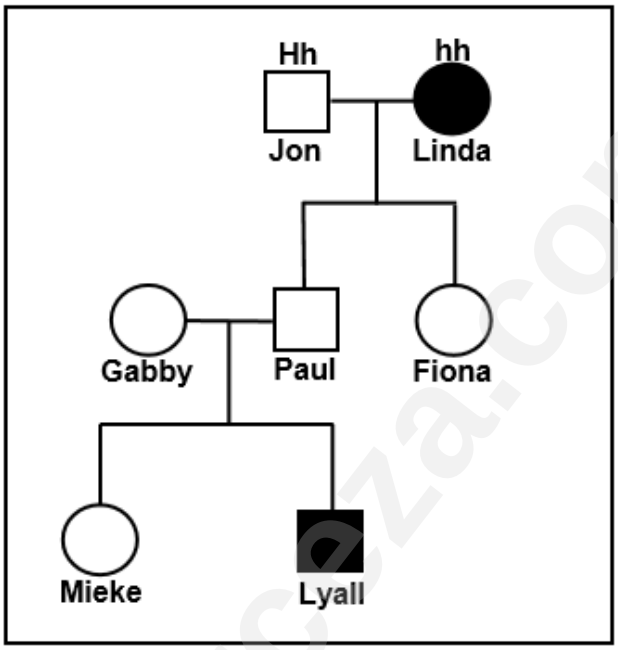
Explain the probability of individual **10** and **11** having a child with the disease. (3)

3.1	3.1.1	Pedigree ✓ diagram	(1)
	3.1.2	Recessive ✓	(1)
	3.1.3	- Neither individual 1 and 2 have the disease ✓ but - they have two children 7 and 8 with the disease. ✓ **OR** - Individual 3 and 4 do not have the disease ✓ - but have child 12 with the disease. ✓	(2)
	3.1.4	(a) Nn ✓	(1)
		(b) nn ✓	(1)
	3.1.5	- Individual 11 can only have genotype NN ✓ - If crossed with individual 10 with the genotype nn ✓ - there is no chance/ 0% probability of having a child with the disease ✓ - as all offspring will have the genotype Nn ✓ (Any 3)	(3)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.2 The diagram below shows the pattern of inheritance of deafness in a family. The letter **H** represents the allele for hearing and **h** represents the allele for deafness.



2.2.1 How many of EACH of the following are represented in this diagram?

(a) Males (1)

(b) Generations (1)

2.2.2 Give the:

(a) Phenotype of Jon (1)

(b) Genotype of Paul (1)

2.2.3 Both Lyall's parents can hear, yet he is deaf.

Explain how he inherited deafness. (2)

2.2.4 Lyall marries a woman who is homozygous dominant for hearing. Use a genetic cross to show the percentage chance of them having a deaf child. (7)
(13)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.2	2.2.1	(a) 3✓	(1)
		(b) 3✓	(1)
	2.2.2	(a) Hearing✓/Normal	(1)
		(b) Hh✓	(1)
	2.2.3	- Lyall inherited one recessive allele✓ - from each parent✓	(2)

OR

P_1	Phenotype	Hearing	x	Deaf ✓
	Genotype	HH	x	hh ✓

Meiosis

Fertilisation

Gametes	H	H
h	Hh	Hh
h	Hh	Hh

1 mark for correct gametes
1 mark for correct genotypes

F_1 Phenotype All hearing✓
0% deaf ✓*

P_1 and F_1✓
Meiosis and fertilisation✓

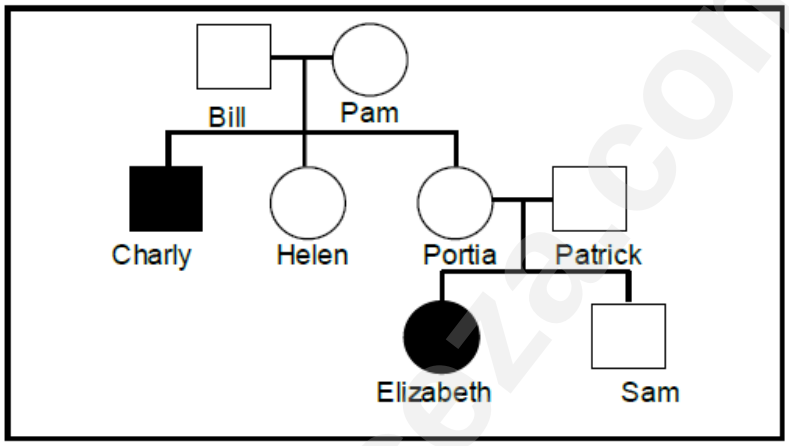
***1 Compulsory mark** + Any 6 (7)
(13)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.5 Tay-Sachs disease is caused by an autosomal recessive allele (**n**). Children with Tay-Sachs disease lose motor skills and mental functions. Over time, the children become blind, deaf, mentally retarded and paralysed. Tay-Sachs children die by the age of five.

The pedigree diagram below shows the inheritance of Tay-Sachs disease in a family.



[Source: www.tay-sachs.org]

2.5.1 Give:

(a) Charly's phenotype (2)

(b) Portia's genotype (2)

(c) Bill's genotype (2)

2.5.2 Explain why Patrick is normal, but a carrier of Tay-Sachs disease. (2)
(8)
[40]

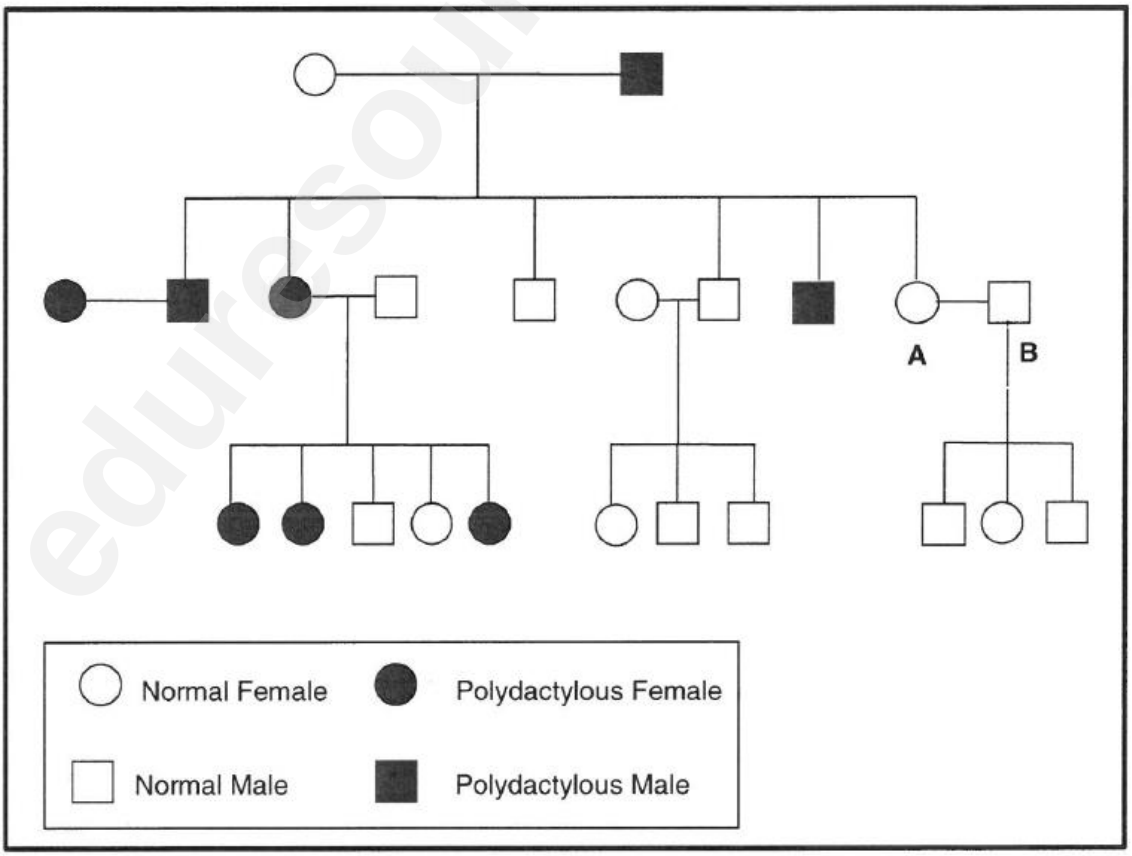
Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.5	2.5.1	(a)	Male✓ with Tay Sachs disease✓/all 4 symptoms must be given blind, deaf, mentally retarded and paralysed/ lose motor skills and mental functions	(2)
		(b)	Nn✓✓	(2)
		(c)	Nn✓✓	(2)
	2.5.2		- Since Elizabeth has Tay-Sachs disease✓/nn she had to inherit one recessive allele from each of her parents✓/Portia and Patrick. - Patrick's genotype is Nn✓/heterozygous which means he is a carrier but normal. (Any 2)	(2) **(8)** **[40]**

1.5 Polydactyly (extra finger/toe) is a dominant trait in humans controlled by a single pair of alleles. The pedigree diagram below shows a family in which this trait has occurred.

Use **F** to represent the allele for polydactyly.



Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.5.1	How many of the males in this pedigree diagram are polydactylous?	(1)
1.5.2	Give the genotype of all normal people shown in this pedigree diagram.	(2)
1.5.3	Can individuals **A** and **B** have a polydactylous child?	(1)
1.5.4	Give ONE reason for your answer in QUESTION 1.5.3.	(2) **(6)**

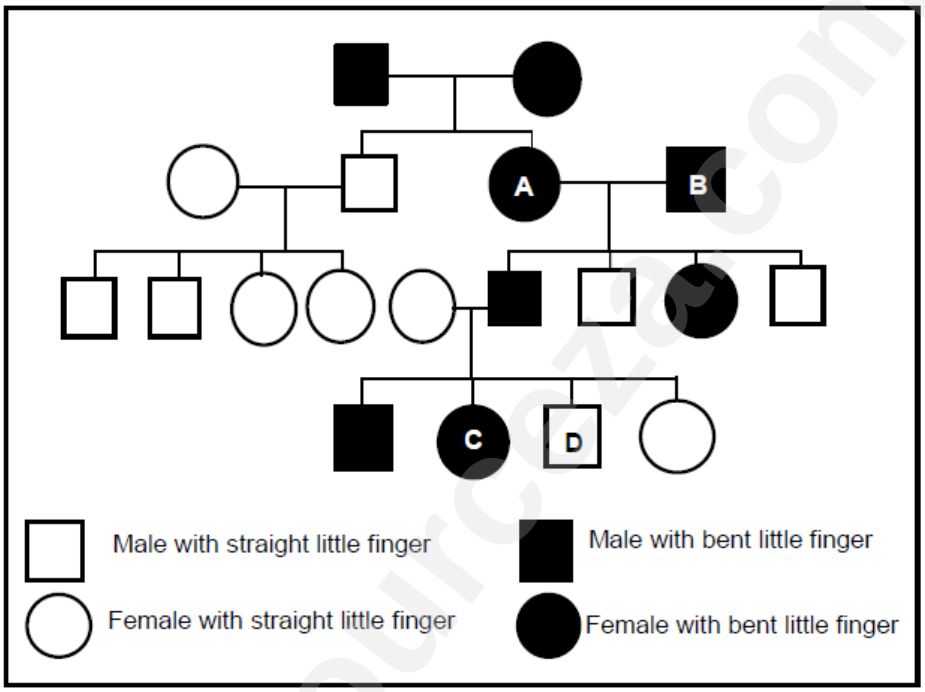
1.5	1.5.1	3✓	(1)
	1.5.2	ff✓✓	(2)
	1.5.3	No✓	(1)
	1.5.4	- Both A and B are normal✓ and - do not have any dominant alleles✓ that can be passed on to their offspring.	(2) **(6)**

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.1 A dominant allele causes the last joint of the little finger to bend inwards towards the fourth finger (**B**) and is called 'bent little finger'. The recessive allele (**b**) causes the little finger to be straight.

