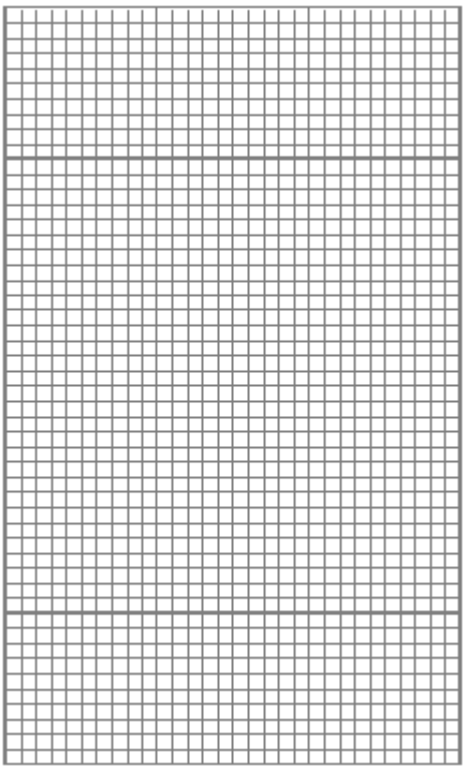
Q1. (a) The table shows an athlete's breathing rate after the end of a race.

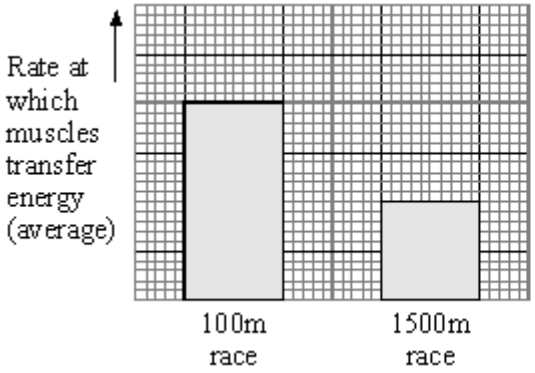
Use the information shown in the table to draw a line graph.

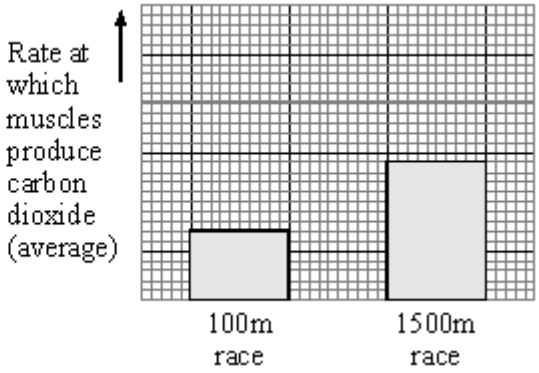
Time after end of race (minutes)	Breathing rate (litres per second)
0	4
1	2
2	1
3	1
4	1
5	1



(3)

(b) The bar charts show what happens in an athlete's muscles when running in two races of different distances.





(i) Compare what happens in the athlete's muscles when running in the two races.

.....

.....

(3)

(ii) Use the information in the box to explain your answer to (i).

aerobic respiration	glucose + oxygen ⟶	carbon dioxide + water
anaerobic respiration	glucose ⟶	lactic acid

.....

.....

(2)

(c) Explain why the athlete breathes at a faster rate than normal for two minutes after finishing a 100 metres race.

.....

.....

.....

(2)

(Total 10 marks)

Q2. Cystic fibrosis is an inherited disease which causes the tubes in the lungs to be blocked with sticky mucus. Two parents who do not have the disease can still produce children who do have the disease.

(a) Explain how children can inherit this disease from parents who do not have it (use a genetic diagram in your answer if you want to).

.....

.....

.....

.....

.....

(4)

(b) Mucus contains protein. The information for the production of this protein is stored in a gene.

Explain how a change in a gene causes a different protein to be produced.

.....

.....

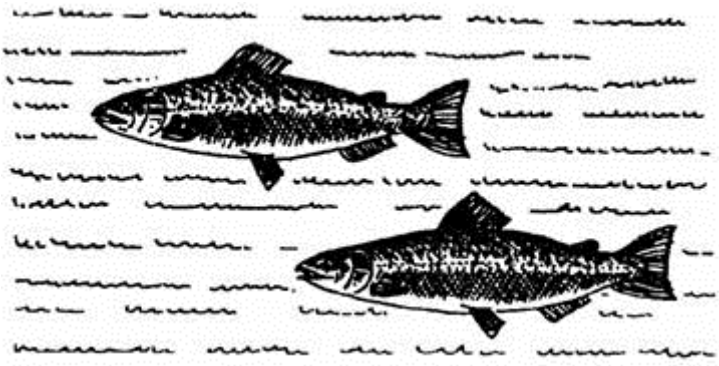
.....

.....

(3)

(Total 7 marks)

Q3. Wild salmon hatch from eggs laid in rivers. The small salmon then swim downstream to the sea. After 3-4 years they return to breed, usually in the same river in which they were hatched. If fish return to a different river they do not breed as successfully as those returning to the same one. This means that each river has its own breeding population of salmon. Each breeding population is slightly different from all the others.



Use the idea of natural selection to explain how each river has its own breeding population.

.....

.....

.....

.....

.....

(Total 4 marks)

Q4. For many years scientists studied the organisms in an area of grassland.

One of the animals was a species of black fly. In this population only one allele **B** existed for colour. All the flies were homozygous **BB.**

A mutation occurred which produced a new recessive allele **b** which could produce a green colour.

(a) Draw **two** genetic diagrams to show how the single **b** allele in just one fly was able to produce homozygous **bb** green flies in two generations.

First generation

Second generation

(4)

(b) Although this new allele was recessive and the mutation only occurred once, a large proportion of the fly population was soon green.

