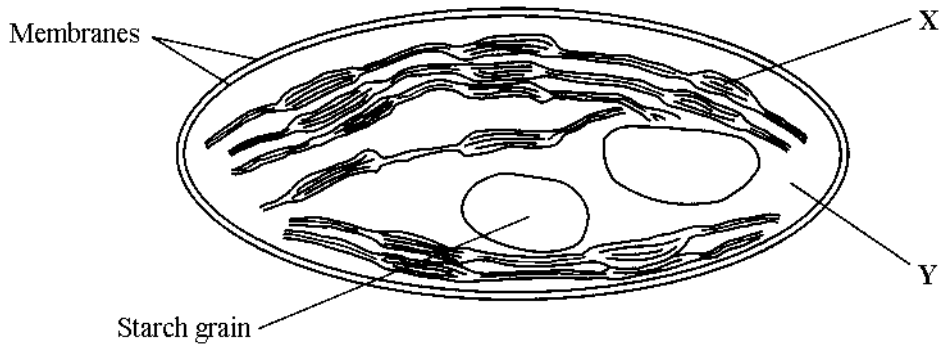


1. The diagram shows a cell organelle.



(a) Identify the parts labelled X and Y.

X

Y

(2)

Light was shone on a suspension of these organelles while it was kept in an atmosphere of pure nitrogen. During this time the organelles made large amounts of two different substances, and gave off oxygen.

(b) Name the two substances that were made when the organelles were illuminated.

1

2

(2)

The membranes around the outside of the organelles were then broken, and the parts labelled X and Y were separated from each other. In the dark, part Y was supplied with a substance, which it converted into a carbohydrate.

(c) What is the name of the substance which was converted into a carbohydrate?

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(1)

(d) (i) Name the part of the organelle where the enzymes of the light-independent reaction are located.

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(1)

(ii) Use the diagram to give the function of one other enzyme that is present in this part of the organelle.

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(1)

(Total 7 marks)

2. Read the following passage.

Higher animals seem never to have evolved cellulases. Ruminants, such as cattle, deer and camels, house certain types of bacteria in a four-chambered stomach. Cellulose is digested by the prokaryotes, which possess cellulases. The rabbit, *Oryctolagus cuniculus*, has, like the horse, an enlarged caecum in which cellulose breakdown occurs, also brought about by resident bacteria.

Cellulose is also digested in the intestine of the garden snail, *Helix pomatia*, although, in experiments, extracts of the digestive gland lack cellulase activity. A protoctist, *Trichonympha*, inhabits the intestine of wood-eating termites, and is responsible for their being able to digest cellulose in their diet of wood. Bacteria are also present here, but do not produce a cellulase. Instead they seem to be nitrogen-fixing, which may explain how termites are able to thrive on a diet so low in nitrogen-containing compounds.

(a) Give the names of two genera mentioned in the passage.

.....

(1)

(b) Organisms from three kingdoms are mentioned in the passage. Name each of these kingdoms.

.....

(2)

(c) A garden snail was mated with a snail from a different continent. Offspring were produced. What would you need to know about these offspring to be certain that both parents belonged to the same species?

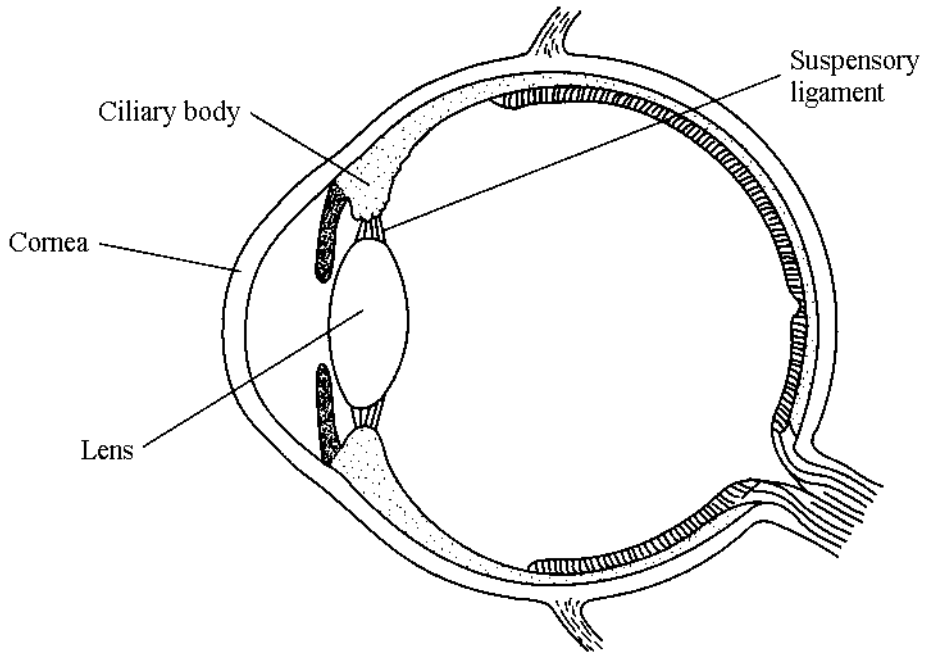
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(1)

