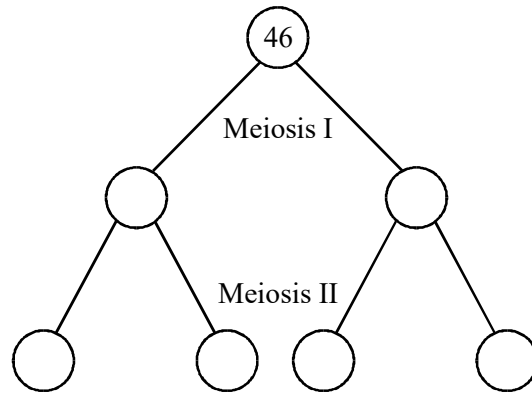


1. The diagram shows stages of meiosis in a human testis. Each circle represents a cell.



(a) In each empty circle, write the number of chromosomes that would be found in the cell. (1)

(b) Describe **two** ways in which meiosis contributes to genetic variation.

1.....  
 .....  
 2.....  
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(2)

(c) Explain the importance of genetic variation in the process of evolution.

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(2)

(Total 5 marks)

2. (a) Describe what happens to chromosomes in meiosis.

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(6)

(b) Meiosis results in genetic variation in the gametes which leads to variation in the offspring formed by sexual reproduction. Describe how meiosis causes this variation and explain the advantage of variation to the species.

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(5)

(c) An old form of wheat, emmer wheat (*Triticum turgidum*), has a diploid chromosome number of 28 ( $2n = 28$ ). A wild wheat, einkorn wheat (*Triticum tauschii*), has a diploid chromosome number of 14 ( $2n = 14$ ). These two species occasionally crossed and produced sterile hybrid plants. Due to an error during cell division, one of these hybrid plants formed male and female gametes with 21 chromosomes. Fusion of these gametes resulted in viable offspring. These plants were a new species, *Triticum aestivum* ( $2n = 42$ ), our modern bread wheat.

(i) How many chromosomes would there have been in each of the cells of the hybrid plant produced by crossing *Triticum turgidum* with *Triticum tauschii*?

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(1)

(ii) Explain why *Triticum aestivum* is fertile while the majority of hybrid plants were not.

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(3)

(Total 15 marks)

3. Division of the nucleus by meiosis produces haploid cells from a diploid cell. Nuclei produced by mitosis have the same number of chromosomes as the parent nucleus.

(a) What is the biological importance of reducing the chromosome number when the cell divides by meiosis?

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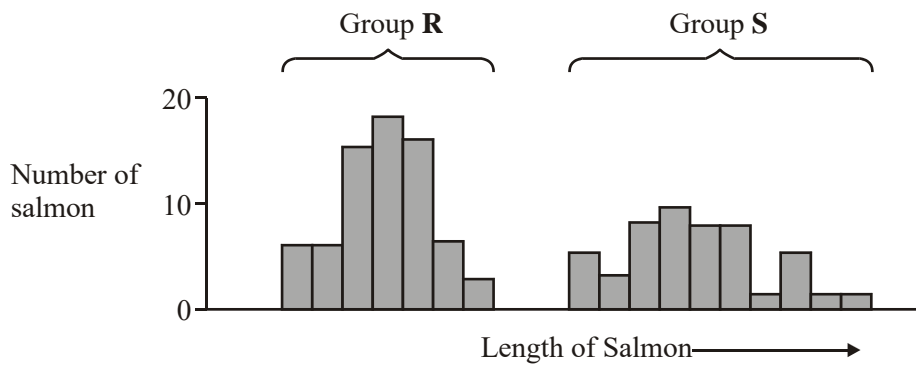
(2)

- (b) The table gives one difference between meiosis and mitosis. Complete the table by giving **three** further differences.

	Meiosis	Mitosis
1	Reduces the chromosome number	Maintains the same chromosome number as in the parent nucleus
2		
3		
4		

(3)  
(Total 5 marks)

4. The graph shows the variation in length of 86 Atlantic salmon.



- (a) (i) What type of variation is shown by the lengths of the salmon in group **R**? Give the evidence to support your answer.

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(1)

(ii) Give **two** possible causes of this variation that result from meiosis during gamete formation.

1 .....

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2 .....

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(2)

(b) When comparing variation in size between two groups of organisms, it is often considered more useful to compare standard deviations rather than ranges. Explain why.

