





## Improve your Skills

### Genetics & Inheritance

#### Question 1

- 1.1 A plant with red flowers is crossed with a white-flowered plant of the same species. All the seeds, when grown, produce plants with red flowers. Assuming that the flower colour is controlled by a single pair of alleles, which allele is dominant and which is recessive? (2)
- 1.2 If a dominant allele for tall plants is represented by the letter D, what letter should represent the corresponding recessive allele? (1)
- 1.3 Distinguish between the terms homozygous and heterozygous (2)
- 1.4 Explain why Mendel chose pea plants for his investigation on inheritance. (4)
- 1.5 How did he ensure that the plants he used were true breeding? (4)
- 1.6 How did he ensure that his results were reliable? (4)

#### Question 2

Gregor Mendel conducted breeding experiments with pea plants to study the inheritance patterns of four different traits (plant height, seed shape, seed colour and seed coat colour). For each trait, for example plant height, he crossed homozygous tall plants with homozygous dwarf plants. The offspring obtained in the F<sub>1</sub>-generation were then interbred to form the F<sub>2</sub>-generation. He did the same for each of the other traits. The results obtained for the F<sub>2</sub>-generation are shown in the table below:

TRAIT	RESULTS OF F <sub>2</sub> -CROSSING	RATIO
Plant height (Tall or dwarf)	Tall: 787	2,84 : 1
	Dwarf: 277	
Seed shape (Round or wrinkled)	Round: 5 474	X
	Wrinkled: 1 850	
Seed colour (Yellow or green)	Yellow: 6 022	Y
	Green: 2 001	
Seed coat colour (Grey or white)	Grey: 705	3,15 : 1
	White: 224	

[Adapted from *Basic Concepts in Biology*, 3<sup>rd</sup> edition., C Starr, 1997]

- 2.1 What is the expected phenotypic ratio for a trait involving two heterozygous parents? (1)
- 2.2 From the results, calculate X and Y. Also state which trait provided a ratio closest to the expected phenotypic ratio mentioned in QUESTION 2.1. Show ALL working. (3)
- 2.3 Give a possible reason why the ratio selected in QUESTION 2.2 was closest to the theoretical ratio. (2)
- 2.4 Using the results, state whether the allele for round seeds or for wrinkled seeds is dominant. (1)
- 2.5 State TWO factors that Mendel controlled during these breeding experiments. (2)
- 2.6 Write down Mendel's law of segregation. (2)

**Question 3**

Sheep homozygous for white wool are crossed with sheep homozygous for black wool. All the offspring are white. Use the letters **B** and **b** to represent a genetic cross to show the results and show the expected results if the F1 were to interbreed. (6)