The pedigree diagram below shows the inheritance of a 'bent little finger' in a family.



2.1.1 Explain why individuals **A** and **B** are definitely heterozygous for this trait. (3)

2.1.2 Individual **C** has a child with a partner that has straight little fingers.

Use a genetic diagram to show the possible genotypes and phenotypes of the child. (6)
(9)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.1 2.1.1

- The parents have the dominant phenotype✓/have one dominant allele
- To have children with the recessive characteristic✓/bb
- The other allele of each parent must be recessive✓ (3)

2.1.2

P_1	Phenotype	Bent little fingers	x	Straight little fingers✓
	Genotype	Bb	x	bb✓
Meiosis				
	G/gametes	B, b	x	b, b ✓
Fertilisation				
F_1	Genotype	Bb; Bb;		bb; bb ✓
	Phenotype	bent little finger		straight little fingers✓

P_1 and F_1✓
Meiosis and fertilisation✓

OR

P_1	Phenotype	Bent little fingers	x	Straight little fingers ✓
	Genotype	Bb	x	bb ✓

Meiosis

Fertilisation

Gametes	b	b
B	Bb	Bb
B	bb	bb

1 mark for correct gametes
1 mark for correct genotypes

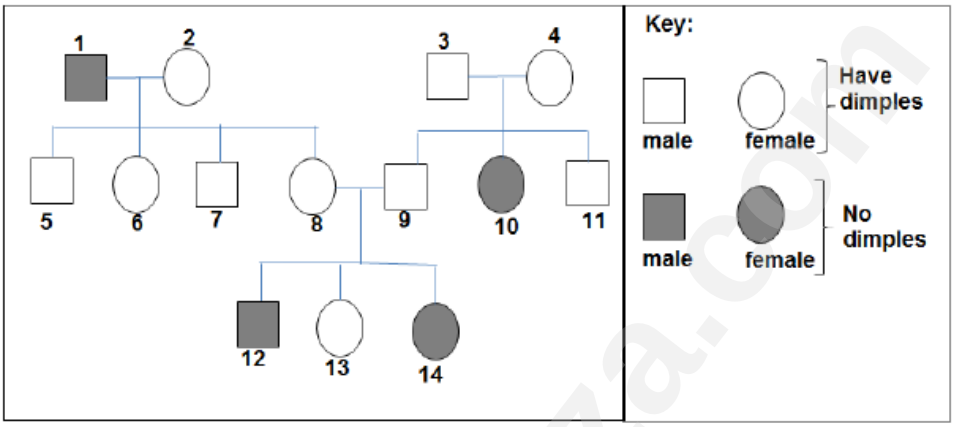
F_1	Phenotype	bent little fingers; straight little fingers✓

P_1 and F_1✓
Meiosis and fertilisation✓ Any (6)
(9)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.4 Use the pedigree diagram below to answer the questions about dimples (small depressions that occurs on the cheeks when one smiles).
The dimple gene (D) controls whether a person has dimples or does not have dimples. Allele for having dimples is dominant to allele for not having dimples (d).



1.4.1 How many family members have dimples? (1)

1.4.2 What is the genotype of the individuals?

(a) 3 (1)
(b) 4 (1)

1.4.3 State whether the following individuals are homozygous or heterozygous for having dimples:

(a) 2 (1)
(b) 9 (1)

1.4.4 State the family relationship between individual 12 and individual 2. (2)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

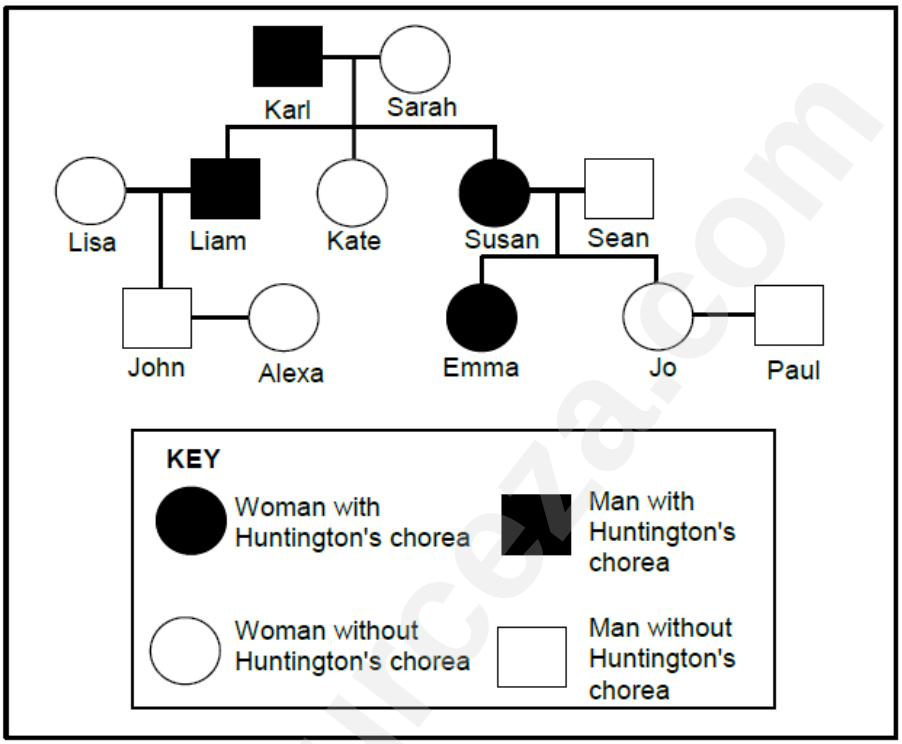
1.4	1.4.1	10 ✓	(1)
	1.4.2	(a) Dd ✓	(1)
		(b) Dd ✓	(1)
	1.4.3	(a) Homozygous ✓	(1)
		(b) Heterozygous ✓	(1)
	1.4.4	Individual 2 is the grandmother ✓ of individual 12.	
		OR	
		Individual 12 is the grandson ✓ of individual 2.	(2)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.4 Huntington's chorea is a disease caused by a gene mutation that results in the degeneration of brain tissue. It is caused by a dominant allele (**H**).

The pedigree diagram below shows the inheritance of this disorder in a family.



2.4.1 What is:

(a) Susan's phenotype (1)

(b) Sarah's genotype (1)

2.4.2 Emma plans to have a baby. What must the father's genotype be so that there is a 50% chance that their child will not have Huntington's chorea? (1)

2.4.3 Explain your answer to QUESTION 2.4.2. (3)
(6)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

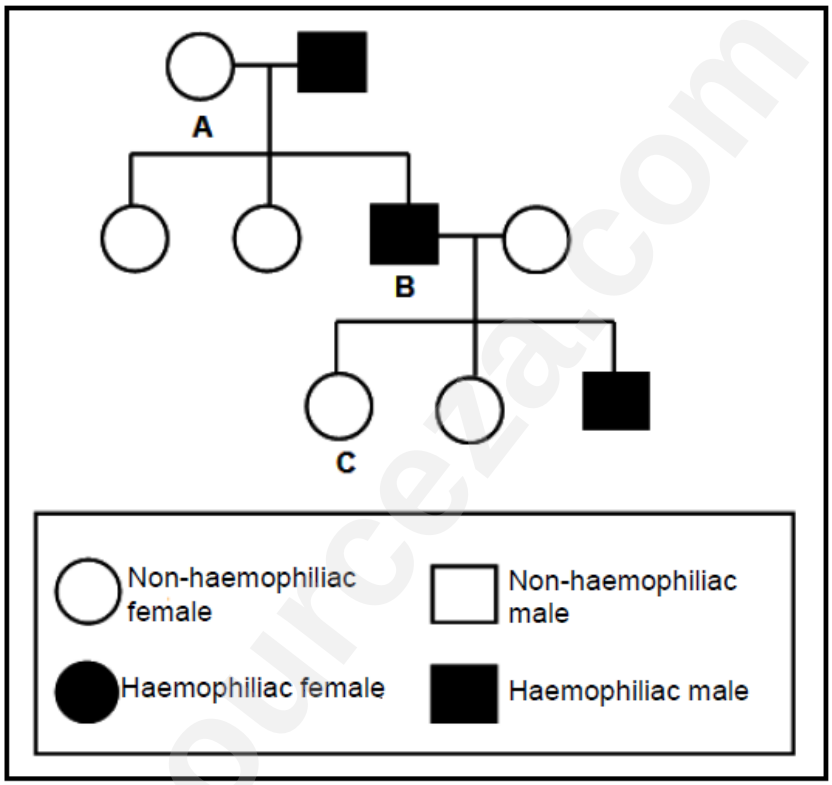
2.4	2.4.1	(a) Suffers from Huntington's✓chorea	(1)
		(b) hh✓	(1)
	2.4.2	hh✓	(1)
	2.4.3	- Emma's genotype is Hh✓/heterozygous - The father's genotype has to be hh✓/homozygous recessive - a cross between only these two genotypes✓/(Hh and hh) will ensure that there is 50% chance of the child not inheriting the disease - The child inherits one recessive allele from each parent✓	(3) **(6)**

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.5 Haemophilia is a genetic disorder resulting in the abnormal clotting of blood. It is caused by a recessive allele that is carried on the **X**-chromosome. The allele for normal clotting is X^H and the allele for haemophilia is X^h.

The inheritance of haemophilia in a family is shown in the diagram below.



1.5.1 Give the percentage of the males with haemophilia in this family. (1)

1.5.2 Give the phenotype for individual **A**. (1)

1.5.3 Give the genotype for individual:

(a) **B** (1)

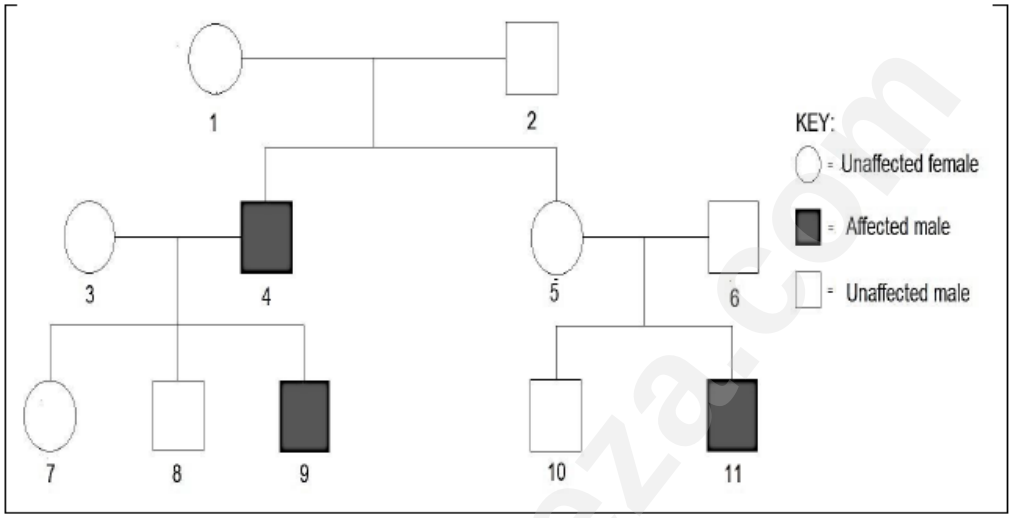
(b) **C** (2)
(5)

1.5	1.5.1	100✓%	(1)
	1.5.2	Non-haemophiliac female ✓/Normal female	(1)
	1.5.3	(a) X^hY ✓ (b) $X^H X^h$ ✓✓	(1) (2) **(5)**

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.4 The pedigree diagram below traces the inheritance of *haemophilia* in a family. Study the diagram and answer the questions that follow.