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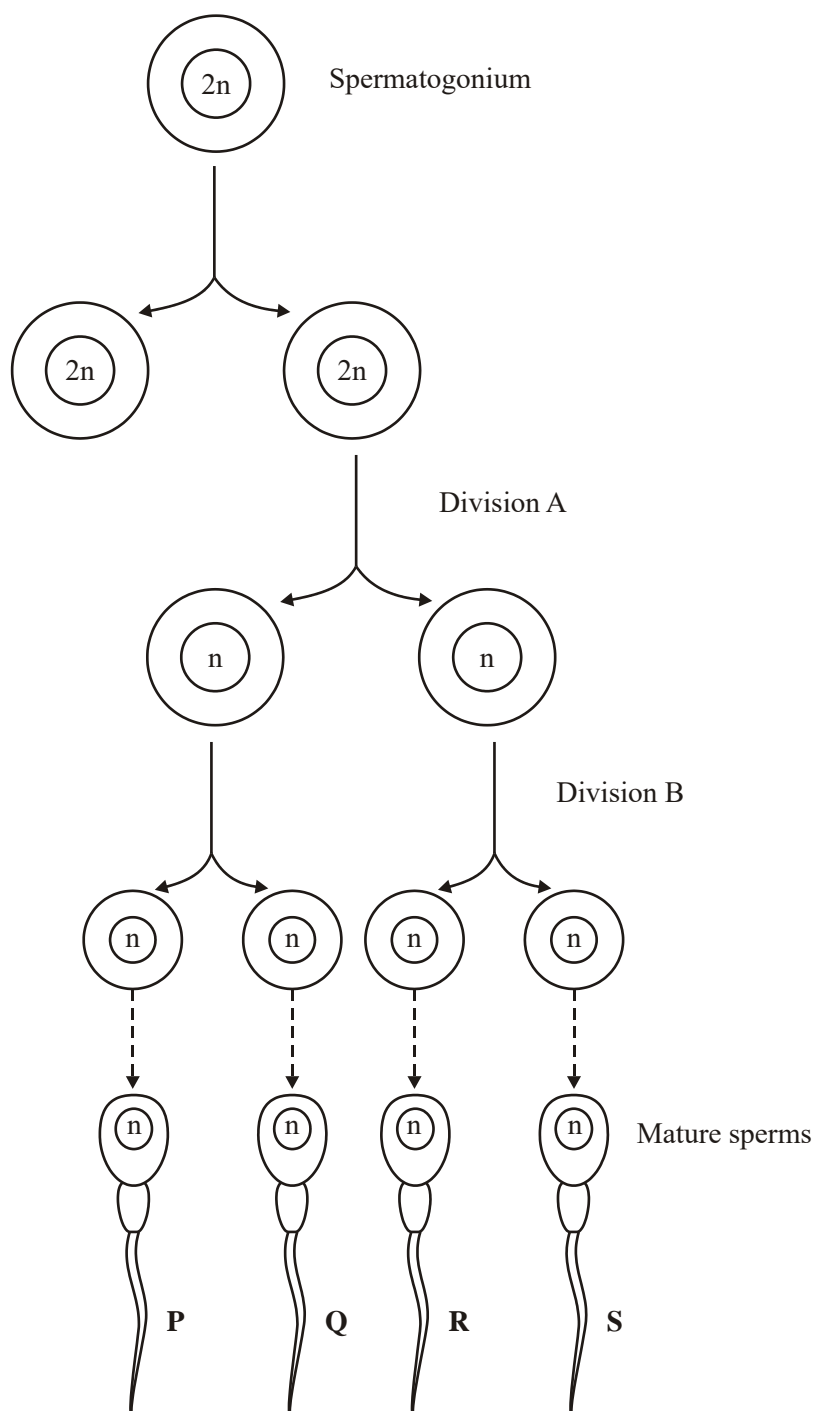
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(2)

(Total 5 marks)

5. The diagram shows the main stages in the formation of sperms in a human testis.



- (a) Describe **two** ways, other than size, in which cells at anaphase of division **A** would differ from cells at anaphase in division **B**.

1 .....

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2 .....

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(2)

- (b) Give **two** ways in which meiosis contributes to genetic variation in the mature sperms.

1 .....

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2 .....

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(2)

(Total 4 marks)

6. Some students investigated the effect of light intensity in the environment on the size of leaves of nettles. They measured leaves on sixty plants in each of two sites. The results are summarised in the table.