Suggest in terms of natural selection why the recessive **b** allele was able to spread through the population.

.....

.....

.....

.....

.....

.....

(3)
(Total 7 marks)

##

Spiders produce a protein thread which is extremely strong compared to man-made fibres of the same diameter.

Spider's web

Explain how genes control the way the protein is made in the spider's body.

.....

.....

.....

.....

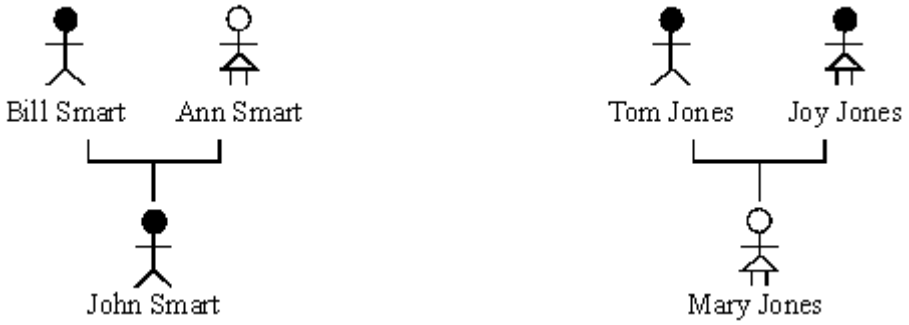
.....

(Total 4 marks)

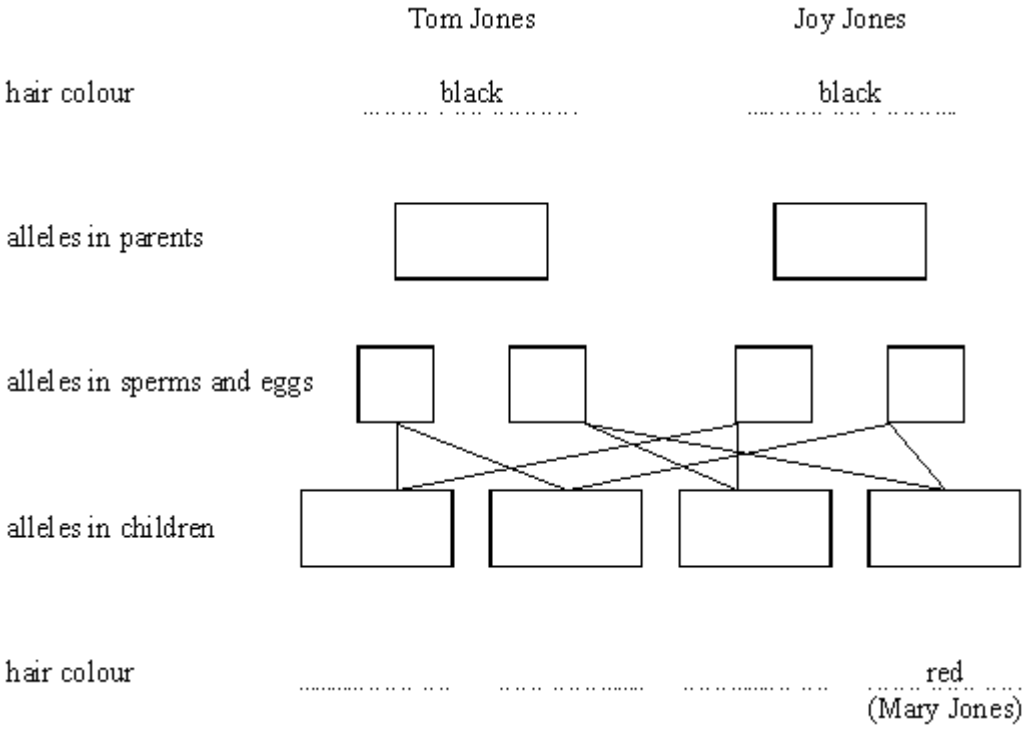
Q6. The family trees below show the inheritance of hair colour in two families.

People with black hair are shown as:

People with red hair are shown as:



(a) The allele for black hair is dominant over the allele for red hair.
Use the letter **B** as the allele for black hair.
Use the letter **b** as the allele for red hair.
Complete the diagram below to show the chances of Mary Jones inheriting red hair.



(4)

(b) John Smart and Mary Jones grew up, got married and had a child.
What would the chances be that the child had red hair?

.....

(1)

Explain your answer. Use a genetic diagram if it makes your answer clearer.

.....

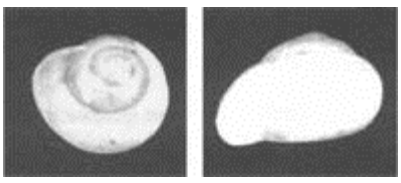
.....

.....

(3)
(Total 8 marks)

##

Cepaea nemoralis is a snail which is found on sand dunes. It may have a plain or banded shell. The snails are found on grass stalks and leaves.



Plain

Banded

A scientist collected young unbanded snails and kept them until they were fully grown and mated them.

The eggs laid produced 35 unbanded and 12 banded snails.

(a) Explain these figures as fully as you can. You may use a genetic diagram if you wish to make your answer clearer.

.....

.....

.....

.....

.....

.....

.....

.....

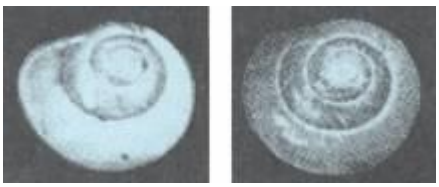
.....

.....

.....

.....

(7)



Variation in colour

Variation in banding

(b) The snail shells show a lot of variation in colour. They are yellowy/green, brown, pink or cream. The banding varies from a single wide band to a mixture of thick and thin bands.