(Total 4 marks)

3. The diagram shows a section through the human eye.



(a) Explain how the structures labelled on the diagram help to focus an image on the retina when

(i) the object is a long distance away;

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(ii) the object is close to the eye.

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(6)

There are three different types of receptor cells for colour in the retina. The table shows how much light of different wavelengths is absorbed by each of these receptor cells.

Wavelength /nm	Light absorption, as a percentage of maximum		
	Blue-sensitive cells	Green-sensitive cells	Red-sensitive cells
400	30	-	-
430	100	-	-
450	85	10	-
500	30	75	35
540	4	100	72
550	-	90	85
575	-	50	100
600	-	15	75
650	-	-	10

(b) Use information from the table to explain why

(i) light of wavelength 430 nm appears blue;

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(1)

(ii) light of wavelength 550 nm appears yellow.

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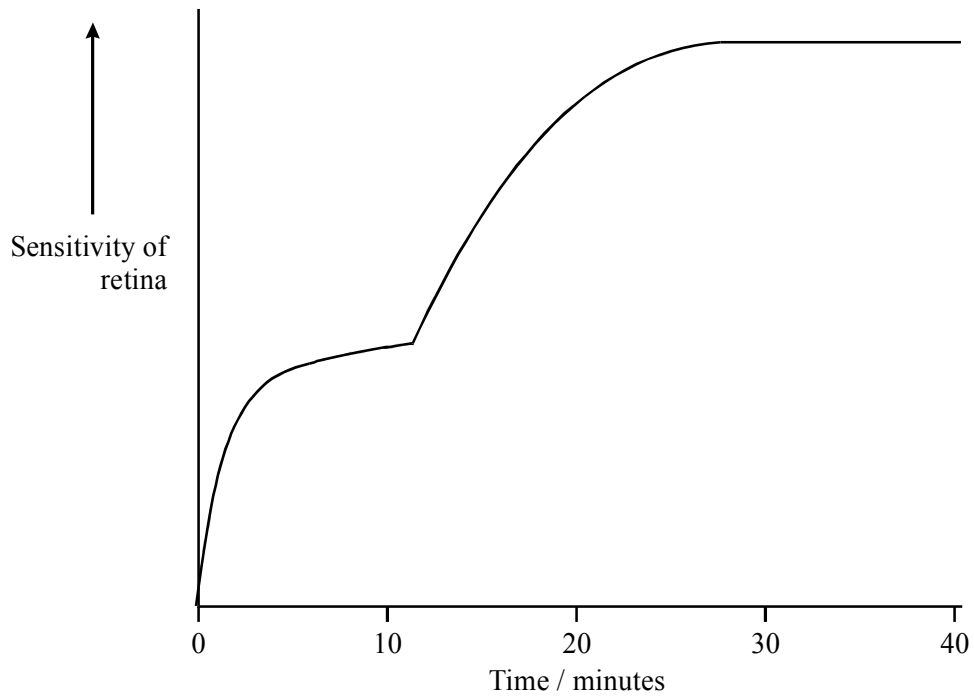
(1)

(c) Suggest, using information in the table, what range of wavelengths of light appears orange.

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(1)

A person leaves a well-lit room at night and goes outside into almost complete darkness. At first she is able to see very little, but after a few minutes her vision improves, and continues to do so for 20 to 30 minutes. The graph shows the changes in the sensitivity of her retina over this period.



(d) What is the evidence from the graph that two different types of receptor cell are involved?