Dimensions of leaves / mm	Site with high light intensity	Site with low light intensity
Length of longest leaf	113	116
Length of shortest leaf	41	42
Mean length	86	92
Mean maximum width	68	74

Standard deviation of lengths	11	16
Standard deviation of maximum widths	113	116

(a) Each leaf to be measured was selected in the following way.

- The top left hand corner of a quadrat frame was placed at coordinates given by a random number table; the nettle plant nearest the centre of the quadrat was selected,
- The sixth leaf from the tip of the plant was selected.

Explain the importance of

(i) the method of selecting the nettle plant;

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(2)

(ii) measuring the sixth leaf.

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(2)



- (b) (i) Use the data about the length of leaves in the two sites to explain why standard deviation is more useful than range as a measure of variation within a population.

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(4)

- (ii) What other statistic could be calculated from the standard deviation that would give an indication of how the mean leaf length might vary in other samples from the same population of nettles?

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(1)

- (c) The area of a nettle leaf can be estimated using the formula

$$\text{area} = \text{length} \times \text{maximum width} \times 0.5$$

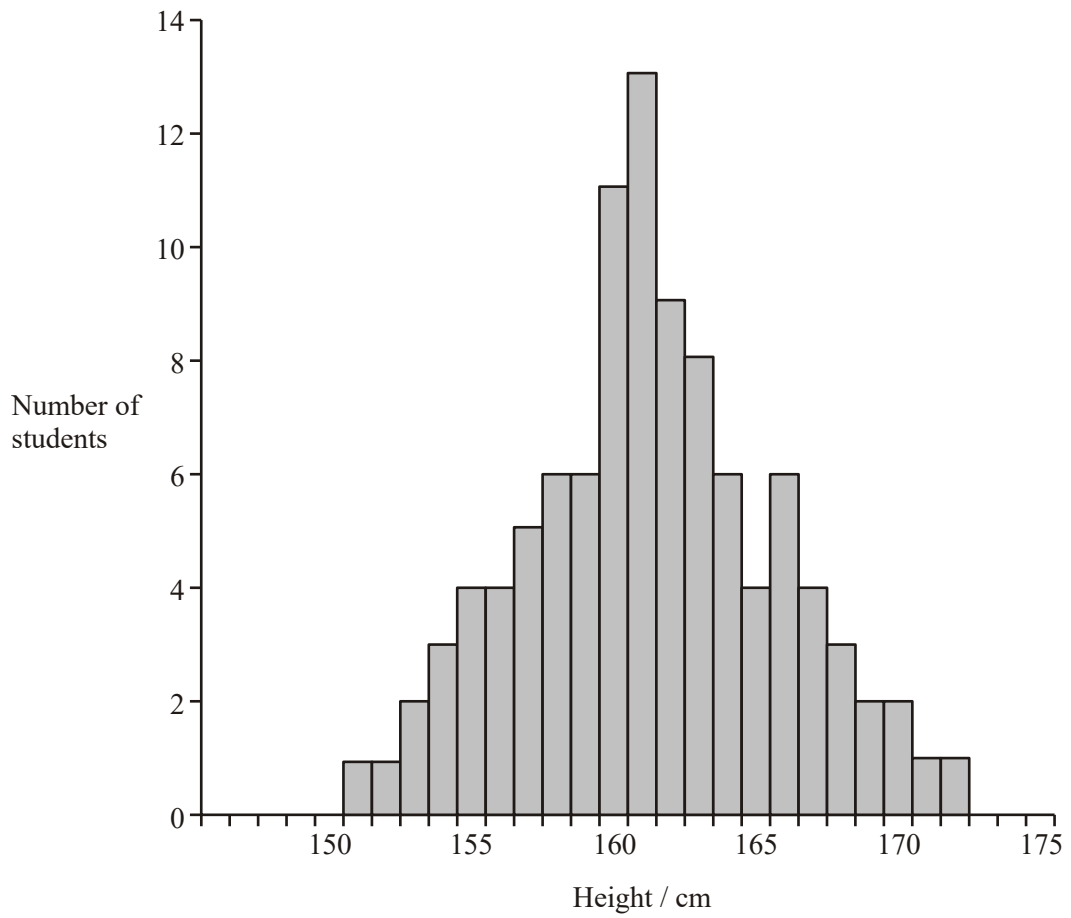
Calculate the ratio of the mean area of the leaves from the site with low intensity to the mean area of the leaves from the site with high light intensity. Show your working.

Answer .....

(2)

(Total 11 marks)

7. The histogram shows the variation in height of 17-year-old male students from one college.



(a) What does the histogram indicate about the inheritance of this feature? Explain your answer.