3.4.1 How many family members not affected by *haemophilia* are carriers? (2)

3.4.2 Use the possible alleles X^H ; X^h and Y to determine the genotype for each of the following:

(a) Individual 1 (1)

(b) Individual 4 (1)

3.4.3 Explain why this disorder affects mostly males. (2)

3.4.4 Individual 10 and his wife, who is a carrier (not shown in the diagram), have a son. What are the chances of this son developing *haemophilia*? (1)

3.4.5 Suggest TWO reasons why individual 9 and his partner should undergo genetic counselling before starting a family. (2)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

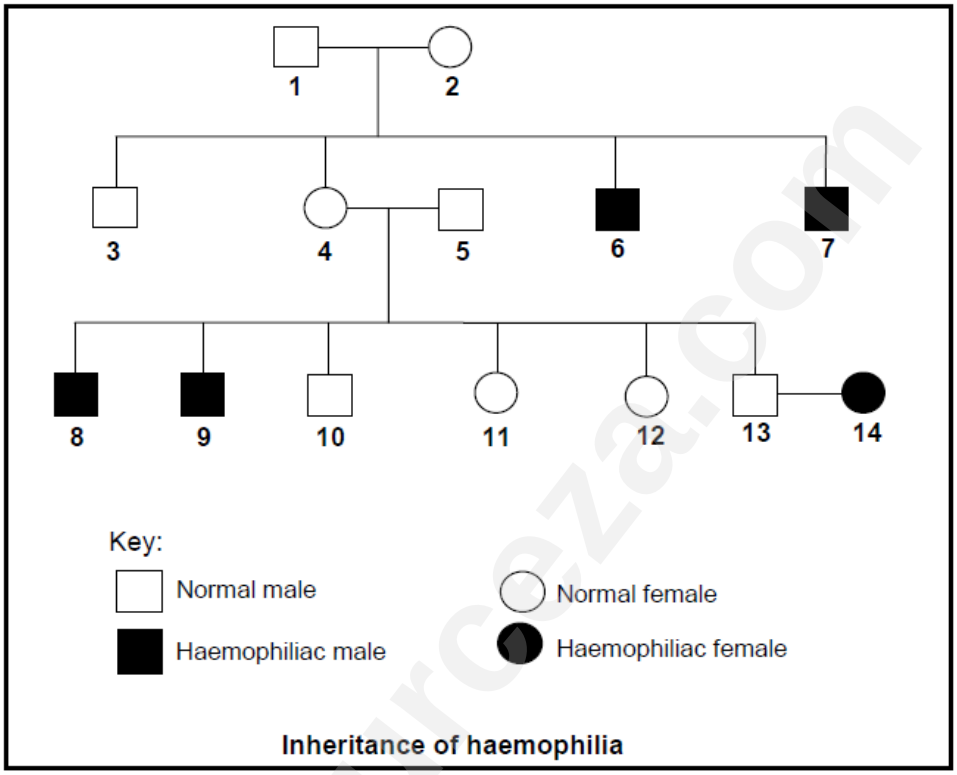
3.4	3.4.1	Four/4 ✓✓	(2)
	3.4.2	(a) X^HX^h ✓	(1)
		(b) X^hY ✓	(1)
	3.4.3	• The allele for the trait is carried on the X-chromosome ✓/Y-chromosome does not carry the allele for the trait. • Males only have one X-chromosome ✓ • A male only needs one recessive allele ✓ to be haemophiliac, whereas for a female to be haemophiliac both alleles must be recessive. ✓ (Any 2 x 1)	(2)

	3.4.4	50✓%✓ / ½	(1)
	3.4.5	• To determine if the wife is a carrier. ✓ • To determine what the chances are of having a child with *haemophilia*. ✓ • Help them evaluate whether they would cope with such a child. ✓ • Help them to make an informed decision about whether to have children. ✓ (Any 2 x 1)	(2)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.5 The pedigree diagram below shows the inheritance of haemophilia in a family. The allele causing haemophilia is represented by X^h and the normal allele is represented by X^H.



Inheritance of haemophilia

3.5.1 Determine the:

(a) Phenotype of individual **4** (1)

(b) Genotype of individual **2** (2)

3.5.2 Explain why females have a smaller chance of suffering from haemophilia. (3)

3.5.3 Represent a genetic cross to show the percentage chance of individuals **13** and **14** having a haemophiliac son. (7)
(13)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.5 3.5.1 (a) Normal female✓ (1)

(b) X^HX^h✓✓ (2)

3.5.2
- Haemophilia is caused by a recessive allele✓
- Carried on the X chromosome✓
- Females have two X chromosomes✓/ Males only have one X chromosome
- Females must inherit two copies of the recessive allele✓/ females who inherit only one of the recessive allele are still normal

Any 3 (3)

3.5.3

P_1/P_3 Phenotype Normal male x Haemophiliac female✓

Genotype X^HY x X^hX^h✓

Meiosis

G/gametes X^H, Y x X^h, X^h✓

Fertilisation

F_1/F_3 Genotype X^HX^h; X^HX^h; X^hY; X^hY✓

Phenotype 2 normal daughters : 2 haemophiliac sons✓

* **50%✓ chance of having a haemophiliac son**

P_1 and F_1✓

Meiosis and fertilisation✓

***1 compulsory** +any 6 (7)

OR

P_1/P_3 Phenotype Normal male x Haemophiliac female ✓

Genotype X^HY x X^hX^h✓

Meiosis

Fertilisation

Gametes	X^h	X^h
X^H	X^HX^h	X^HX^h
Y	X^hY	X^hY

1 mark for correct gametes
1 mark for correct genotypes

F_1/F_3 Phenotype 2 normal daughters : 2 haemophiliac sons✓

* **50%✓ chance of having a haemophiliac son**

P_1 and F_1✓

Meiosis and fertilisation✓ ***1 compulsory**+any 6 (7)

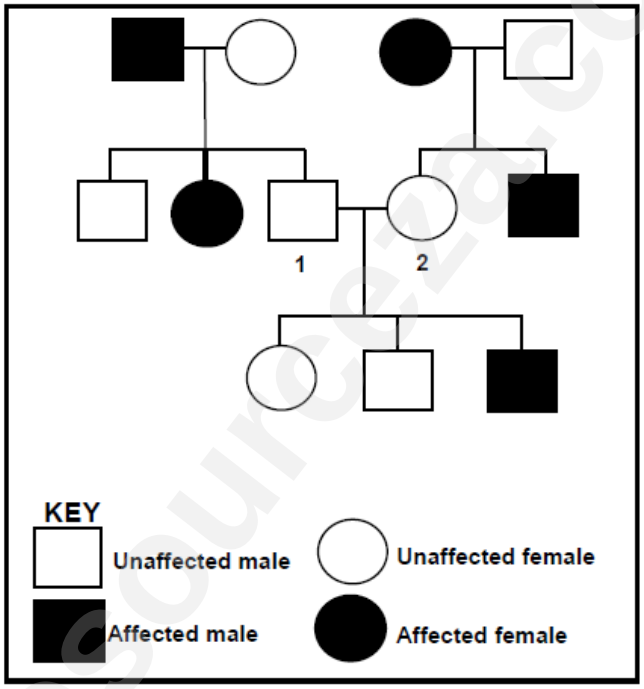
(13)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.3 A lack of immunity to infections (agammaglobulinemia) is a sex-linked recessive genetic disorder in humans. The dominant allele is represented by X^A and the recessive allele is represented by X^a.

An individual with the disorder is described as affected and an individual without it is described as unaffected. The pedigree diagram below illustrates inheritance of this disorder.



3.3.1 Name the genotypes of individuals:

(a) **1** (2)

(b) **2** (2)

3.3.2 What percentage of the males in this pedigree diagram is affected? Show ALL working. (2)

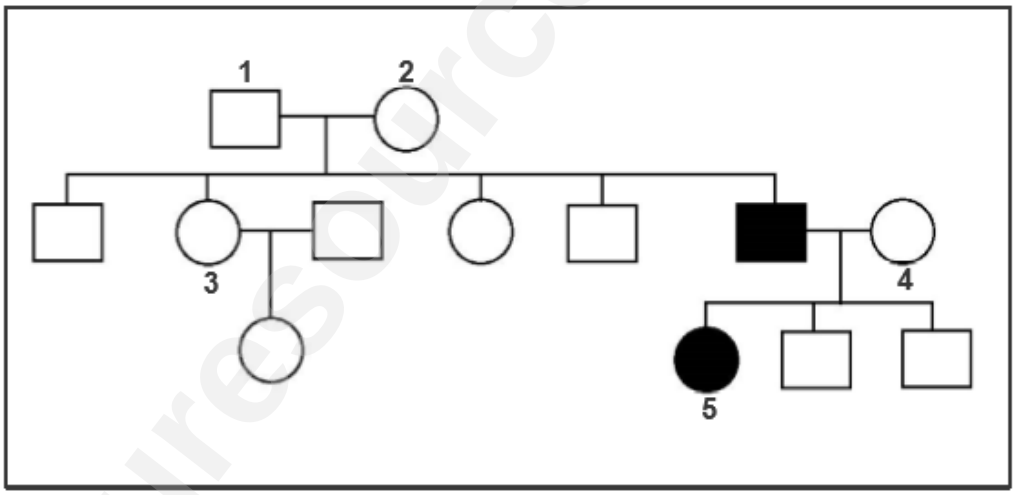
3.3.3 Explain why any son of an affected female will always have this disorder. (3)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.3	3.3.1	(a) X^AY✓✓	(2)
		(b) X^AX^a✓✓	(2)
	3.3.2	$\left[\frac{3}{7} \times 100\right]$ ✓ $= 42{,}86$✓$/42{,}9/43\%$	(2)
	3.3.3	- An affected female carries two/only recessive alleles✓/X^aX^a - Sons/males inherit one X chromosome✓ from their mothers - Sons/males need only one recessive allele to be affected✓ - And therefore must inherit X^a from their mother✓ Any 3	(3) **(9)**

3.2 The pedigree diagram below shows the inheritance of colour-blindness in a family. Colour-blindness is a sex-linked disorder caused by a recessive allele (**h**). The ability to see colour normally is caused by a dominant allele (**H**).



Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.2.1 How many of the male offspring of parents **1** and **2** were normal? (1)

3.2.2 State the genotype of:

(a) Individual **2** (2)

(b) Individual **5** (2)

3.2.3 A person with a recessive allele for colour-blindness may not be colour-blind. Explain why males with an allele for colour-blindness are always colour-blind. (4)

3.2.4 If individual **5** marries a normal male, what percentage of their daughters will have an allele for colour-blindness, but will NOT be colour-blind? (2)

3.2	3.2.1	2 ✓		(1)
	3.2.2	(a)	X^HX^h ✓✓	(2)
		(b)	X^hX^h ✓✓	(2)
	3.2.3	- Since the allele is found only on the X-chromosome ✓ - a male only has one allele ✓ - that is either dominant (normal) or ✓ - recessive (colour blind) ✓ - and therefore will always be colour blind ✓ (if recessive allele inherited) (Max. 4)		(4)
	3.2.4	100% ✓✓		(2)

Downloaded from eduresourceza.com

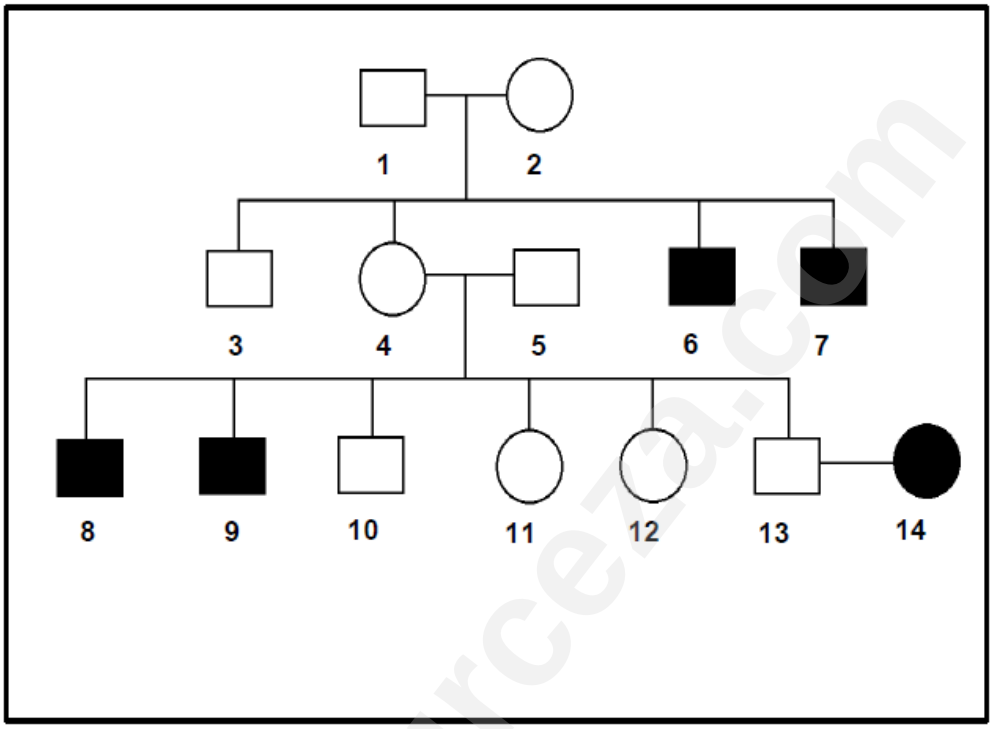
Downloaded from eduresourceza.com

eduresourceza.com

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.1 The pedigree diagram below shows the inheritance of colour blindness in a family. The allele causing colour blindness is represented by X^d and the normal allele is represented by X^D.



3.1.1 Determine the:

(a) Phenotype of individual **4** (1)

(b) Genotype of individual **2** (1)

3.1.2 Explain why females have a smaller chance of suffering from colour blindness. (3)

3.1.3 Represent a genetic cross to show the percentage chance of individuals **13** and **14** having a colourblind son. (7)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.1 3.1.1 (a) Normal female ✓ (1)

(b) X^DX^d ✓ (1)

3.1.2
- Colour blindness is caused by a recessive allele ✓
- Carried on the X chromosomes ✓
- Females have two X chromosomes ✓ / Male only have one X chromosome
- Females must inherit two copies of the recessive allele ✓/ females who inherit only one of the recessive allele are still normal.

(Any 3 x 1) (3)

3.1.3

P_3 Phenotype Normal male × Colour blind female ✓

Genotype X^DY × X^dX^d ✓

Meiosis

Gametes X^D Y × X^d X^d

Fertilisation

F_3 Genotype $X^D X^d$ $X^D X^d$ $X^d Y$ $X^d Y$ ✓

Phenotype 2 normal daughters : 2 Colour blind sons

***50% chance of having a colour blind son**

P_3 and F_3 (P_1 and F_1) ✓

Meiosis and fertilisation ✓

(***1 Compulsory** + Any 6) (7)

OR

P_3 Phenotype Normal male × Colour blind female ✓

Genotype $X^D Y$ × $X^d X^d$ ✓

Meiosis

Fertilisation

Gametes	X^d	X^d
X^D	X^DX^d	X^DX^d
Y	$X^d Y$	$X^d Y$

1 mark for correct gametes
1 mark for correct genotypes

F_3 Phenotype 2 normal daughters : 2 Colour blind sons ✓

***50% ✓ chance of having a colour blind son**

P_3 and F_3 (P_1 and F_1) ✓

Meiosis and fertilisation ✓

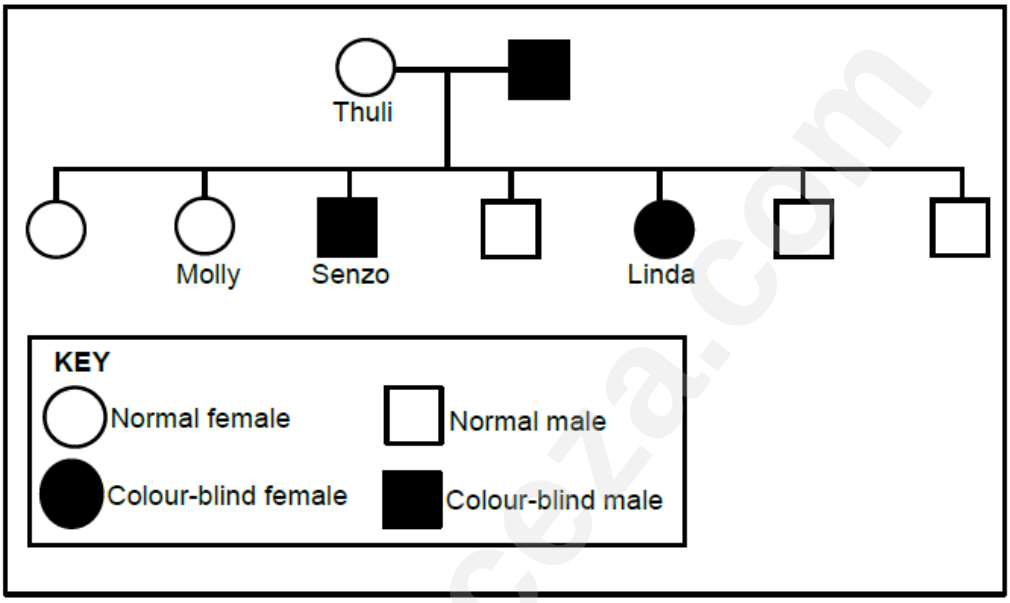
(***1 compulsory** + Any 6) (7)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.3 Colour-blindness (Daltonism) is a sex-linked disorder caused by a recessive allele (X^d).

The diagram below shows the inheritance of this disorder in a family.



2.3.1 Give the:

(a) Phenotype of Senzo (1)

(b) Genotype of Thuli (1)

2.3.2 Describe how Linda inherited colour-blindness. (2)

2.3.3 Explain why there are generally more males than females with colour-blindness in a population. (4)

2.3.4 Molly married a 'normal male'. Use a genetic cross to show the possible genotypes and phenotypes of their children. (6)
(14)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.3	2.3.1	(a) Colour blind male✓/male with Daltonism	(1)
		(b) X^DX^d✓	(1)
	2.3.2	- Linda inherited one recessive allele/X^d from her father✓ - and one recessive allele/X^d from her mother✓	(2)
	2.3.3	- Males only have one X-chromosome✓ - If this chromosome carries the recessive allele✓/X^d - the male will be colour blind✓ - Females have 2 X-chromosomes✓ - They need to have two recessive alleles✓/X^d X^d to be affected - A dominant allele on the other X-chromosome will mask the effect✓ Any 4	(4)

2.3.4

P_1	Phenotype	Normal female	x	Normal male ✓
	Genotype	X^DX^d	x	X^DY ✓
Meiosis				
	G/gametes	X^D, X^d	x	X^D,Y✓
Fertilisation				
F_1	Genotype	X^DX^D X^DY X^DX^d X^dY✓ *		
	Phenotype	Normal females, Normal male, Colour blind male ✓ *		

P_1 and F_1✓
Meiosis and fertilisation✓

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

OR

P_1	Phenotype	Normal female	X	Normal male ✓
	Genotype	X^DX^d	X	X^DY ✓

Meiosis

Fertilisation

Gametes	X^D	Y
X^D	X^DX^D	X^DY
X^d	X^DX^d	X^dY

1 mark for correct gametes✓
1 mark for correct genotypes✓ *

F_1 Phenotype Normal females, Normal male, Colour blind male ✓ *

P_1 and F_1✓ (6)

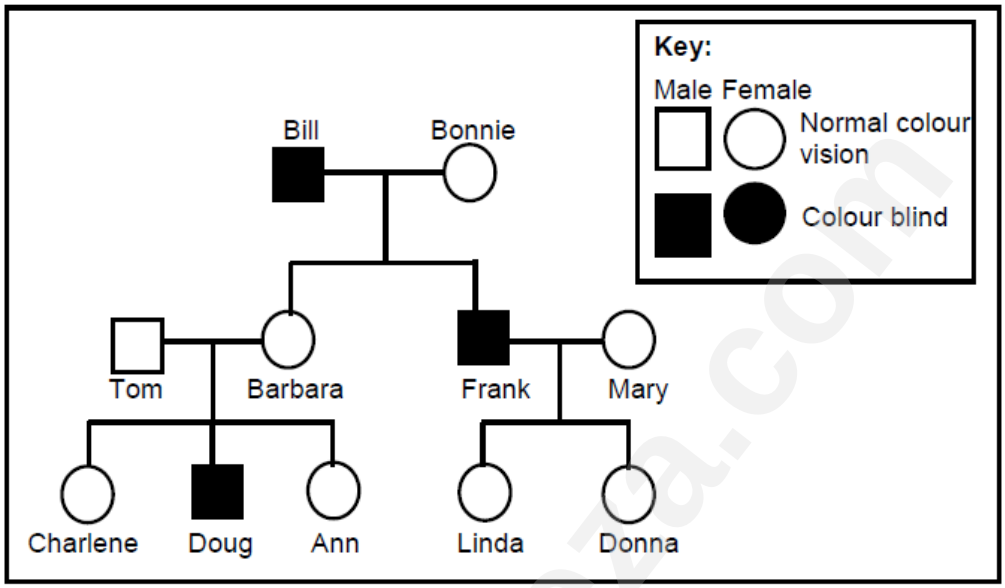
Meiosis and fertilisation✓ ***Compulsory** 2 + Any 4 **(14)**

[40]

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.3 The diagram below represents the inheritance of colour blindness in a family.