**Inheritance & Variation**

**Question 1**

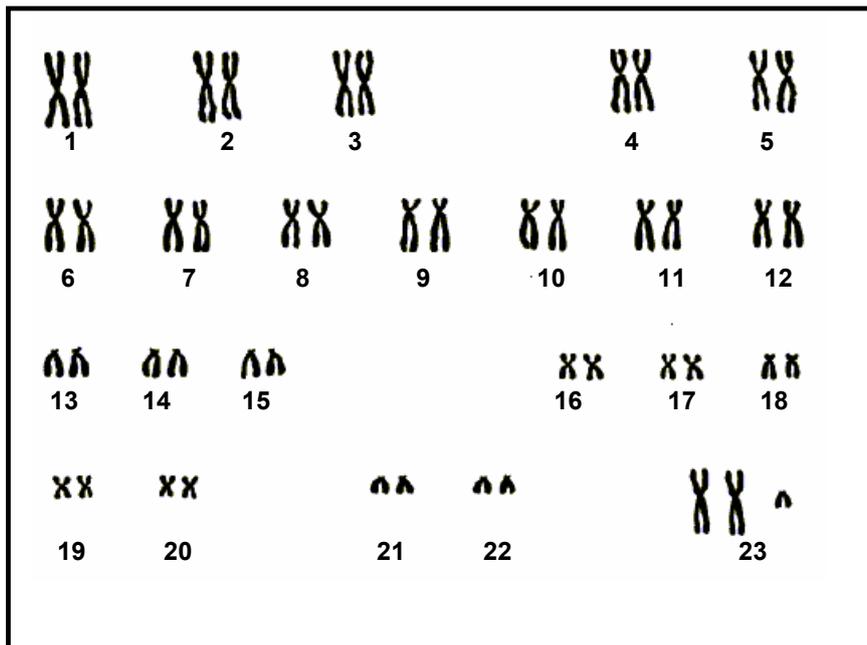
- 1.1 A boy's mother had a patch of white hair called a 'white forelock' which is caused by a dominant allele H. The mother is heterozygous for this trait. His father does not have a 'white forelock'. The symbol for the recessive allele is h. Represent a genetic cross to determine the possible genotypes and phenotypes of the children. (6)
- 1.2 What type of dominance is illustrated in this cross? (1)
- 1.3 Rabbits with brown fur colour (B) were crossed with rabbits with white fur colour (W). All the resultant offspring were cream. Represent a genetic cross to determine the possible genotypes and phenotypes of the offspring in the F1 and F2 generations. (6)
- 1.4 What type of dominance is illustrated here? Provide a reason for your answer. (2)
- 1.5 In an experiment to show co-dominance, plants with white flowers were crossed with plants with red flowers. All the offspring in the F1 generation have red flowers with white spots. The F1 offspring were interbred. The results of the cross between the F1 offspring are shown below:

Phenotype	Red	Red with white spots	White
Number of offspring	210	420	210

- 1.5.1 Provide the genotypes of all the varieties shown in the table above. (3)
- 1.5.2 Give the ratio of the different phenotypes shown in the table. (1)
- 1.5.3 Use the data in the table to draw a pie chart to illustrate the proportions of the different genotypes. (6)

**Question 2**

The karyotype below is that of a male person with a genetic disorder called Klinefelter syndrome.



A karyotype of a male with Klinefelter syndrome

notes for...

- 2.1 Provide the numbers of the chromosomes which are autosomes and of those that are gonosomes? (2)
- 2.2 State ONE visible difference between the karyotype above and the karyotype of a normal male. (2)
- 2.3 Use your knowledge of meiosis to explain how Klinefelter syndrome could have resulted. (6)
- 2.4 Andrew and Sabeeha have 9 children. All girls. What is the probability that their 10th child will be a boy? Illustrate your diagram with a punnet square only. (2)