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(2)

- (b) The standard error of the mean was calculated. What information would this give about the mean height of 17-year-old males?

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(2)  
(Total 4 marks)

8. Farmers have steadily improved the yields from plants and animals by the process of selective breeding. One of the factors determining whether selective breeding will be worthwhile is heritability. Heritability can be defined as the proportion of all phenotypic variation in a population that is due to genetic effects. Heritability values can range from zero (with no influence of genes on phenotypic variation) to 1.0 (where all the phenotypic variation is due to genetic differences). The table shows some estimated heritability values.

Feature	Organism	Heritability value
Plant height	Corn	0.70
Yield	Corn	0.25
Body mass	Chicken	0.20
Egg mass	Chicken	0.60
Egg production	Chicken	0.30

- (a) Use the information in the table to evaluate whether it would be worthwhile to select for an increase in egg mass and body mass in chickens.

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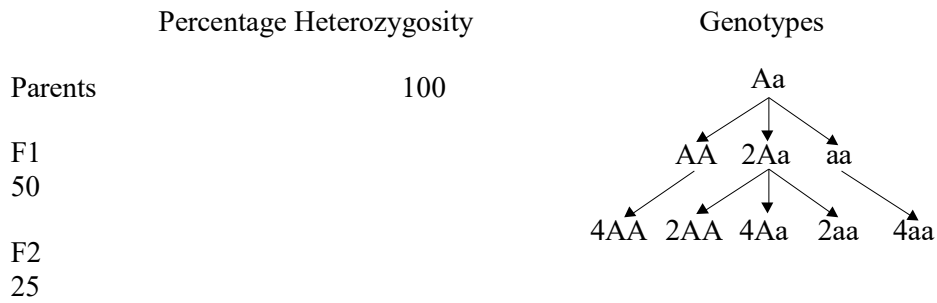
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(2)

- (b) Inbreeding, the crossing together of related individuals, has been used extensively in selective breeding programmes. One effect of inbreeding is to produce strains which are homozygous at practically all gene loci. The diagram shows the effect of inbreeding at one gene locus.



- (i) Explain what is meant by the term *gene locus*.

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(1)

- (ii) Calculate the percentage of F3 plants which you would expect to be homozygous if inbreeding was continued.

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(1)

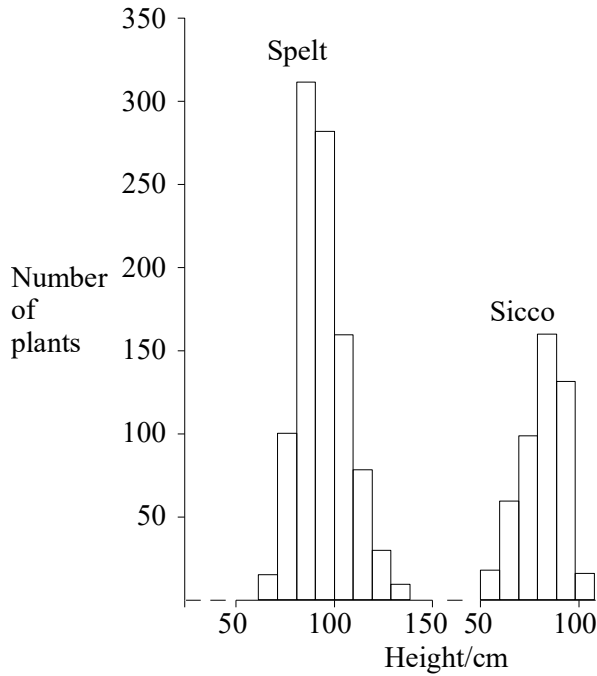
- (iii) Explain why undesirable features may appear more frequently in some strains after inbreeding.

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(1)

(Total 5 marks)

9. The histograms show the range of heights of Spelt wheat, a variety grown by early farmers, and Sicco, a modern hybrid wheat.



- (a) (i) What kind of variation is shown by Spelt?

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- (ii) Assuming that the cause of this variation is genetic, explain its basis.

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(2)

- (b) Describe the differences in pattern between Spelt and Sicco.