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(1)

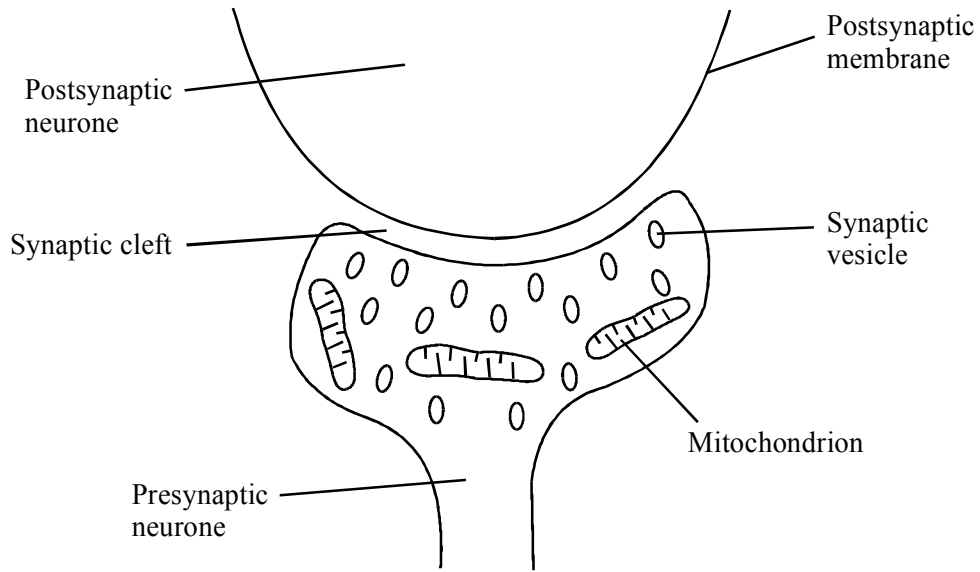
(e) Explain the changes that would take place in rod cells to bring about an increase in retinal sensitivity.

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(2)

(Total 12 marks)

4. The drawing shows a synapse in which acetylcholine acts as the transmitter substance.



(a) Describe the part played by acetylcholine in synaptic transmission.

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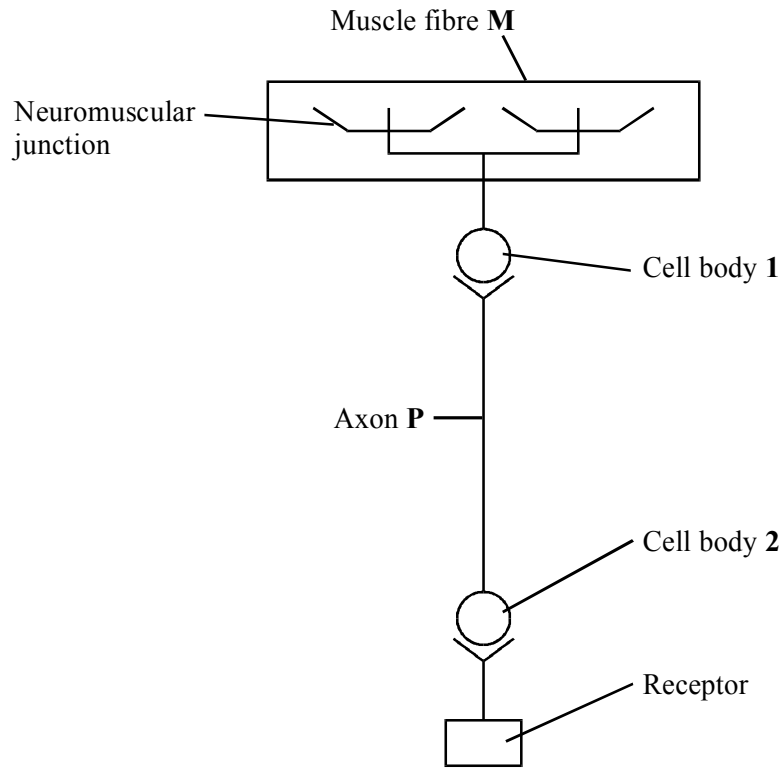
(3)

(b) Describe the function in synaptic transmission of the mitochondria shown.

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.....

(1)

The diagram represents a nerve pathway found in a burrowing animal. Contraction of muscle fibre **M** helps to bring about an escape response in which the head of the animal is pulled quickly back into the burrow.



- (c) Explain how the escape response in this animal may be regarded as being controlled by a simple reflex arc.

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(3)

- (d) Impulses are able to travel in either direction along an axon. Explain why impulses cannot pass from muscle fibre **M** to the receptor along the nerve pathway shown in the diagram.