2.3.1 Give evidence from the pedigree diagram that suggests that colour blindness is a sex-linked genetic disorder. (1)

2.3.2 What is the percentage chance that Mary and Frank's next daughter will be colour blind if Mary is a carrier of the mutation? (2)

2.3.3 Explain how Tom and Barbara have a son who is colour blind even though neither of them suffers from the condition. (3)
(6)

2.3

2.3.1 Only the males in the family suffer from colour blindness✓ (1)

2.3.2 50✓✓ (2)

2.3.3
- Barbara is a carrier✓/heterozygous and does not suffer from colour blindness
- Their son received a Y chromosome from his father✓/ Tom/ no allele on Y chromosome for colour blindness
- but an X chromosome with the allele for colour blindness from his mother✓/Barbara (3)

(6)

Downloaded from eduresourceza.com

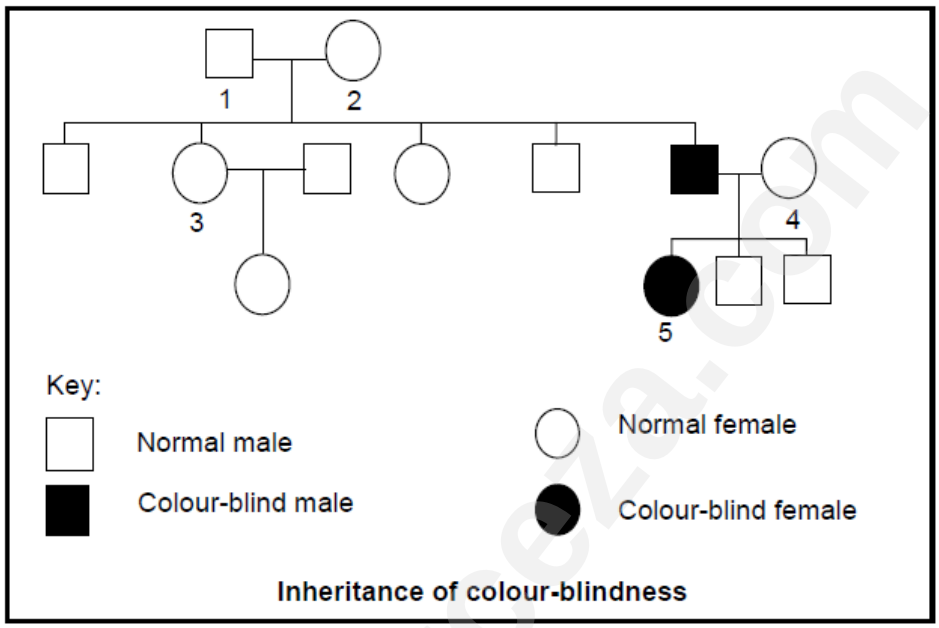
Downloaded from eduresourceza.com

eduresourceza.com

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.1 The pedigree diagram below shows the inheritance of colour-blindness (Daltonism) in a family. Colour-blindness is sex-linked and is caused by a recessive allele (**d**). The ability to see colour normally is caused by a dominant allele (**D**).



Inheritance of colour-blindness

2.1.1 How many of the male offspring of parents **1** and **2** were normal? (1)

2.1.2 State the genotype of:

(a) Individual **2** (2)

(b) Individual **5** (2)

2.1.3 A person with a recessive allele for colour-blindness may not be colour-blind. Explain why males with an allele for colour-blindness are always colour-blind. (4)

2.1.4 If individual **5** marries a normal male, what percentage of their daughters will have an allele for colour-blindness, but will NOT be colour-blind? (2)

(11)

Downloaded from eduresourceza.com

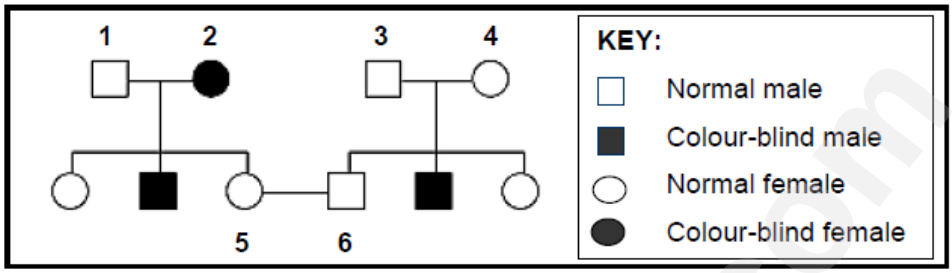
Downloaded from eduresourceza.com

2.1	2.1.1	2✓	(1)
	2.1.2	(a) X^DX^d✓✓	(2)
		(b) X^dX^d✓✓	(2)
	2.1.3	Since the allele is found only on the X-chromosome✓ A male only has one allele✓ that is either dominant✓ (normal) or recessive✓ (colour-blind) and therefore will always be colour blind✓ (if recessive allele inherited) (Any 4)	(4)
	2.1.4	100%✓✓	(2)
			(11)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.3 The pedigree diagram below shows the inheritance of Daltonism in a family. Daltonism (red-green colour-blindness) is sex-linked. The allele for Daltonism is recessive to the allele for normal colour vision.



3.3.1 Use the symbols X^D, X^d and Y to state the genotype of the following:

(a) Individual **2** (2)

(b) Individual **3** (2)

3.3.2 How many family members not affected by Daltonism are definitely carriers? (2)

3.3.3 Use a genetic cross to determine the possible genotypes and phenotypes of the offspring that may be formed by individuals **5** and **6**. (6)
(12)

3.3 3.3.1 (a) X^dX^d✓ (2)

(b) X^DY✓ (2)

3.3.2 3✓ (2)

3.3.3 **P_1** phenotype Normal female x Normal male ✓
genotype X^DX^d x X^DY ✓

Meiosis

G_1 X^D , X^d x X^D , Y ✓

Fertilisation

X^DX^D, X^DX^d, X^DY, X^dY ✓

F_1 genotype / phenotype: 2 normal females; 1 normal male; 1 colour-blind male ✓

Parents and offspring✓/P_1 & F_1
Meiosis and fertilisation✓ (any 6)

OR

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

P_1/parent phenotype Grey bodied x grey bodied✓
genotype Gg x Gg ✓

Meiosis

Fertilisation

gametes	X^D	X^d
X^D	X^DX^D	X^DX^d
Y	X^DY	X^dY

1 mark for correct gametes✓
1 mark for correct genotypes✓

F_1 genotype 2 normal females 1 normal male 1 colour-blind male
phenotype

Parents and offspring✓/P_1 & F_1
Meiosis and fertilisation✓ (any 6) (6)
(12)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

7. Mutations

2.2 A group of eighteen year old learners conducted a survey on the frequency of genetic disorders in a rural area (with a sample size of 500). The results are shown in the table below.

Genetic disorder	Frequency in population (%)
Haemophilia	2
Down syndrome	3
Sickle cell anaemia	15
Absence of any disorder	80

2.2.1 Explain why age needed not to be controlled in this investigation. (2)

2.2.2 State TWO ways in which the learners could ensure reliable results. (2)

2.2.3 State any TWO planning steps that the learner had to consider before conducting the investigation. (2)
(6)

2.2 2.2.1 Age is a fixed √ variable√ (2)

2.2.2 - Repeats the survey√
- Increase the sample size√ (2)

2.2.3 -Ask for permission from the school√
-Inform participants√
-Decide on venue/ data/ and time√ and material to be used√
-How to record the data collected√
-Training of investigators√ any 2 (2)
(6)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.2 A group of Grade 12 learners did a survey about the occurrence of three genetic disorders in a small human population. The results are shown in the table below. The number of people in the population is 1 500.

RESULTS OF THE SURVEY ON THE FREQUENCY OF GENETIC DISORDERS IN A POPULATION

GENETIC DISORDERS	OCCURRENCE IN POPULATION (%)
Down's syndrome	9
Sickle cell anaemia	12
Albinism	X
Without any disorder	75

2.2.1 Which disorder is most common in this community? (1)

2.2.2 Calculate the number of people with albinism. Show ALL working. (3)

2.2.3 Give ONE reason why genetic counselling would be important for parents who are expecting a child that may have a disorder such as Down's syndrome. (1)

2.2 2.2.1 Sickle cell anaemia✓ (1)

2.2.2 100% – (75+12+9) = 4✓%

$\frac{4}{100} \times \frac{1500}{1}$ ✓

= 60✓ people (3)

2.2.3 - Parents can decide whether to abort foetus or not✓
- Help prepare parents to manage with such a child✓
- Help them make an informed decision about whether to have children ✓ **Any** (1)

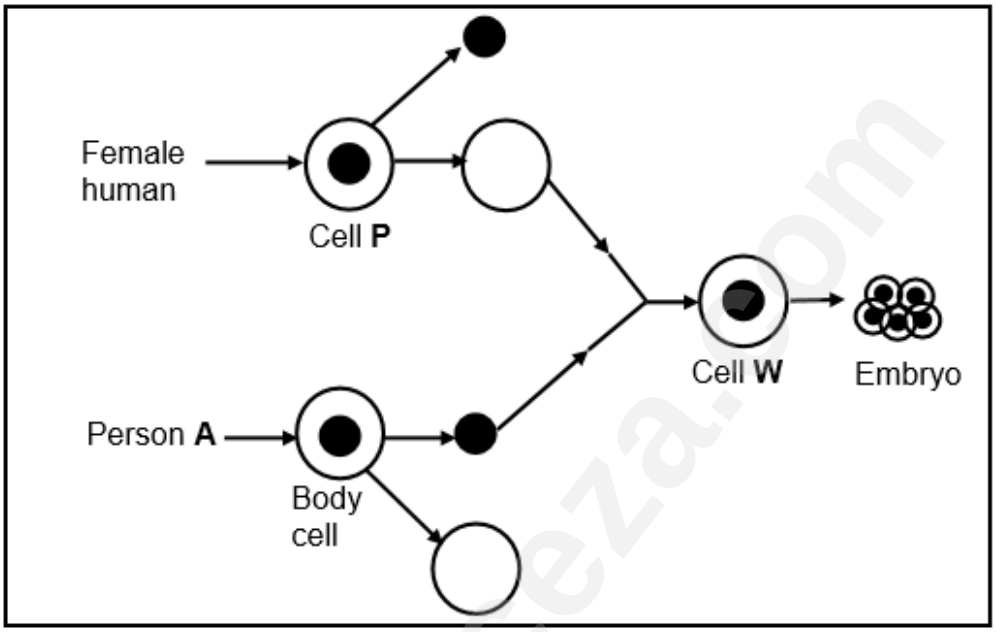
(Mark first ONE only)

8. Genetic engineering

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.5 The diagram below shows a process that could be used in the future to produce a human without sexual reproduction.



1.5.1 Name the process shown above. (1)

1.5.2 Identify cell **P**. (1)

1.5.3 The embryo must be placed in an adult female to develop into a child.

Where, in the adult female, should the embryo be placed? (1)

1.5.4 If this technique was used in a human, how many chromosomes would be found in cell **W**? (1)

1.5.5 If this process were to be allowed to be used in humans in future, describe ONE way in which it would be of benefit to humans. (1)

Downloaded from eduresourceza.com

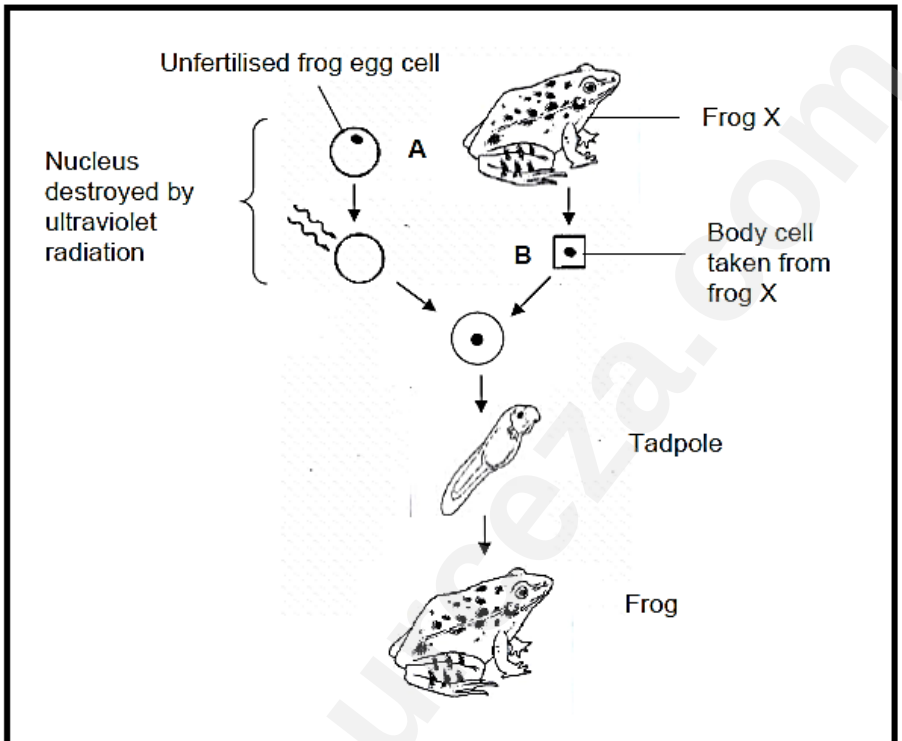
Downloaded from eduresourceza.com

1.5	1.5.1	Cloning ✓	(1)
	1.5.2	Ovum ✓	(1)
	1.5.3	Uterus ✓	(1)
	1.5.4	46 ✓	(1)
	1.5.5	- Production of children for infertile couples ✓ - Compensating for the loss of a loved one ✓ - Cloning of organs from a person's tissue and used as a transplant ✓ - Young cells cloned to prolong life ✓/ Delayed aging (Any 1) **(Mark first ONE only)**	(1)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.6 The diagram below shows the steps of an experiment in which a large number of genetically identical frogs were developed from unfertilised frog eggs. The nucleus of each unfertilised egg was destroyed and replaced by a nucleus obtained from a body cell from frog X.