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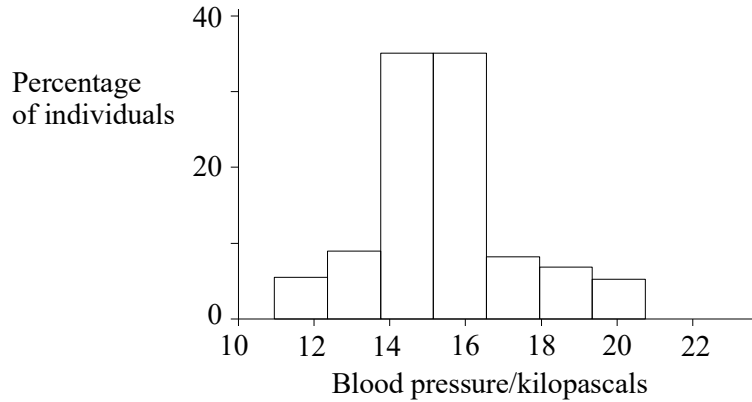
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(2)

(Total 4 marks)

10. High blood pressure can be linked to environmental factors but inherited factors are also known to cause variation in blood pressure. However, there is controversy about the underlying genetic control. Variation in blood pressure is shown in the graph.



- (a) What does the graph suggest about the genetic control of blood pressure?

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(2)

- (b) Explain how data from twin studies could provide further evidence about the inheritance of high blood pressure.

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(3)

(Total 5 marks)

11. The table shows concordance for height between monozygotic and dizygotic twin pairs from birth to the age of eight years. A concordance of 1 indicates that the twins are identical in height.

Age	Concordance for height between	
	monozygotic twin pairs	dizygotic twin pairs of the same sex
Birth	0.62	0.79
3 months	0.78	0.72
6 months	0.80	0.67
12 months	0.86	0.66
24 months	0.89	0.54
3 years	0.93	0.56
5 years	0.94	0.51
8 years	0.94	0.49

- (a) (i) If height were entirely genetically controlled, what concordance would you expect between monozygotic twin pairs? Explain your answer.

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(2)

- (ii) Explain why the concordance between dizygotic twin pairs would have an average value of 0.5.

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(2)

- (b) (i) Do the data for eight-year-old twins suggest that height is largely controlled by genetic factors? Explain your answer.

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(1)

- (ii) Suggest an explanation for the low concordance at birth for monozygotic twins.

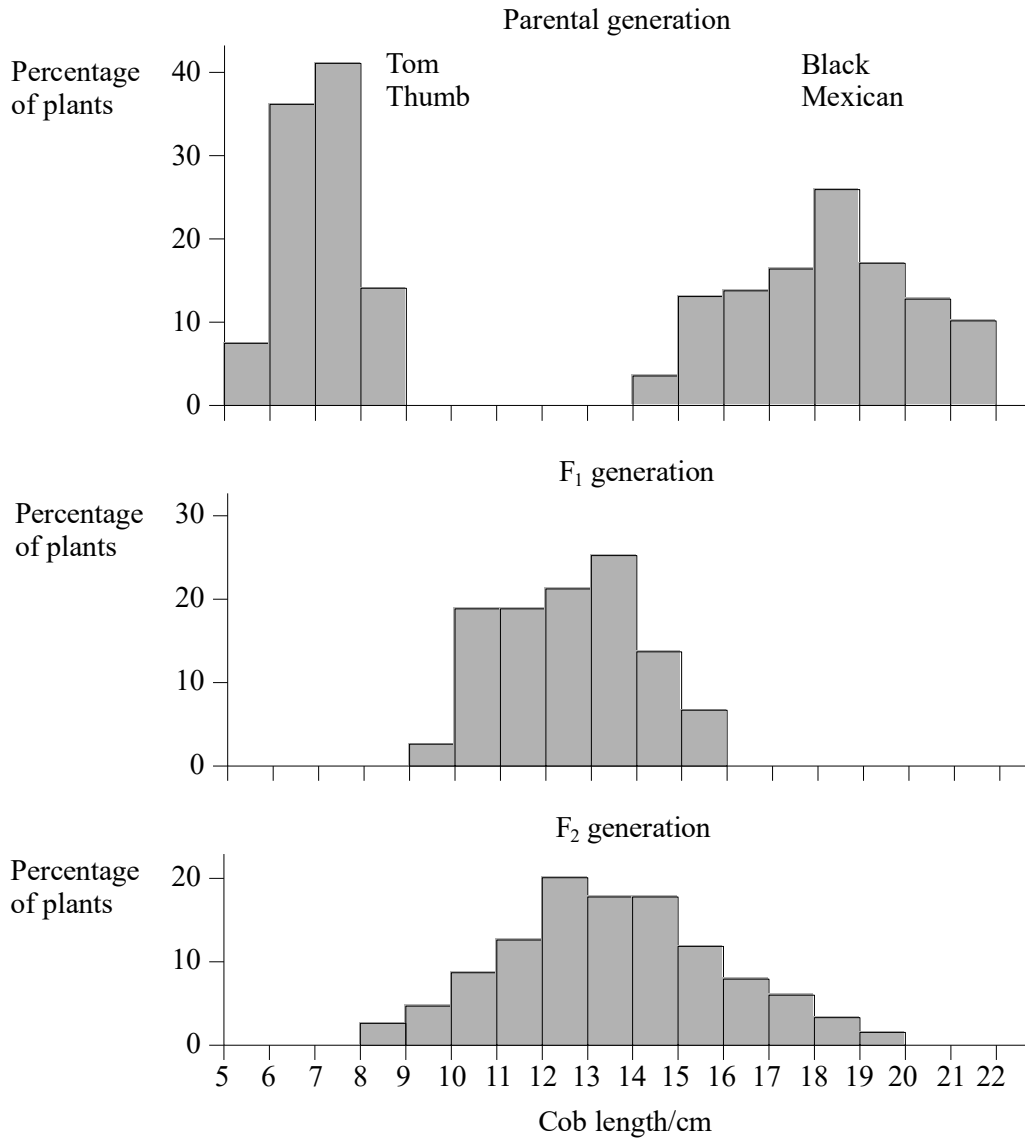
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(2)