**Question 3**

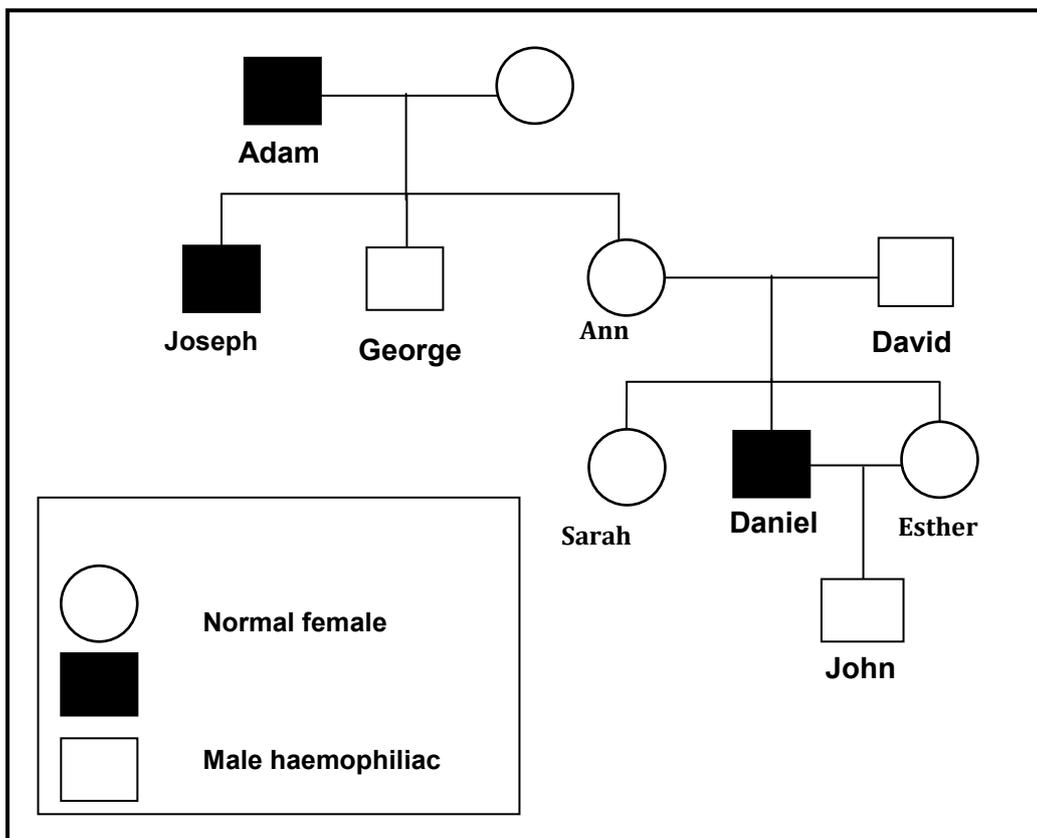
The table below shows the percentage distribution of blood groups in a province in South Africa.

BLOOD GROUPS			
A	B	AB	O
35	15	10	40

- 3.1 How many genes control the blood groups shown above? Explain your answer. (3)
- 3.2 Explain how it is genetically possible to have four blood groups in a population. (2)
- 3.3 Use a genetic diagram to illustrate how a man with blood group A and a woman with blood group B can have a child with blood group AB. Assume that both parents are homozygous.

**Question 4**

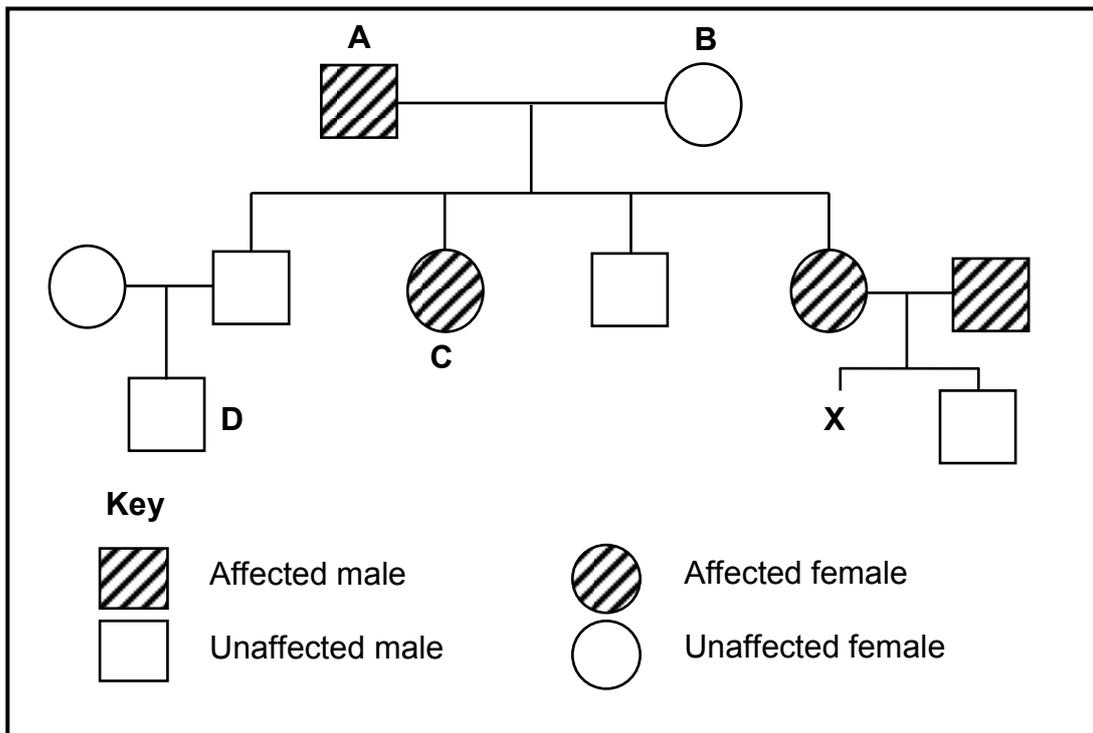
Study the pedigree diagram of a family where some individuals have haemophilia. Haemophilia is a sex-linked disorder. Use  $X^H$  for normal blood clotting and  $X^h$  for the haemophiliac trait.