Experiment to show how genetically identical frogs were developed from unfertilised frog eggs

1.6.1 The diploid number of chromosomes in the above frogs is 26. How many chromosomes are present in the nucleus of the following cells?

(a) Cell A (1)

(b) Cell B (1)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

1.6.2 Why can an egg containing a nucleus from the body cell of a frog develop into a tadpole? (2)

1.6.3 Explain why all the frogs produced from the treated eggs are genetically identical. (2)

1.6.4 Name the method of producing genetically identical offspring as shown in the diagram. (1)

1.6.5 State ONE reason why some people might:

(a) Favour the process shown in the diagram (2)

(b) Be against the process shown in the diagram (2)

(5)

1.6

1.6.1 (a) 13✓ (1)

(b) 26✓ (1)

1.6.2 Has a full set✓ of chromosomes✓ /Diploid number of chromosomes/ complete set of chromosomes/26 (2)

1.6.3 They have same/identical chromosomes✓/genetic material/DNA from the nucleus of the somatic/body cell collected from the same frog/X✓ (2)

1.6.4 Cloning✓ (1)

1.6.5 (a) In favour:

- Producing individuals with desired traits✓✓
- Better yield✓✓
- Resistant to diseases✓✓
- Organisms produced in a shorter time✓✓
- Saving endangered species✓✓
- Producing body parts✓✓
- Produce offspring for organisms that cannot have offspring✓✓

(Mark FIRST answer only in learner's script) (1 x 2) (2)

(b)Against:

- Objection to interfering with God's✓✓/Supreme Being's creation/nature
- Reducing the gene pool by reducing variation✓✓/ Reduces genetic diversity
- Cloned organisms may have developmental/morphological problems✓✓
- Costly process✓✓
- May generate more experimental waste✓✓
- May lead to killing of clones to obtain spare body parts✓✓
- Cruelty to animals✓✓

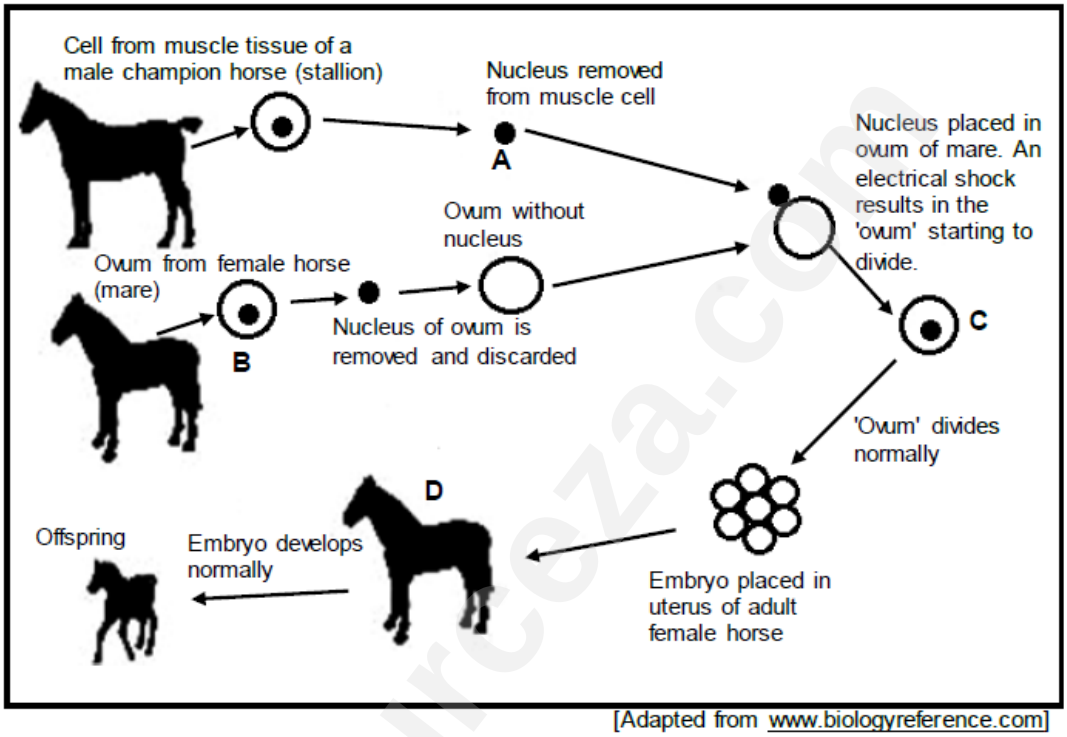
(Mark FIRST answer only in learner's script) (1 x 2) (2)

(11)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.5 The diagram below shows a genetic engineering process. A donor cell was taken from the muscle cell of a male champion horse (stallion) to create a new offspring.



[Adapted from www.biologyreference.com]

3.5.1 Name the:

(a) Genetic engineering process shown in the diagram above (1)

(b) Process that produced ovum **B** (1)

3.5.2 Why is the donor cell extracted from a champion horse? (2)

3.5.3 Explain why only the nucleus of the donor cell is used. (2)

3.5.4 A somatic cell in a horse contains 64 chromosomes.

How many chromosomes would there be in:

(a) Structure **A** (1)

(b) Ovum **B** (1)

(c) A muscle cell in organism **D** (1)

3.5.5 Explain why the 'ovum' labelled **C** cannot be considered a gamete. (2)

(11)

[40]

Downloaded from eduresourceza.com

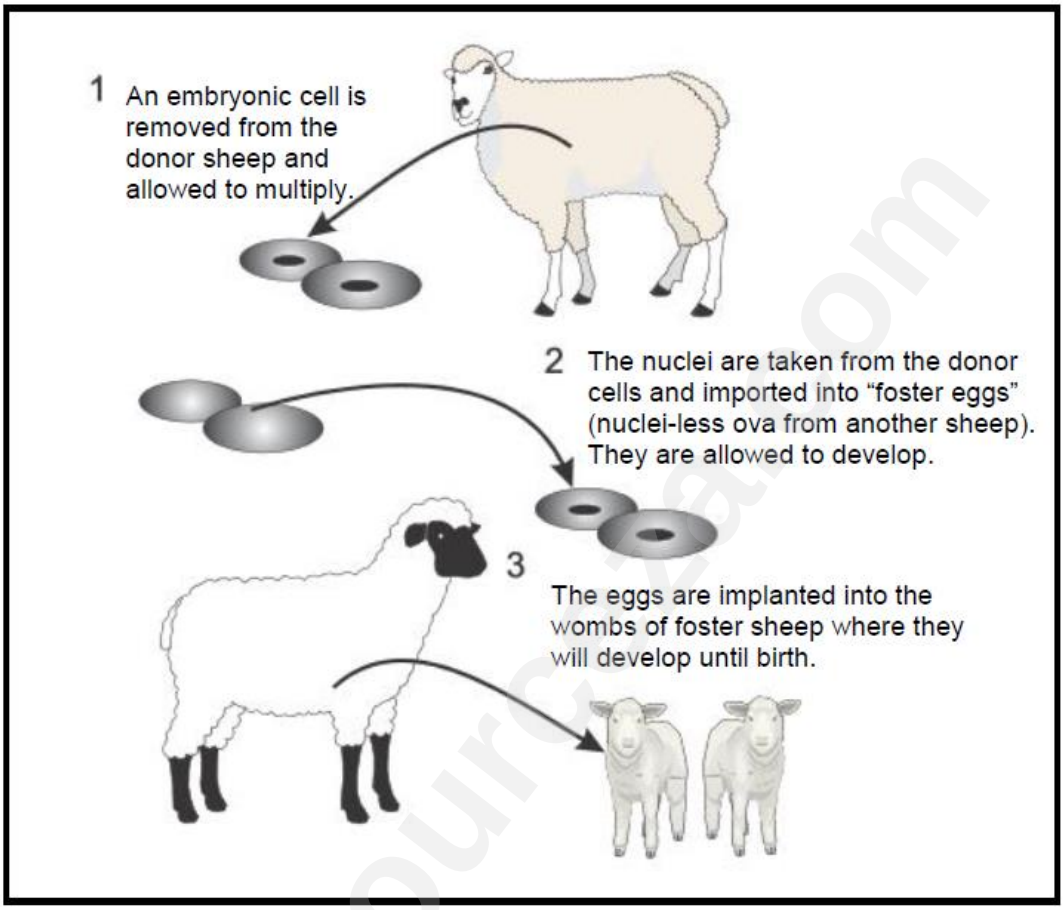
Downloaded from eduresourceza.com

3.5	3.5.1	(a)	Cloning✓		(1)
		(b)	Oogenesis✓/gametogenesis/ meiosis		(1)
	3.5.2	-	The donor horse has the desired characteristics✓ - that need to be copied✓ - and be present in the offspring✓/next generation	Any 2	(2)
	3.5.3	-	The nucleus contains all the genetic information✓✓/ hereditary characteristics/chromosomes of the champion horse		(2)
	3.5.4	(a)	64✓		(1)
		(b)	32✓		(1)
		(c)	64✓		(1)
	3.5.5	-	A gamete is generally haploid✓ - This ovum is diploid✓ since - it has the nucleus of a somatic cell ✓	Any 2	(2) **(11)**

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.4 The diagram below shows one method of cloning sheep.