**(Total 7 marks)**



12. Cob length in maize is controlled by many genes. Two varieties of maize, Tom Thumb and Black Mexican, both homozygous for these genes, have different lengths of cobs. They were crossed to produce an F<sub>1</sub> generation. These F<sub>1</sub> plants were then self-pollinated to produce an F<sub>2</sub> generation. The lengths of the cobs produced by the plants in the parental, F<sub>1</sub> and F<sub>2</sub> generations are shown in the graphs.



(a) What type of variation is shown in the F<sub>1</sub> generation?

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(1)

(b) Both genetic and environmental factors can cause variation.

(i) Give **two** pieces of evidence from the graphs that genetic factors are involved in determining the length of maize cobs.

1. ....

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2. ....

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(2)

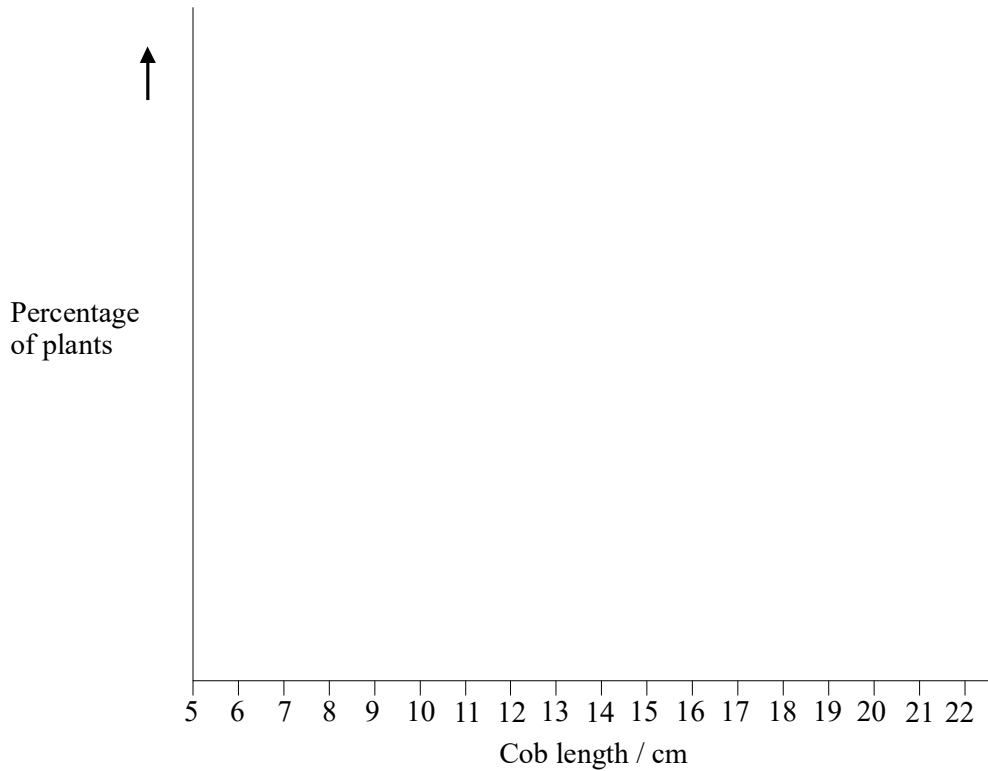
(ii) Describe the evidence that environmental factors are also involved in determining the length of maize cobs.