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(1)

(e) Axon **P** was found to conduct impulses much faster than other axons in the animal.

(i) Describe one feature of axon **P** that might cause this difference.

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(1)

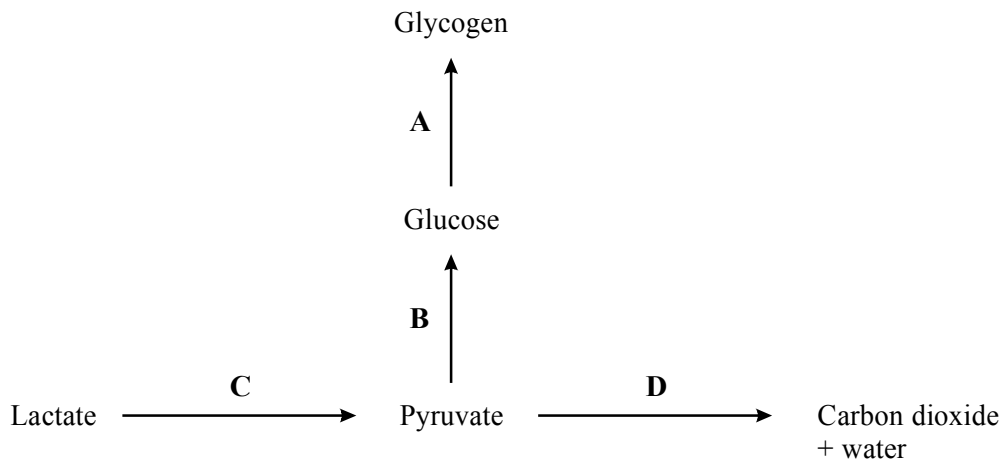
(ii) Suggest how the speed of conduction in axon **P** helps to adapt the animal to its environment.

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(1)

(Total 10 marks)

5. In an experiment, lactate containing radioactive carbon was added to a preparation of muscle tissue in the presence of oxygen. The muscle preparation was able to respire some of the lactate and this provided the energy needed to convert the remaining lactate into glycogen. The diagram summarises the biochemical steps involved.



(a) Which **one** of the labelled arrows shows a biochemical conversion in muscle that can proceed only in the direction shown?

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(1)

(b) Give the names of the stages in aerobic respiration in which energy is made available from the respiration of lactate.

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(2)

The results from the experiment are shown in the table. The values have been rounded to the nearest 100 counts per minute (cpm).

Substance	Total amount of radioactivity found in each substance / cpm	
	at the start of the experiment	at the end of the experiment
Glycogen	0	6200
Lactate	8000	0
Carbon dioxide	0	1200

- (c) Suggest a reason for the lower total amount of radioactivity found at the end of the experiment.

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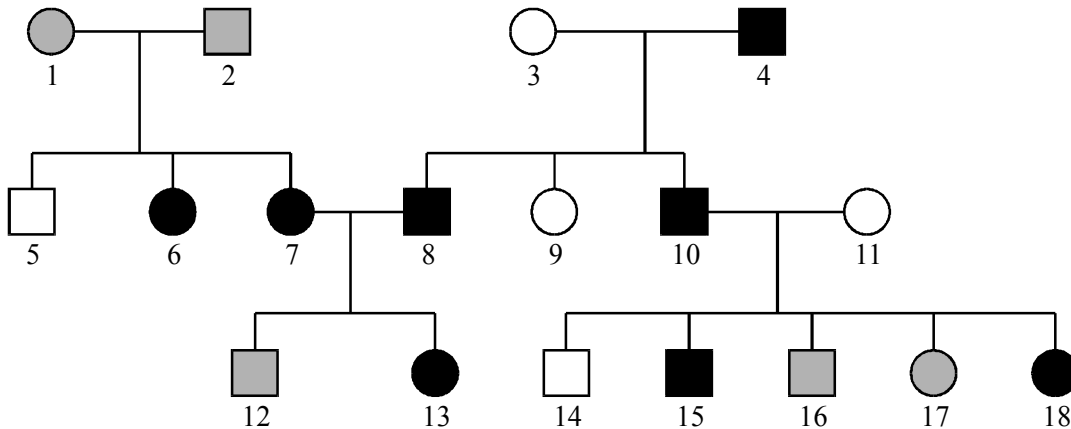
(1)

- (d) Use values from the table to calculate the percentage of lactate that was respired to provide the energy for glycogen synthesis. Show your working.