3.4.1 Explain why the lambs produced by this technique are identical to each other. (2)

3.4.2 Explain why the lambs are not genetically identical to the sheep which produced the "foster" eggs. (2)

3.4.3 Describe how cloning in animals or plants can be beneficial to humans (2)
(6)

Downloaded from eduresourceza.com

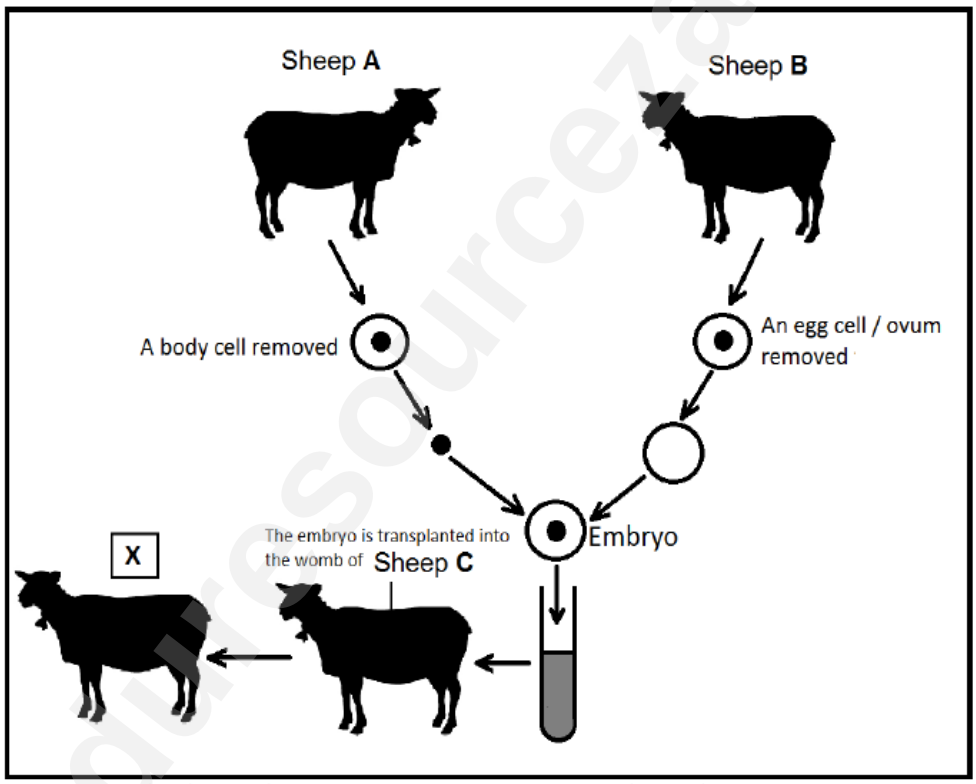
Downloaded from eduresourceza.com

3.4 3.4.1 Contain the same chromosomes ✓because the embryonic cell has divided by mitosis ✓/ they are all produced from nuclei of the donor sheep ✓ which multiply / divide by mitosis✓ therefore have the same DNA ✓ (2)

3.4.2 The nucleus and genetic material ✓originated from another sheep ✓ / the nuclei of the foster sheep were not used ✓and therefore did not contain the same genetic material / the ova used did not contain nuclei✓ / it is the nucleus which contains the genetic material ✓ (2)

3.4.3 Animals or plants with superior / favourable characteristics ✓ can be produced to enhance food production ✓ / biotechnology. (2)
(6)

2.2 The diagram below shows a biotechnology research project to improve quality of sheep. Study the diagram and answer the questions.



2.2.1 Identify the biotechnological process represented in the above diagram. (1)

2.2.2 Describe the process mentioned in QUESTION 2.2.1. (5)

2.2.3 Does sheep **X** inherit desired characteristics from Sheep A or B? (1)

2.2.4 Explain your answer in QUESTION 2.2.3. (2)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.2 2.2.1 Cloning (1)

2.2.2
- Remove an ovum from sheep B ✓
- Remove the haploid ✓ nucleus ✓ of this ovum in the laboratory using micro-surgery
- Remove an actively dividing somatic ✓ cell from sheep A of the same species ✓
- Extract the diploid ✓ nucleus from the somatic cell using micro-surgery
- The diploid nucleus of sheep A is inserted into the ovum of sheep B ✓
- The ovum behaves like a fertilised egg ✓
- The manipulated or 'fertilised ovum' is then placed in the uterus of sheep C for further development ✓
- A new individual is born (x) and is called a clone of sheep A ✓ (Any 5 x 1) (5)

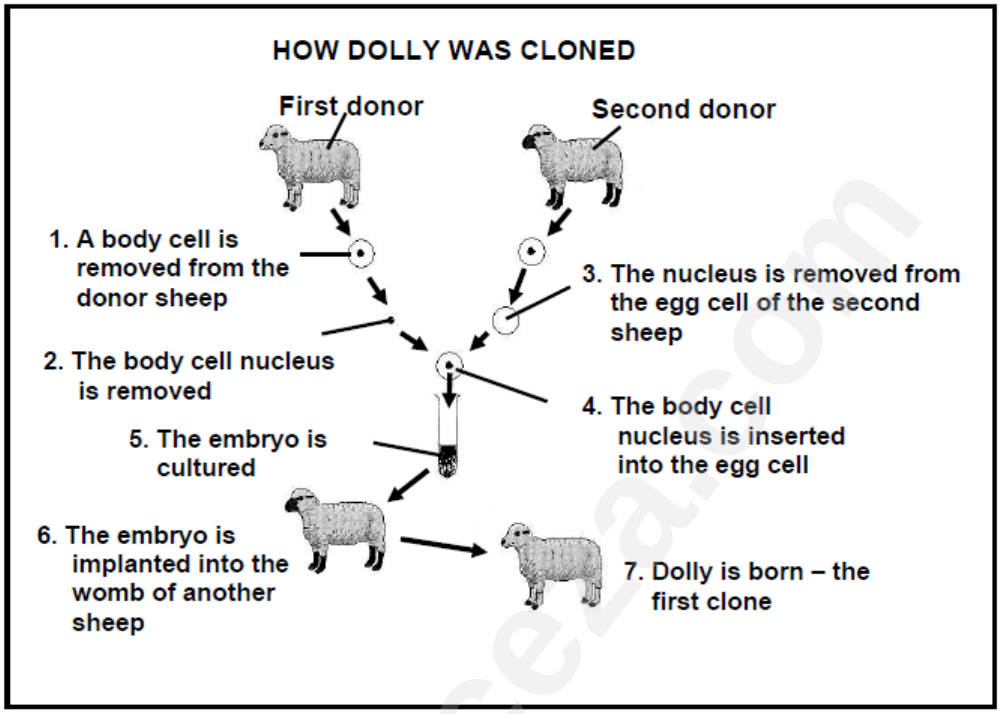
2.2.3 Sheep A ✓ (1)

2.2.4
- This technique involves no natural fusion of male and female gametes ✓
- Therefore there is no variation in the offspring ✓
- The offspring **X** receives its genetic material only from sheep A ✓
- Therefore, the new offspring (**X**) will be phenotypically and genotypically identical to sheep A ✓ (Any 2 x 1) (2)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

4.1 Study the diagram below that shows the cloning of a sheep named Dolly.



4.1.1 Why was it necessary to remove the nucleus from the egg cell of the second donor before the sheep could be cloned? (2)

4.1.2 Will Dolly have the characteristics of the first or second donor sheep? (1)

4.1.3 Explain your answer to QUESTION 4.1.2. (2)

4.1.4 Number 5 in the diagram states that 'the embryo is cultured'. Through which type of cell division does the embryo develop? (1)

4.1.5 Give:

(a) THREE reasons why people could be in favour of genetic engineering in plants (3)

(b) THREE reasons why people could be against cloning in humans (3)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

4.1

4.1.1 To insert the DNA✓/nucleus of sheep that you want to clone✓into the egg cell of the recipient (2)

4.1.2 First✓ (1)

4.1.3 Dolly will have exactly the same DNA✓ as the first donor sheep✓/ DNA/nucleus of the second donor was removed and replaced (2)

4.1.4 Mitosis✓ (1)

4.1.5 (a) **In favour of genetic engineering**

- enhanced taste/quality of food✓
- reduced/ increased maturation time✓
- increased yield of plants (fruit, vegetables)✓
- improved resistance to disease, pests, drought and herbicides✓
- increased food security for growing populations✓
- increased shelf life✓ (any) (3)

(Mark first THREE only)

(b) **Against cloning**

- They might feel that scientists want to play God✓
- The clones might be used for 'spare' organs✓ etc./
- Could be sold to anybody that can pay for it – lead to exploitation✓
- Reducing the gene pool by reducing variation✓
- Cloned organisms may have developmental✓/morphological problems
- Costly process✓
- May generate more experimental waste✓

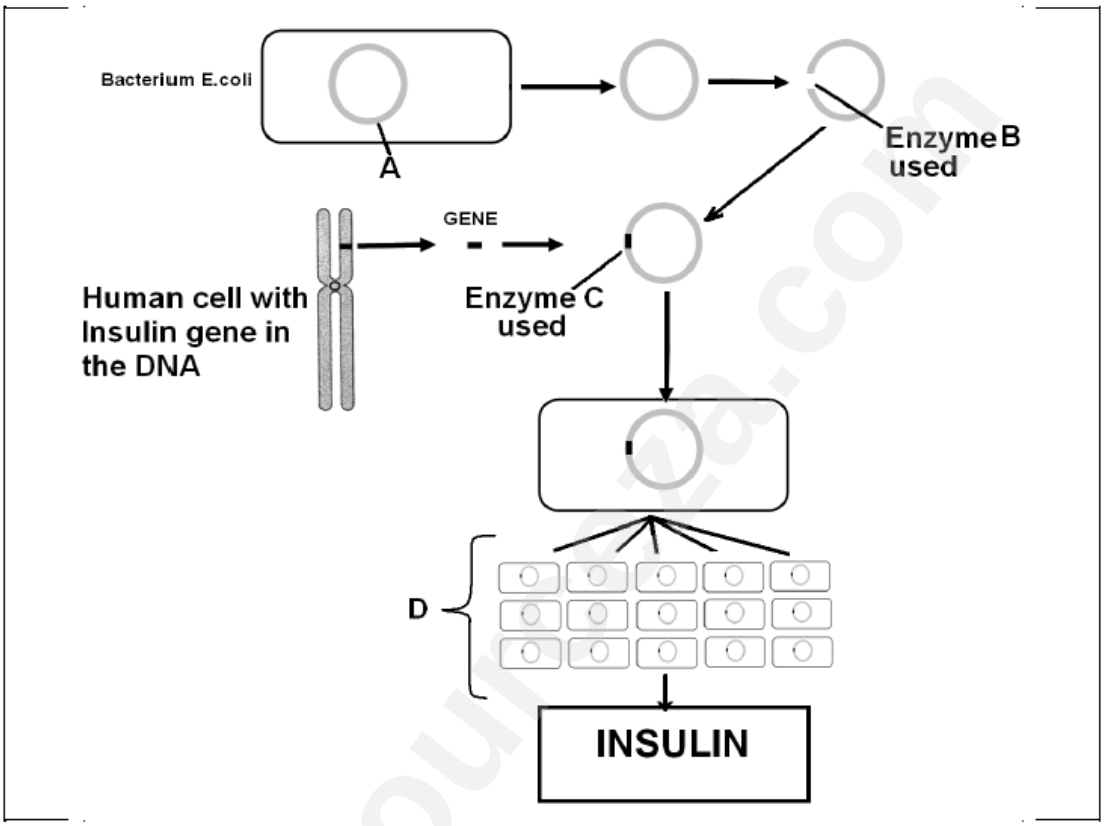
(Mark first THREE only) (any) (3)

(12)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.2 The diagram below shows a modern technique to manufacture insulin. Study the diagram and answer the following questions.



3.2.1 Name the technique used in the manufacturing of insulin. (1)

3.2.2 Identify the part labelled A. (1)

3.2.3 Supply the names of the enzymes B and C. (2)

3.2.4 What type of cell division takes place at D? (1)

3.2.5 Mention any TWO advantages of the above technique. (2)

3.2.6 Name another unicellular organism that can be used in the above process. (1)

3.2.7 Supply ONE reason for the use of the unicellular organism mentioned in QUESTION 3.2.6. (1)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.2	3.2.1	Recombinant DNA technology/Genetic engineering ✓	(1)
	3.2.2	A – Plasmid ✓	(1)
	3.2.3	B – Restriction enzymes ✓ C – Ligase enzymes ✓	(2)
	3.2.4	Mitosis ✓	(1)
	3.2.5	• The product is produced rapidly✓ in large quantities ✓ • Is relatively inexpensive ✓ • Has few side effects ✓ and is considered as a natural product ✓ • No religious resistance ✓ (any 2)	(2)
	3.2.6	Yeast cells ✓	(1)
	3.2.7	• Are readily available ✓ • More cost effective than *E. coli* ✓ • Reproduce rapidly ✓ (any 1)	(1)

3.3 Since the 1980s, human insulin has been produced using genetically modified bacteria and yeast.

3.3.1 State THREE advantages of producing human insulin by genetic modification. (3)

3.3.2 Give TWO reasons why some people might be against genetic modification. (2)

3.3

3.3.1

May have fewer side effects✓
May not be contaminated✓/will be in it's natural form
No problem from a religious perspective✓
Can be mass produced✓/produced faster
Avoids killing animals✓
(Mark first THREE answers only in learner's script) (3)

3.3.2 Against:
- risk to human health✓
- risk to the environment✓
- risk to the health and well-being of other organisms✓
- interference with nature✓/God's creation
- cultural sensitivity✓e.g. objection to the use of pigs and cows

(Mark first TWO answers only in learner's script) (2)
(5)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.4 Study the extract below.