Describe briefly the factors which have produced this variation and explain how these factors may themselves have arisen.

.....

.....

.....

.....

.....

(4)
(Total 11 marks)

Q8. Diagram 1 shows the main features of human blood circulation.

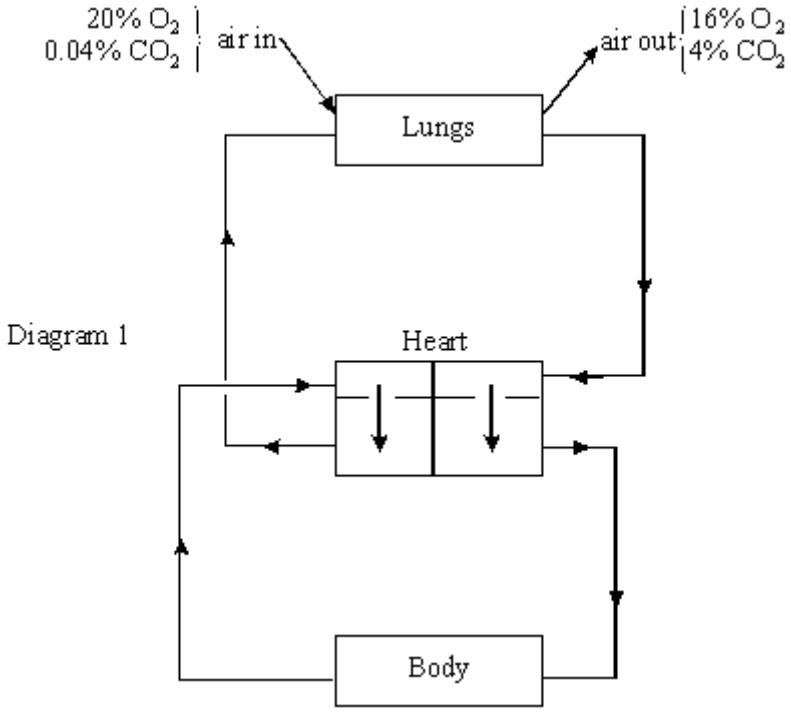


Diagram 1

(a) What changes in the composition of **blood** occur in the lungs?

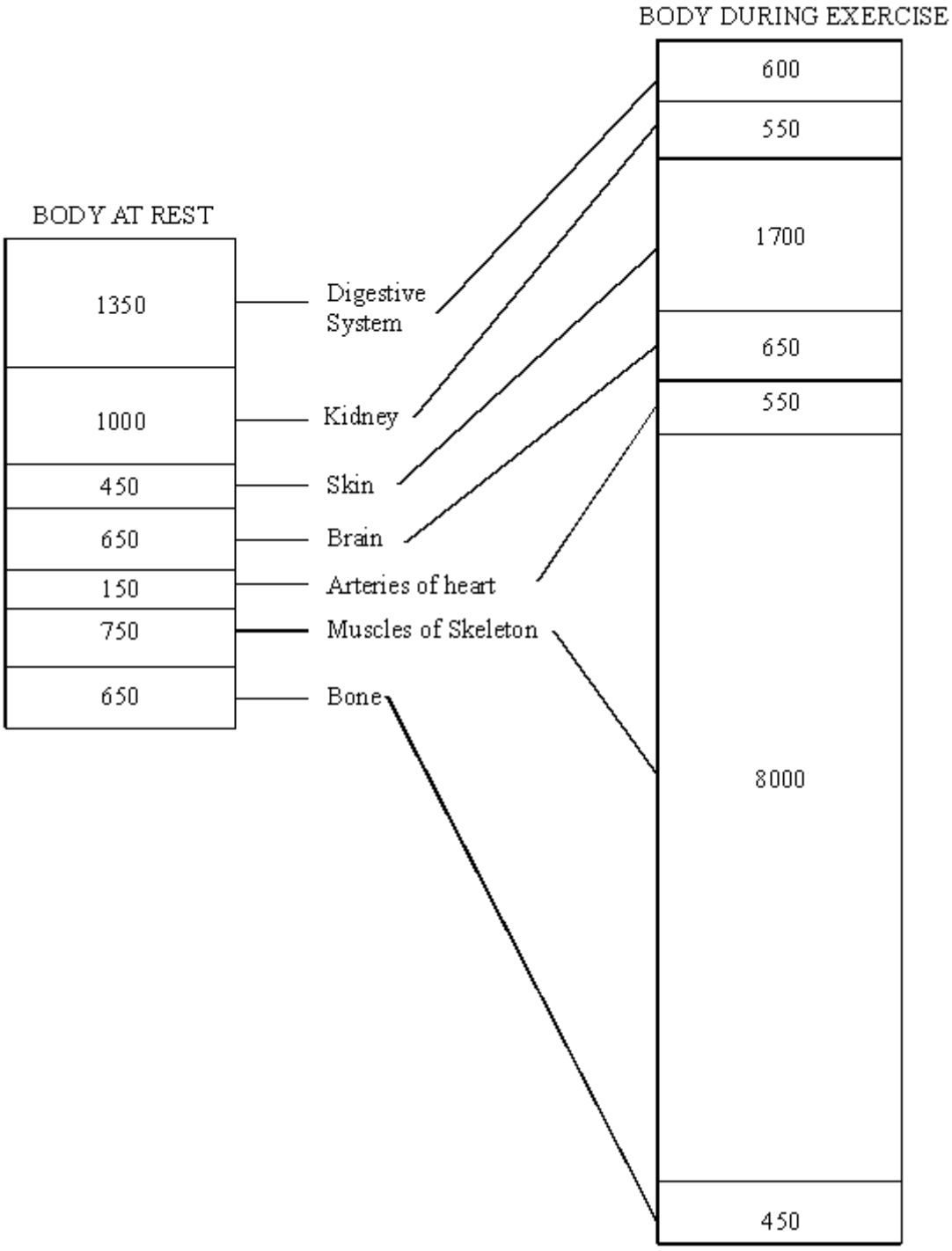
.....