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(2)

- (c) A cross was carried out between a plant from the F<sub>1</sub> generation and a Tom Thumb plant. Sketch a graph using the axes below to show the expected cob lengths of the offspring.



(1)  
(Total 6 marks)

13. (a) Monozygotic twins are sometimes called identical twins. However, there are slight differences in the appearance of monozygotic twins at birth. Explain why.

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(2)

- (b) A twin study carried out in the United States investigated the effects of genes and the environment on length of life. The investigators recorded the difference in age at death for each pair of twins and calculated the mean values. The results are shown in the table.

	Monozygotic twins		Dizygotic twins	
Mean difference in age at death/months	Female	Male	Female	Male
	47.6	29.4	89.1	61.3

- (i) The researchers only collected data from twin pairs in which the first twin to die was over 60 years old. Explain why.

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(1)

- (ii) Use the data to evaluate the effects of genes and the environment on length of life.

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(3)

**(Total 6 marks)**

14. (a) Give the meaning and explain **one** possible cause of each of the following types of variation.

(i) continuous variation

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(2)

(ii) discontinuous variation

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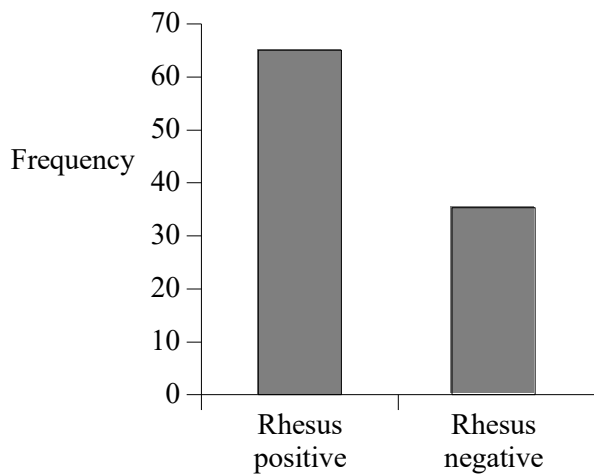
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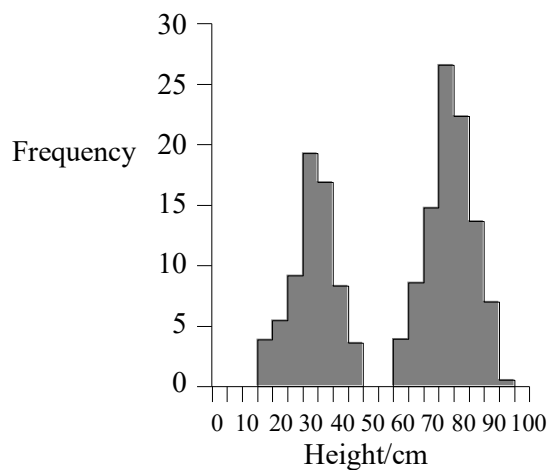
(2)

(b) There are two Rhesus blood groups in humans. *Figure 1* shows the frequency of the Rhesus blood groups in a human population. *Figure 2* shows the frequency of tall and short individuals in a population of plants.

**Figure 1** Blood Groups



**Figure 2** Height of plants



Both characteristics are inherited through two alleles of single genes. Suggest an explanation for the different patterns of variation between *Figure 1* and *Figure 2*.

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(2)  
(Total 6 marks)

15. (a) Explain how crossing over can contribute to genetic variation.