> Cloning in biotechnology refers to processes used to create identical copies of DNA fragments (molecular cloning), cells (cell cloning) or organisms (organism cloning).
>
> Cloning may play a part in animal conservation, by cloning animals that are endangered. Embryo cloning is the production of human embryos for use in stem cell research.
>
> Blood from the umbilical cord and placenta is one of the richest sources of stem cells that can ever be collected.

3.4.1 Define the following terms:

(a) Cloning (1)

(b) Stem cells (1)

3.4.2 State from the extract:

(a) THREE types of cloning used in biotechnology (3)

(b) ONE source of stems cells (1)

3.4.3 Explain why cloning of animals is advantageous to dairy farming. (2)

3.4.4 Explain why embryo-cloning is significant to stem cell research. (2)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

3.4 3.4.1 (a) **Cloning:**
- Process by which genetically identical individuals are formed.✓ (1)

(b) **Stem cells:**
- Are undifferentiated or unspecialised cells ✓ which can give rise to any of the other cells of the same organism. ✓ (Any 1) (1)

3.4.2 (a)
- Molecular cloning ✓
- Cell cloning ✓
- Organism cloning ✓ (3)

(b)
- Embryos ✓
- Blood from placenta and umbilical cord ✓ (Any 1) (1)

3.4.3
- In order to increase the productivity and profit ✓ animals that produce large amounts of milk are carefully selected and cloned ✓/ high yield of milk.
- Hence the quality of herd is improved faster ✓ than the traditional way of breeding. (Max. 2) (2)

3.4.4
- Embryos are cloned in order to maintain a steady supply of stem cells for research purpose. ✓
- This enables researchers and research institutions to be self-sufficient in terms of the availability of stem cells. ✓ (2)

[40]

2.2 The risks and benefits of using biotechnology have been the subject of considerable debate in recent times. State the following:

2.2.1 THREE disadvantages of genetic engineering (3)

2.2.2 THREE advantages of genetic engineering (3)

(6)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

2.2 2.2.1 **Disadvantages of genetic engineering**

- Expensive✓
- May be difficult for poor people to access ✓
- Interfere with nature✓
- Immoral✓/ we cannot play God
- Domination of the world food products by only a few companies ✓
- Loss of biodiversity✓
- Potential health impacts✓
- Violation of natural organism's intrinsic value✓(right to independent existence)
- Unsure of long term effects✓
- Genes from transgenic organisms could escape✓and be transferred to wild organisms

(Mark first THREE only) Any 3 (3)

2.2.2 **Advantages of genetic engineering**

- Production of medication✓
- Production of resources cheaply✓
- Control pests with specific genes inserted into the crop✓
- Selecting the best genes to produce better resistant crops✓
- Using specific genes to increase crop yields✓ / food security
- Selecting genes to increase shelf life of plant products✓
- Selecting genes that may increase maturation times✓ to meet the demand
- Selecting genes that may decrease maturation times✓ to meet the demand
- Using specific genes to improve nutritional value✓of food for better health
- Improve the taste✓ of food
- DNA and proteins of transgenic organisms unlikely to cause problems ✓/ transgenic organisms do not survive easily in wild
- Produce organisms that can can clean up pollution✓
- Endangered species can be saved✓
- Increases genetic variation✓

(Mark first THREE only) Any 3 (3)
(6)

9. ESSAYS

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

QUESTION 4

Describe how blood groups in humans are determined by different alleles and explain how blood typing can be used to solve paternity cases. Also explain why and how DNA profiling is sometimes required to solve paternity cases.

Content: (17)
Synthesis: (3)
(20)

How alleles determine blood groups:

- Human blood groups are determined by multiple alleles✓
- I^A✓; I^B✓ and i✓
- I^A and I^B are co-dominant ✓
- i is recessive✓
- Blood group A can have the genotypes I^AI^A✓
- or I^Ai✓
- Blood group B can have the genotypes I^BI^B ✓
- or I^Bi✓
- Blood group AB has the genotype I^AI^B✓
- Blood group O has the genotype ii✓ Any 9

How blood typing is used to solve paternity cases

- The blood groups of the father, mother and child must be compared✓
- If it proves that it is not possible✓ for the man and woman to have a child with the specific blood group
- the man is not the father✓
- If it shows that the man and the woman can possibly✓ have a child with that specific blood group
- DNA profiling✓
- needs to be done to confirm that he is the father or not✓ Any 4

Why and how DNA profiling can be used to confirm paternity

- The DNA profiles of the possible father and child must be compared✓
- A child receives 50%/half of his/her DNA from his/her father✓
- If half/50% of the dark bands on the DNA profile of the child correlate with that of the possible father✓
- the man is the father of the child✓
- If there is no/little correlation between the DNA of the child and the possible father✓
- the man is not the father of the child✓ Any 4

Content: (17)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

QUESTION 4

Describe the inheritance of blood groups and the use of blood groups in paternity testing.

Content: (17)
Synthesis (3)
(20)

Inheritance of blood groups

- Blood groups in humans is controlled by one gene✓
- with three alleles✓/ I^A, I^B, i
- Each person inherits any 2 of the three alleles✓ from their parents
- I^A and I^B alleles are co-dominant✓
- I^A and I^B are dominant over the i allele✓/ the i allele is recessive to I^A and I^B

- Inheriting the I^A allele from both parents✓/ having the genotype I^AI^A
- or inheriting the I^A allele from one parent and i from the other parent✓/ having the genotype I^Ai
- results in blood group A✓

- Inheriting the I^B allele from both parents✓/ having the genotype I^BI^B
- or inheriting the I^B allele from one parent and i from the other parent✓/ having the genotype I^Bi
- results in blood group B✓

- Inheriting I^A from one parent and inheriting I^B from the other parent✓/having the genotype I^AI^B
- results in the AB blood group✓

- Inheriting the i allele from both parents✓/having the genotype ii
- results in blood group O ✓ Max 12

Use of blood groups in paternity testing

- If a genetic diagram shows that the mother and the man could produce a child with a particular blood group✓
- then he may be the father✓
- but we cannot say for sure that he is the father✓
- because there are many males with the same blood type✓

- If a genetic diagram shows that the mother and the man could not produce a child with a particular blood group✓
- then he is definitely not the father✓ Max 5

Content: 17
Synthesis: 3

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

QUESTION 4

Describe TWO types of mutations and how they lead to altered characteristics in FOUR genetic disorders you have studied.

Content: (17)
Synthesis: (3)

Mutations

- Mutations refer to sudden changes✓
- in the genetic composition of an individual✓

- Gene mutations✓
- result in a change in the structure of the DNA in a single gene✓

- Chromosomal aberrations✓
- are changes in the normal structure/number of chromosomes✓

- Harmful/lethal mutations✓
- result in genetic disorders✓/characteristics that decrease the survival of an organism

Any 5 (5)

Genetic disorders

- Haemophilia✓
- Blood does not clot✓
- because the protein for blood clotting is not produced✓

- Colour blindness✓
- The person cannot differentiate between different colours✓
- due to the absence of the necessary protein for photoreception✓

- Albinism✓
- The lack of pigment in the skin✓
- due to the absence of the protein that forms melanin✓

- Down syndrome✓
- The person has an extra copy of chromosome 21✓
- due to non-disjunction✓ during meiosis.

(4 x 3) (12)

Content: (17)
Synthesis: (3)
(20)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

QUESTION 4

4.1 Sandy has given birth to a baby girl. There are two men claiming to be the father of the child. Explain how the inheritance of blood groups and DNA testing could assist in establishing who the father is.

Content	(17)
Synthesis	(3)
	(20)

QUESTION 4

4.1

- Blood groups are controlled by three alleles✓ I^A, I^B, i ✓which in combination will provide four different phenotypes namely blood groups A, B, O and AB. ✓
- An individual with blood group A✓ ,will inherit one allele✓ from each parent✓ and will therefore inherit a genotype of either I^Ai✓ or $I^A I^A$ ✓from his parents
- An individual with Blood group B✓ will inherit one allele from each parent and will therefore inherit genotype of either I^Bi✓ or I^BI^B✓ ; and
- An individual with blood group AB✓ will inherit one allele from each parent and will have both✓ alleles I^A and I^B which are co - dominant✓, and
- An individual with blood group O✓ will inherit i✓ allele from both parents and will be homozygous recessive (ii) ✓
- The blood of each male as well as the baby's blood must be tested.
- If the baby's blood group is O, then the father with blood group AB✓ will be eliminated✓ as he does not✓ carry the recessive O✓(i) allele.
- Should the father have a blood group B ✓ with a I^BI^B✓ genotype, then he will be eliminated as a potential father as he does not✓ have the recessive O(i) allele.
- Should the father have a blood group A✓ with a I^AI^A✓ (homozygous) genotype , then he will be eliminated✓ as a potential father as he does not✓ have the recessive O✓(i) allele.
- The father who also has a blood group B✓ but a genotype of I^Bi (Heterozygous)✓,could be a possible father as he is carrying ✓the i✓ allele of which the baby inherited.
- If the father who has a blood group A✓ with a genotype of I^Ai✓, could be a possible✓ father as he is carrying the i ✓allele of which the baby inherited.

(any 12)

DNA testing can further ✓confirm the father of the child by analysing✓ and comparing✓ the DNA genetic bands✓ of each✓ potential male parent✓ with the genetic bands✓ of DNA taken from the baby✓.
Should there be more ✓genetic bands that are identical ✓to that of the baby✓ then that would confirm ✓the male✓ parent/father. (any 5)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

QUESTION 4

Describe how meiosis and different types of mutations contribute to genetic variation and the role of this variation in natural selection.

Content: **(17)**
Synthesis: **(3)**

Meiosis

- Crossing over✓
- occurs during prophase I✓
- Homologous chromosomes / chromatids overlap✓
- at points called chiasma✓/ chiasmata
- Genetic material is exchanged✓
- resulting in new combinations of genetic material ✓ Max 3 (3)

- Random arrangement✓of chromosomes
- occurs during metaphase✓
- so that they separate in a random✓/ independent manner
- resulting in new combinations of genetic material✓

Max 3 (3)

Mutations

- A gene✓/ (point and frameshift) mutation occurs
- as a result of a change in sequence of nitrogen bases✓ in the DNA molecule

- A chromosome✓mutation occurs as a
- result of a change in the structure of a chromosome✓/ number of chromosomes during meiosis

- Mutations that occur in sex cells✓
- are passed on to the new generations✓
- creating new characteristics✓

Max 5 (5)

Downloaded from eduresourceza.com

Downloaded from eduresourceza.com

Role of variation in natural selection

- Organisms of a particular species shows a great deal of variation✓
- Some individuals may have characteristics that are favourable✓ / any example
- Others may have characteristics/any example that are unfavourable✓
- If there is competition/changing environmental conditions✓/ Selective pressure by the environment
- organisms with favourable characteristics survive✓
- and reproduce✓
- and pass this favourable characteristics to their offspring✓
- while organisms with unfavourable characteristics will die out✓
- Over time the whole population will have this favourable trait✓

Max 6	(6)
Content:	**(17)**
Synthesis:	**(3)**
	(20)

Downloaded from eduresourceza.com