.....

.....

(2)

Diagram 2 shows how the circulation of blood changes between rest and exercise.



Rate of supply of blood to parts of the body (cm^3/min) when at rest and during exercise.

(b) (i) Use the information from Diagram 2 to complete the table below.

Parts of the body to be included:

Digestive System

Skin

Brain

Arteries of Heart

Muscles of Skeleton

Bone

HOW BLOOD SUPPLY CHANGES DURING EXERCISE		
reduced	unchanged	increased
Kidney		

(4)

(ii) What happens to the rate of supply of blood to the whole body with exercise?

(You should make full use of the information provided.)

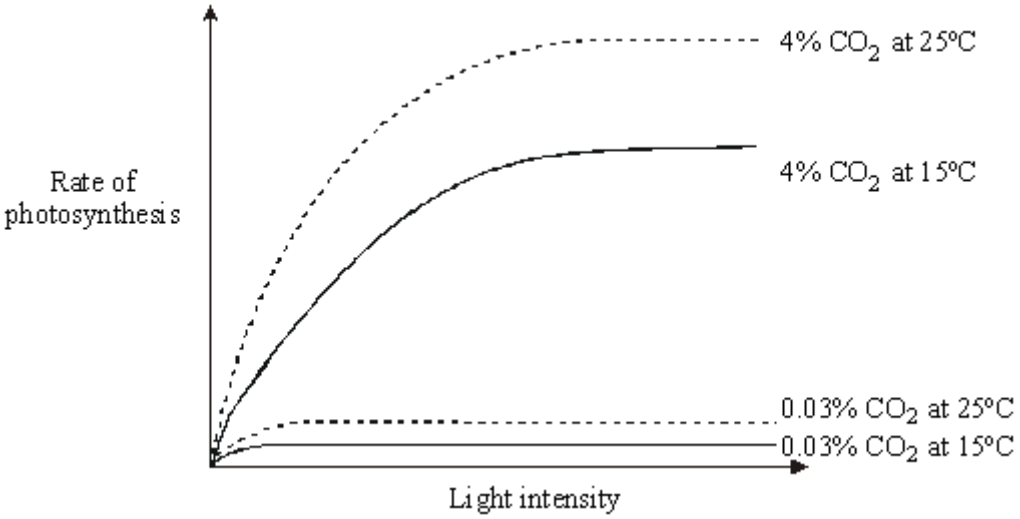
.....

.....

.....

(3)
(Total 9 marks)

Q9. The graph shows how the rate of photosynthesis is affected by different conditions.



(a) What patterns can you find from this graph?

.....

.....

.....

.....

.....

(5)

(b) How useful could this information be to a grower using glasshouses? Give reasons for your answer.

.....

.....

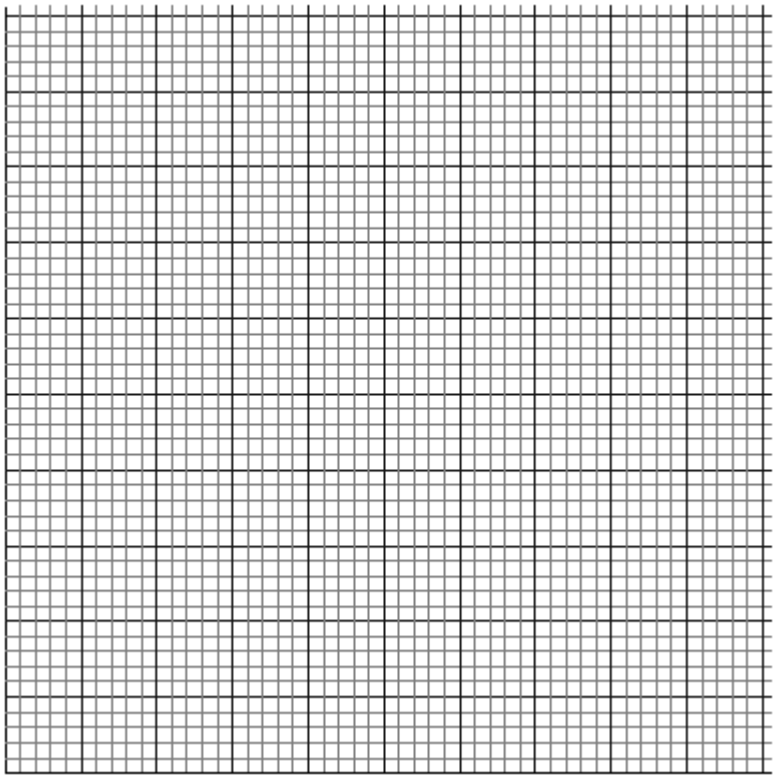
.....

(2)
(Total 7 marks)

Q10. The figures below show how the yield of a wheat crop is affected by adding nitrogen fertiliser.

Nitrogen fertiliser added (kg/hectare)	Yield (tonnes/hectare)
0	26
50	28
75	31
100	34
125	40
150	43
175	44
200	44

(a) Display these results on the graph paper in the most suitable way.



(4)

(b) What conclusions can you draw from the graph?

.....

.....

.....

.....

.....

(3)
(Total 7 marks)

Q11. (a) How many pairs of chromosomes are there in a body cell of a human baby?

.....

(1)

(b) Place the following in order of size, **starting with the smallest,** by writing numbers **1 – 4** in the boxes underneath the words.

chromosome	nucleus	gene	cell

(1)

(c) For a baby to grow, its cells must develop in a number of ways.