- 4.1 From the pedigree diagram above, state the relationship between gender and the incidence of haemophilia. (2)
- 4.2 Write down ALL the possible genotypes of:  
 a.) Adam  
 b.) Ann  
 c.) John (6)

**Question 5**

A scientist gathered information about the affected and unaffected individuals for a certain genetic disorder. The genetic disorder is caused by a dominant allele. The findings of the scientist are represented in the pedigree diagram below.



- 5.1 Using the letters R and r to represent the dominant and recessive alleles respectively, state the genotype of individual:  
 a.) A (2)  
 b.) D (2)
- 5.2 What is the percentage chance of individual X having a genetic disorder? (2)
- 5.3 If individual C marries an unaffected male, state the possible genotype(s) of their offspring. (2)

## Genetics & Genetic Engineering

### Question 1

- 1.1 About 70% of Americans get a bitter taste from the substance called phenylthiocarbamide (PTC). It is tasteless to the rest. The "taster" allele is dominant to non-taster. Also, normal skin pigmentation is dominant to albino. A normally pigmented woman who is taste-blind for PTC has an albino-taster father. She marries an albino man who is a taster, though the man's mother is a non-taster. Show the expected offspring of this couple.

### Question 2

- 2.1 Distinguish between genetic engineering and biotechnology.  
2.2 Read the passage below and answer the questions that follow.

#### **GENETICALLY MODIFIED PIG BRED WITH 'GOOD FAT'**

*Scientists in the United States of America have produced genetically modified pigs with fat containing omega-3 fatty acids. These fatty acids, which are usually found in salmon, mackerel and fresh tuna, are thought to be responsible for a number of benefits, from combating heart disease to improving intelligence.*

*Researchers from the University of Pittsburgh – School of Medicine created piglets capable of converting less useful omega-6 fatty acids into omega-3 fatty acids. They implanted 1 800 embryos into 14 female pigs. Ten live offspring, which were able to make high levels of omega-3 fatty acids, were born.* [Adapted from: Cape Argus, 27 March 2006]

- 2.2.1 Name TWO health benefits of omega-3 fatty acids.
- 2.2.2 What percentage success did the scientists have with the implanted embryos in forming a clone of pigs capable of producing omega-3 fatty acids? Show ALL working.
- 2.2.3 To produce genetically modified pigs, the gene that produces omega-3 fatty acids is inserted into the pig embryos. Describe the steps in forming and introducing many copies of the desirable gene (using bacteria) into the pig embryos.
- 2.2.4 Give TWO reasons why:
- a.) Some people may support the use of genetically modified pigs to produce omega-3 fatty acids
- b.) Some people may be against the use of genetically modified pigs to produce omega-3 fatty acids