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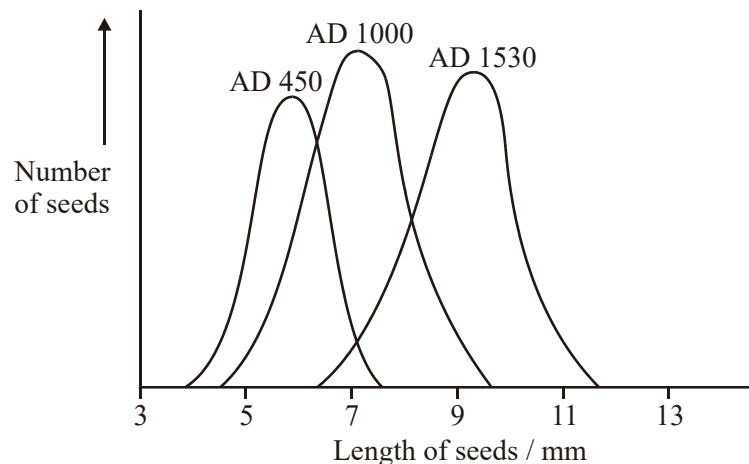
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(3)

- (b) Maize seeds were an important food crop for the people who lived in Peru. The seeds could be kept for long periods. Each year, some were sown to grow the next crop. Archaeologists have found well-preserved stores. The graph shows the lengths of seeds collected from three stores of different ages.



- (i) Within each store the maize seeds showed a range of different lengths. Explain **one** cause of this variation.

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(2)

- (ii) Use your knowledge of genetics and selection to explain the changes in the mean length of the seeds between AD 450 and AD 1530.

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(4)

(Total 9 marks)

16. (a) ABO blood groups in humans are an example of discontinuous variation, whereas height in humans is an example of continuous variation. Describe how discontinuous variation differs from continuous variation in terms of

(i) genetic control;

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(ii) the effect of the environment;

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(iii) the range of phenotypes.

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(3)

(b) Genetically identical twins often show slight differences in their appearance at birth. Suggest **one** way in which these differences may have been caused.

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(1)

(Total 4 marks)

17. IQ test scores have been used as a measure of intelligence. Genetic and environmental factors may both be involved in determining intelligence. In an investigation of families with adopted children, the mean IQ scores of the adopted children was closer to the mean IQ scores of their adoptive parents than to that of their biological parents.

(a) Explain what the results of this investigation suggest about the importance of genetic and environmental factors in determining intelligence.

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(1)



- (b) Explain how data from studies of identical twins and non-identical twins could provide further evidence about the genetic control of intelligence.

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(4)  
(Total 5 marks)

- 18. (a) Meiosis results in variation between individuals within a population. Describe and explain one way the production of gametes by meiosis contributes to this variation.

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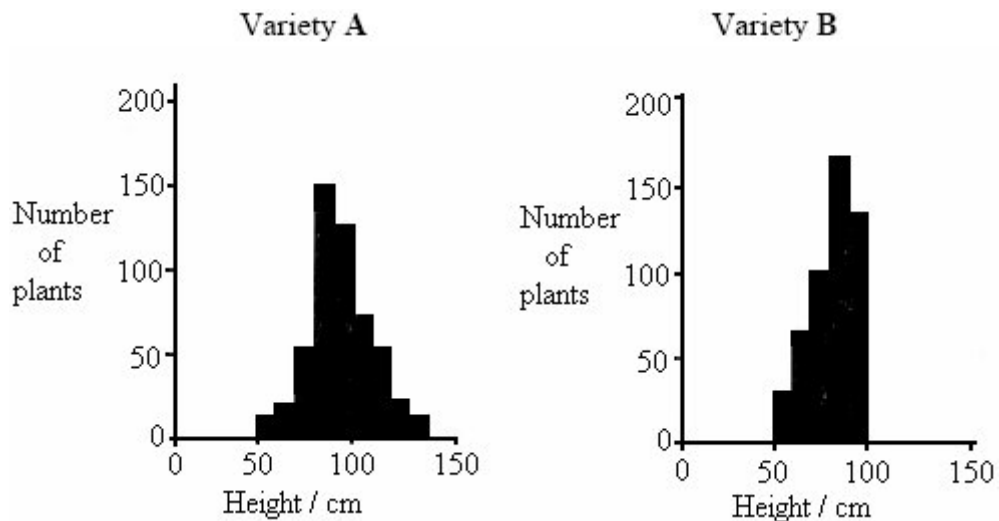
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(2)

- (b) **A** and **B** are varieties of wheat. Scientists grew both varieties in identical conditions and measured the heights of the fully grown plants. The results are shown in the diagram.



- (i) Describe **two** ways in which the results for variety **A** differ from the results for variety **B**.

1 .....

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2 .....

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(2)

- (ii) Suggest the advantage to a farmer of growing variety **B** rather than variety **A**.

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(2)

- (c) The effect of global warming on the environment is uncertain. It is important to keep seeds of the old varieties. Suggest why.

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(2)  
(Total 8 marks)