(2)

(Total 6 marks)

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



Key: Square = male
 Circle = female

● red
 ● sandy
 ○ white

(a) Explain **one** piece of evidence from the diagram which shows that coat colour is **not** controlled by one gene with two codominant alleles.

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(3)

Two hypotheses were put forward to explain the results, each based on the action of two pairs of alleles.

	Hypothesis 1	Hypothesis 2
Phenotype	Genotype	Genotype
Red	A_B_	A_B_ or A_bb
Sandy	A_bb or aaB_	aaB_
White	aabb	aabb

(_ represents either a dominant or a recessive allele of the gene)

(b) Assuming that Hypothesis 1 is correct, give **one** possible genotype for each of the following individuals in the diagram.

11

10

2

(2)

(c) Explain **one** piece of evidence from the diagram which shows that Hypothesis 2 should be rejected.

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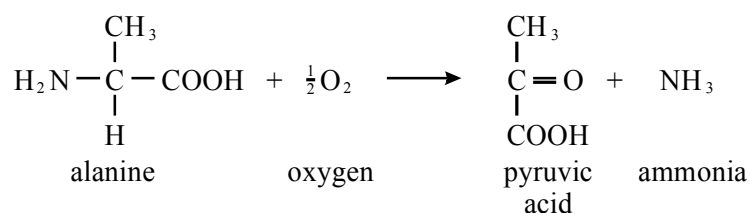
(2)

- (d) Individual 18 was crossed with a pig of genotype **Aabb**.
Use Hypothesis 1 to predict the genotypes and the ratio of phenotypes expected in the offspring of this cross.

	Individual 18	Other parent
<i>Parental genotypes</i>	Aabb
<i>Parental gametes</i>		
<i>Offspring genotypes</i>		
<i>Offspring phenotypes</i>		
<i>Expected ratio of offspring phenotypes</i>		

(4)
(Total 11 marks)

7. The equation shows a reaction involved in the removal of metabolic waste from mammals. Alanine comes from the hydrolysis of protein.



- (a) (i) What is the name of the group of substances to which alanine belongs?
 (1)
- (ii) Name the type of chemical reaction shown in the equation.
 (1)
- (iii) In which organ in the body does this type of reaction take place?
 (1)
- (b) The products of this reaction are converted into other compounds. Into which substance is ammonia converted in a mammal?
 (1)
- (c) Pyruvic acid is an organic acid that can be used in respiration to release energy for the cell.
- (i) For this to happen, into which substances is pyruvic acid immediately converted?
 (1)
- (ii) Where, precisely, in the cell, does this reaction occur?
 (1)
- (iii) How is the energy released made available to metabolic processes?
 (1)

- (d) If a person becomes dehydrated e.g. after strenuous activity on a sunny day, the water potential of the blood can fall. Blood water potential later rises as the result of a control system in the body.

Describe the details of this control system. In your description, explain how the control of blood water potential illustrates the principles of negative feedback.

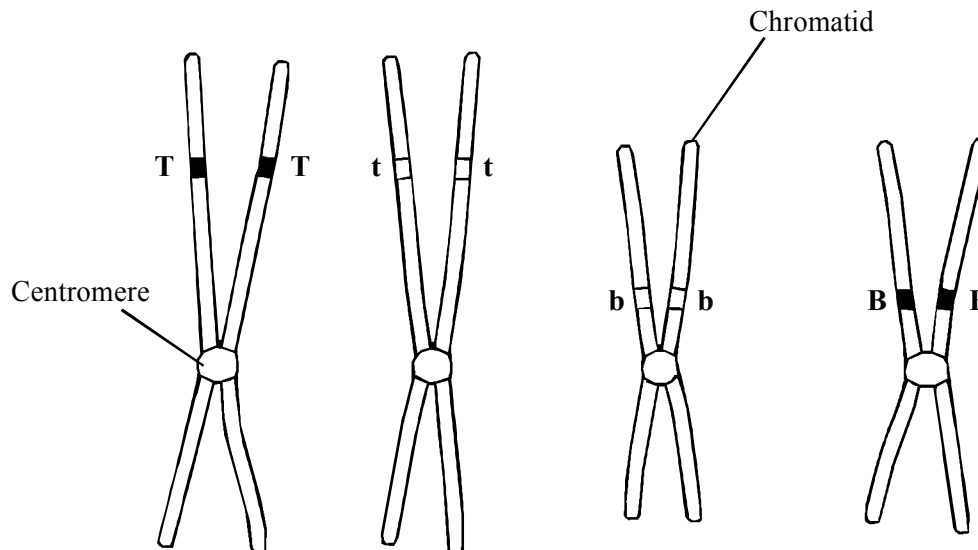
(Allow one lined page)