Explain how each of the following is part of the growth process of a baby.

(i) Cell enlargement

.....

(1)

(ii) The process of cell division by mitosis

.....

.....

.....

.....

.....

.....

(3)

(d) Why is cell specialisation (differentiation) important for the development and growth of a healthy baby from a fertilised egg?

.....

.....

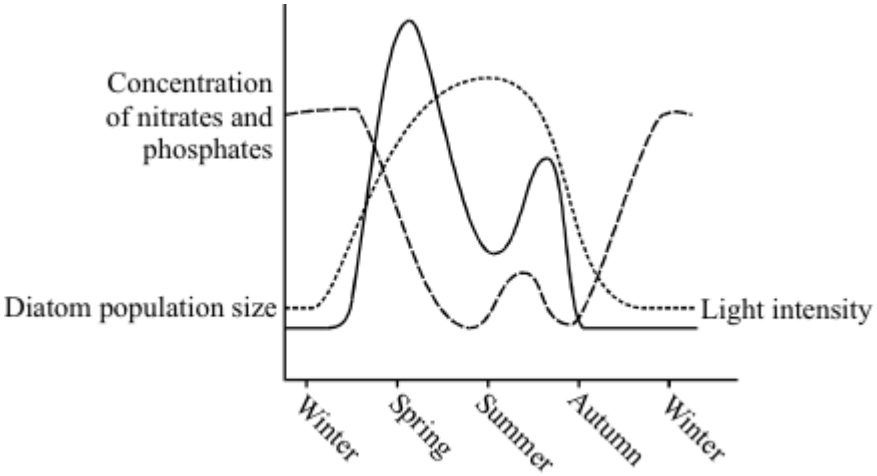
(2)
(Total 8 marks)

Q12. A food chain in the North Atlantic Ocean is:

diatoms → small fish → large fish

The graphs show how over a year:

- the population size of diatoms in the North Atlantic varies;
- the light intensity alters;
- the concentration of nitrate and phosphate minerals alters.



(a) Explain why the light intensity is a major factor in controlling the numbers of diatoms.

.....

.....

.....

(2)

(b) (i) Suggest **two** reasons why the population of diatoms decreases between spring and summer.

1. .....

.....

2. .....

.....

(2)

(ii) Give **two** reasons why the population of diatoms decreases in autumn.

1. .....

.....

2. .....

.....

(2)

(c) Use the information on the graph to suggest what change causes the number of diatoms to increase in the late summer. Give a reason for the change.

.....

.....

.....

(2)
(Total 8 marks)

Q13. (a) Respiration is a process which takes place in living cells. What is the purpose of *respiration*?

.....

.....

(1)

(b) (i) Balance the equation for the process of respiration when oxygen is available.

$C_6H_{12}O_6$ + O_2 → CO_2 + H_2O

(1)

(ii) What is the name of the substance in the equation with the formula $C_6H_{12}O_6$?

.....

(1)

(c) Oxygen is absorbed through the alveoli in the lungs.

(i) How are the alveoli adapted for this function?

.....

.....

.....

(2)

(ii) Name the gas which is excreted through the alveoli.

.....

(1)

(d) (i) What is the name of the process of respiration when oxygen is **not** available?

.....

(1)

(ii) Describe the process of respiration which takes place in human beings when oxygen is **not** available and give an effect.

.....

.....

.....

.....

.....

.....

(3)
(Total 10 marks)

Q14. Two heterozygous parents, with alleles Rr, produce offspring.

(i) Draw a genetic diagram to show all the possible arrangements of alleles in their offspring.

(2)

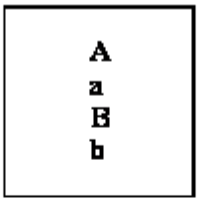
(ii) One of the offspring is dominant homozygous. What is the chance of this occurring?

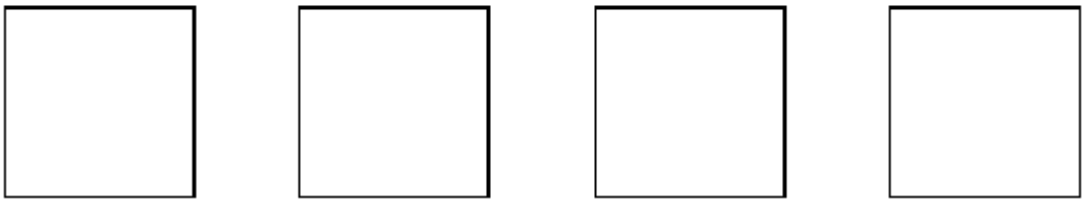
.....

(1)
(Total 3 marks)

Q15. In the cell shown in the diagram as a box, one chromosome pair has alleles **Aa**. The other chromosome pair has alleles **Bb**. The cell undergoes meiosis.

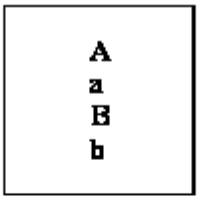
(a) Complete the diagram of the four gametes to show the independent assortment, or reassortment, of genetic material during meiosis.

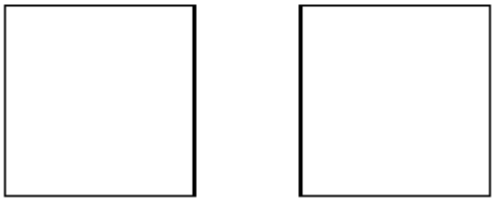




(2)

(b) If the cell undergoes mitosis instead of meiosis, draw the two daughter cells which result to show the chromosomes in each.





(2)

(c) State the number of chromosomes in:

(i) a normal human cell;

.....

(1)

(ii) a human gamete;

.....

(1)

(iii) the daughter cell from mitosis of a human cell.

.....