(8)
(Total 15 marks)

8. The diagram shows the chromosomes from a plant cell in which $2n = 4$. The plant is heterozygous for two characteristics:

- height (the alleles **T** = tall and **t** = dwarf);
- flower colour (the alleles **B** = blue and **b** = white);

Allele **T** is dominant to allele **t** and allele **B** is dominant to allele **b**.



- (a) (i) In the space below, draw a diagram to show the appearance of these chromosomes just as they are beginning to separate in the first stage of meiosis.

(2)

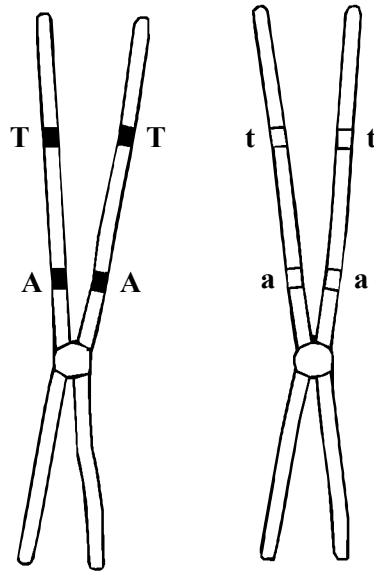
- (ii) Give all the different genotypes of the gametes produced at the end of meiosis in this plant.

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(1)

The plant is also heterozygous for another characteristic, the colour of its stem. The alleles

responsible (**A** = purple stem, **a** = green stem) are carried on the same pair of chromosomes as the alleles for height. Allele **A** is dominant to allele **a**. The pair of chromosomes is shown in the diagram.



The plant was crossed with a dwarf, green-stemmed plant and produced a large number of offspring. The table shows the results.

Phenotype	Tall, purple-stemmed	Tall, green-stemmed	Dwarf, purple-stemmed	Dwarf, green-stemmed
Number of offspring	91	9	11	89

(b) (i) Explain how crossing over accounts for the fact that the offspring include some individuals which are tall and green-stemmed and some which are dwarf and purple-stemmed.

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(2)

(ii) Suggest why there are fewer offspring with these phenotypes.

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(1)

(iii) When observing dividing cells under a microscope, how would you recognise that crossing over had taken place?

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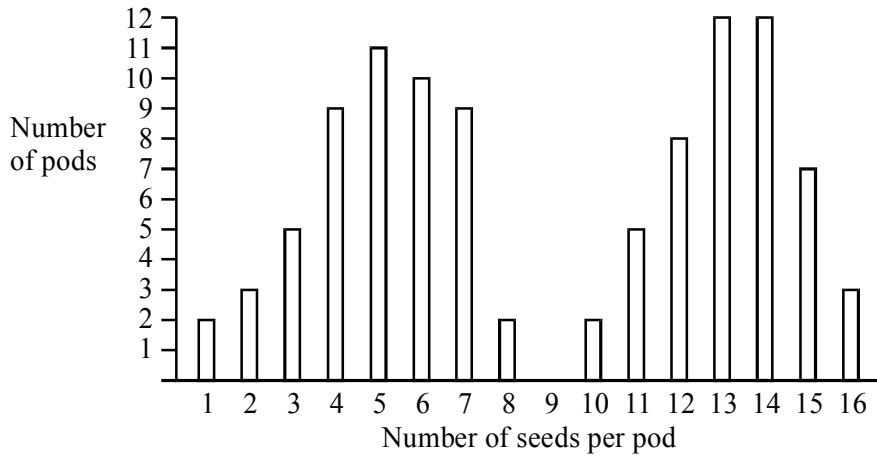
(1)

(c) Give **two** factors, other than crossing over, which result in genetic variation in the offspring produced by a sexually reproducing organism. In each case, explain how the factor brings about genetic variation.

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(4)

(d) The seeds of this plant are produced in pods. One pod was taken at random from each of 100 different plants growing in a large field. The number of seeds in each pod was counted. The bar chart shows the results of the survey.



Explain what the results of the survey suggest about the type and causes of the variation in the number of seeds per pod.

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(4)
(Total 15 marks)