(1)

(Total 7 marks)

Q16. One of Mendel's original experiments was to cross pure-breeding, red-flowering pea plants with pure-breeding white-flowering pea plants. The next year he grew the seed he had collected. This first generation, $\mathbf{F_1}$, of pea plants all had red flowers. Mendel then made each flower on these plants self-pollinate. He collected the seed from these flowers and grew them. The second generation, $\mathbf{F_2}$, gave the following result:

705 red-flowering plants and 224 white-flowering plants.

(a) Which flower colour is due to the recessive allele?

.....

(1)

(b) Draw a genetic diagram to show the inheritance of flower colour in the first generation ($\mathbf{F_1}$) of plants.

Use the letters **r** and **R** to represent the alleles for flower colour.

(3)

(c) Explain why Mendel made the first generation of plants self-pollinate.

.....

.....

.....

(2)

(d) If Mendel had taken any two of his white-flowering peas and crossed them, what would have been the colour of the flowers of the next generation of plants?

.....

(1)

(e) It is very difficult to get red-flowering pea plants that breed true. Explain why you cannot guarantee to breed, by self-pollination, pea plants that only have red flowers.

.....

.....

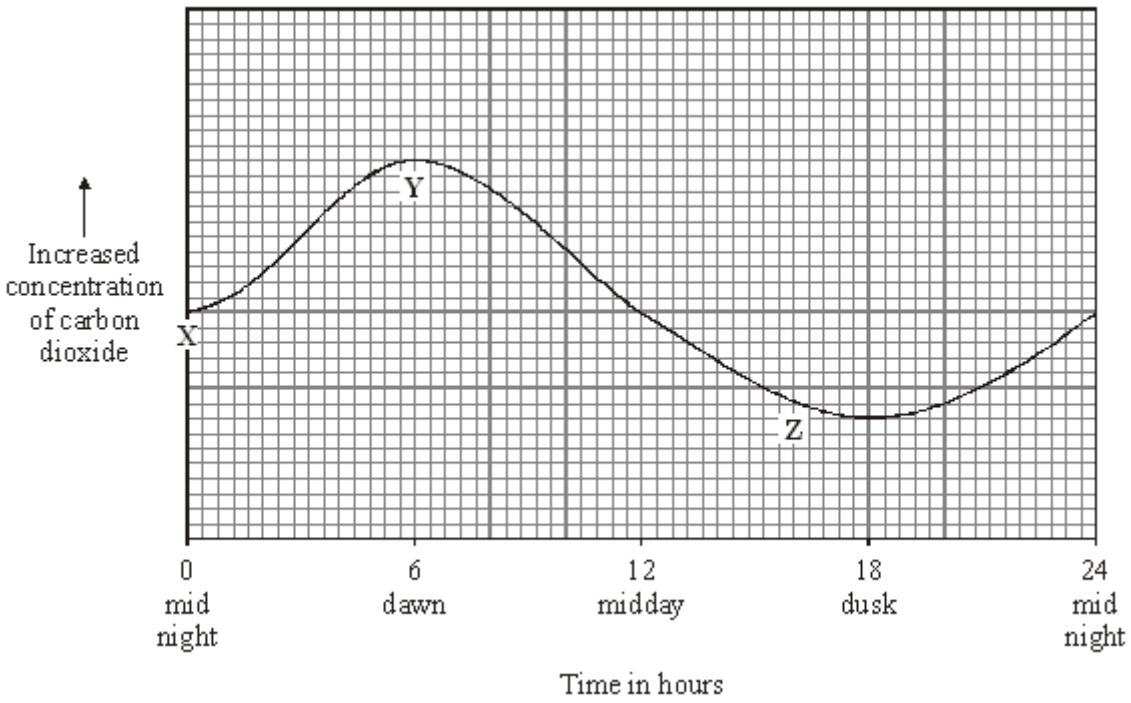
.....

.....

(2)

(Total 9 marks)

Q17. The graph shows the concentration of carbon dioxide in the air in a greenhouse full of tomato plants, measured over a period of 24 hours.



(a) Explain why the concentration of carbon dioxide in the air in the greenhouse increased between **X** and **Y**.

.....

.....

.....

.....

(2)

(b) Explain why the concentration of carbon dioxide in the air in the greenhouse decreased between **Y** and **Z**.

.....

.....

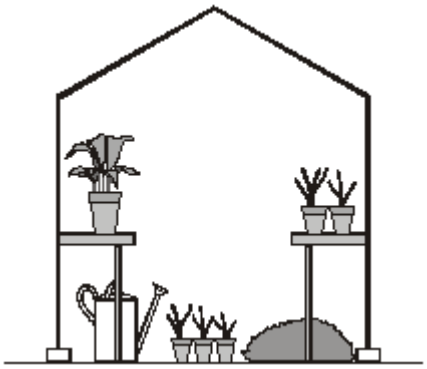
.....

.....

(2)

(Total 4 marks)

Q18. The diagram shows some plants growing in a greenhouse on a hot summer's day.



Which **one** of the following factors is most likely to limit the rate of photosynthesis at this time?

- carbon dioxide concentration
- light intensity
- temperature

Factor .....

Explain the reason for your answer.

.....

.....

.....

.....

.....

.....

(Total 4 marks)

Q19. (a) Sex cells are produced by meiosis.

Describe what happens to the chromosomes when a cell divides by meiosis.

.....

.....

.....

.....

(2)

(b) Darwin's theory of natural selection depends on the fact that individual organisms within a species may show a wide range of variation.

Explain how meiosis and sexual reproduction give rise to variation.

.....

.....

.....

.....

(2)

(c) Mutation may also give rise to variation.

(i) What is meant by mutation?

.....

.....

(1)

(ii) Are all mutations harmful? Explain the reason for your answer.

.....

.....

.....

.....

(2)

(Total 7 marks)

Q20. Low light intensity is one factor that limits the yield of a crop.

In Britain, many tomato growers use artificial lights to increase the yield of tomato crops.

The table shows the amount of natural daylight and artificial lamplight received by a tomato crop grown in a greenhouse.

Month	Natural daylight received by tomato plant		Artificial lamplight given to tomato plant		Total light energy received by plant per day in J/cm^2	Percentage increase in growth resulting from artificial light
	Day length in hours	Light energy received by plant per day in J/cm^2	Hours of light given per day	Light energy received by plant per day in J/cm^2		
January	8.1	239	18	492	731	206
February	9.9	492	18	492	984	100
March	11.9	848	12	328	1176	39
April	13.9	1401	2	55	1456	4
May	15.5	1786	0	0	1786	0
June	16.6	1960	0	0	1960	0
July	16.2	1849	0	0	1849	0
August	14.7	1561	0	0	1561	0
September	12.8	1064	2	55	1119	5
October	10.6	614	11	301	915	49
November	8.8	288	18	492	780	171
December	7.6	183	18	492	675	269

(a) Describe the pattern for the amount of light energy received from natural daylight by a tomato plant during the day.

.....

.....

.....

.....

.....

.....

(3)

(b) A tomato plant needs 600 J of light energy per cm^2 each day to grow and produce tomatoes.

Use this information and data from the table to suggest an explanation for the pattern of the artificial light given to the tomato plants.

.....

.....

.....

.....

.....

.....

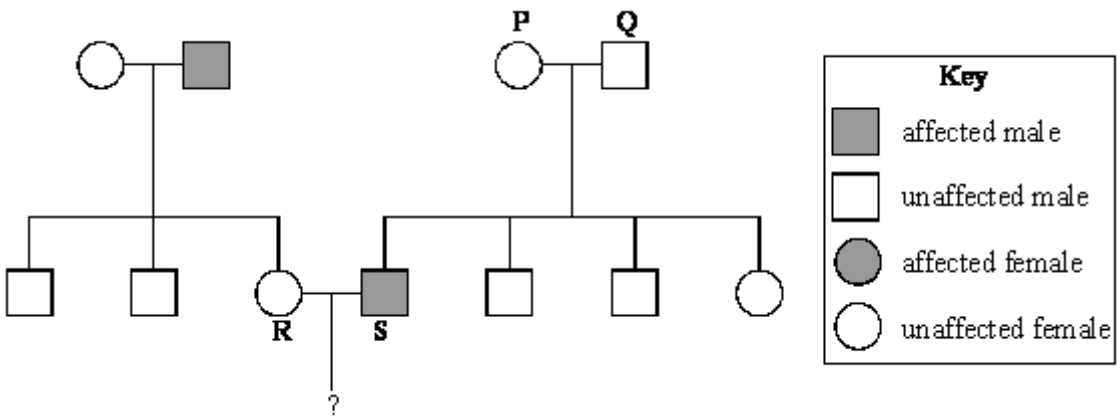
(2)
(Total 5 marks)

Q21. The black pigment in human skin and eyes is called melanin.

A single gene controls the production of melanin.

A person who is homozygous for the recessive allele of the gene has no melanin and is said to be albino.

The diagram shows the inheritance of albinism in a family.



(a) Use a genetic diagram to explain the inheritance of the albino allele by children of parents **P** and **Q**.

(3)

(b) **R** and **S** decide to have a child.

What is the chance that this child will be an albino? .....

Use a genetic diagram to explain your answer.

(3)
(Total 6 marks)

##

Read the passage.

Designer Denim Genes

USA scientists have successfully used genetic engineering to insert genes for blue pigment into cotton plants. Their aim is to get cotton plants which produce blue cotton so that denims can be manufactured without the need for dyeing. The scientists have also inserted genes that prevent cotton fibres twisting, with the aim of producing drip dry shirts made from natural fibres. Other cotton plants are being genetically engineered to produce their own insecticides. When they have perfected these new types of cotton plants, the scientists will use cloning techniques to produce large numbers of them.

(i) Name the substance in cells which carries genetic information.

.....

(1)

(ii) Explain how molecules of this substance control characteristics such as blue colour in cotton plants.

.....

.....

.....

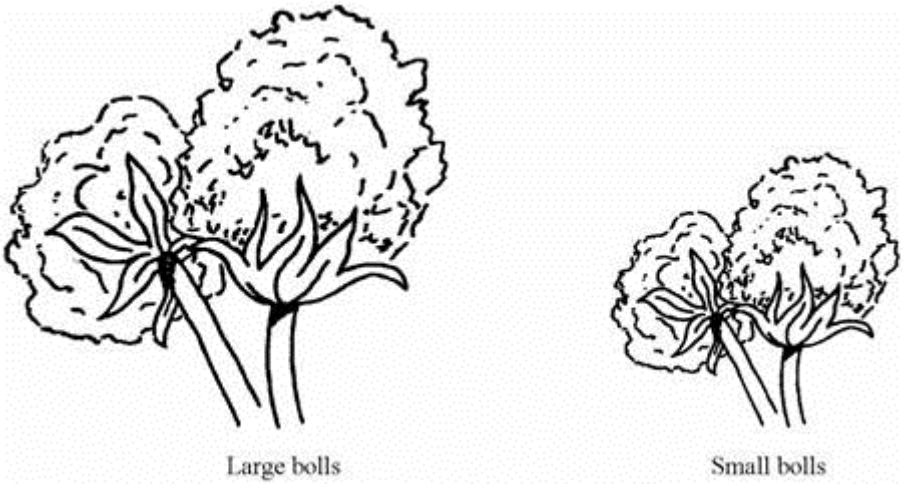
.....

.....

.....

(3)
(Total 4 marks)

Q23. The drawings show bolls on cotton plants. Cotton thread is made from these bolls.

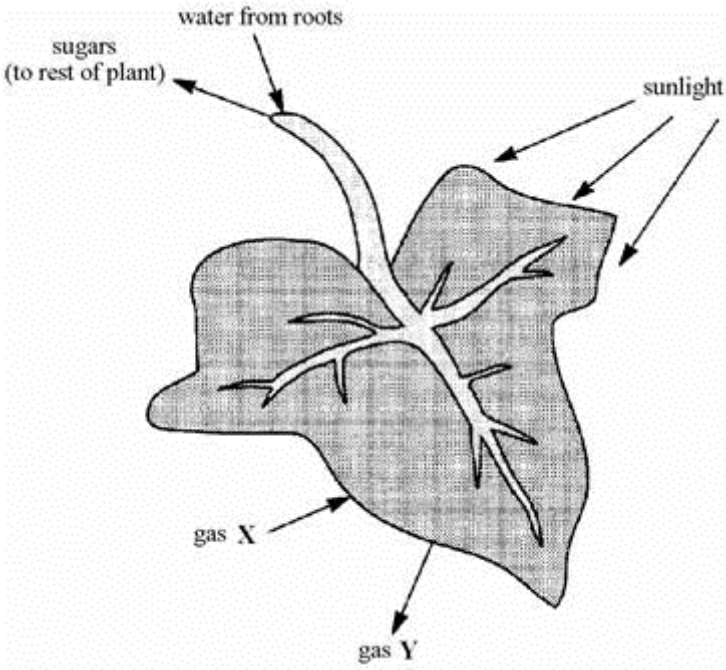


The size of the bolls is controlled by a single gene. This gene has two alleles. The dominant allele **B** is the allele for large bolls. The recessive allele **b** is the allele for small bolls.

Use a genetic diagram to show how two cotton plants with large bolls may produce a cotton plant with small bolls.

(Total 4 marks)

Q24. The diagram shows a plant leaf during photosynthesis.



(a) Name:

(i) gas **X**; .....

(ii) gas **Y**. .....

(2)

(b) Why is sunlight necessary for photosynthesis?

.....

.....

(1)

(c) Some of the sugars produced by photosynthesis are stored as starch in the roots. Explain, as fully as you can, why it is an advantage to the plant to store carbohydrate as starch rather than as sugar.

.....

.....

.....

.....

.....

.....

(3)
(Total 6 marks)

Q25. Describe the roles of the liver and the pancreas in the digestion of fats.

.....

.....

.....

.....

.....

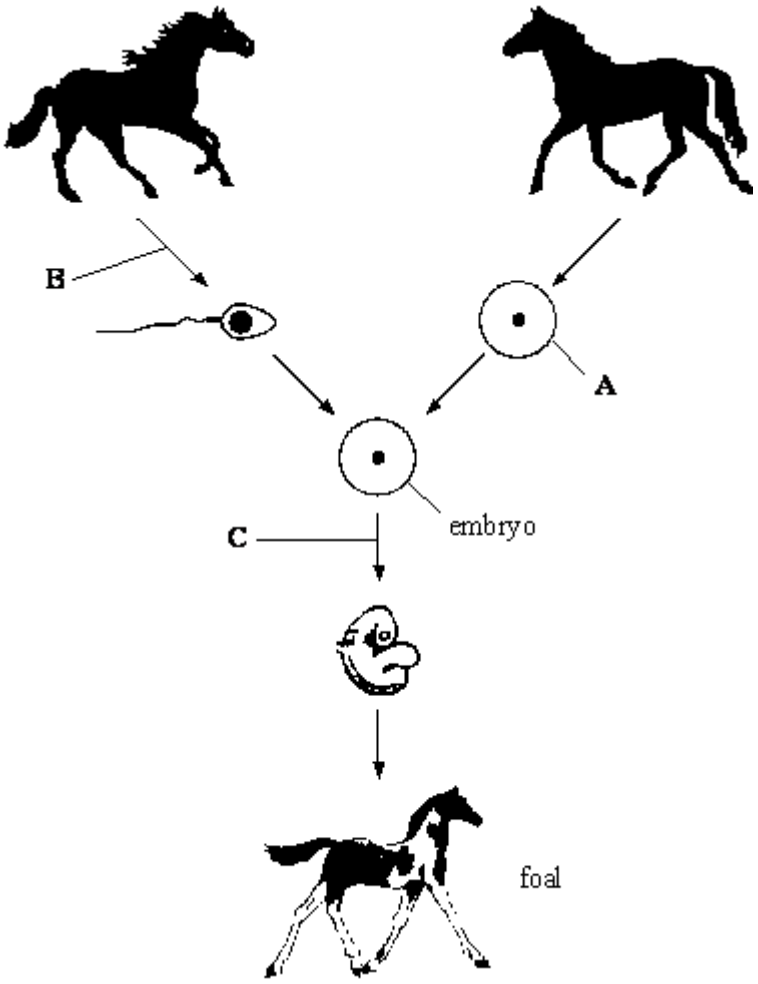
.....

.....

.....

(Total 5 marks)

Q26. The drawing shows some of the stages of reproduction in horses.



(a) (i) Name this type of reproduction .....

(1)

(ii) Name the type of cell labelled **A** .....

(1)

(b) Name the type of cell division taking place at the stage labelled:

(i) **B** .....

(ii) **C** .....

(2)

(c) How does the number of chromosomes in each cell of the embryo compare with the number of chromosomes in cell **A**?

.....

(1)

(d) When the foal grows up it will look similar to its parents but it will **not** be identical to either parent.

(i) Explain why it will look similar to its parents.

.....

.....

(1)

(ii) Explain why it will **not** be identical to either of its parents.

.....

.....

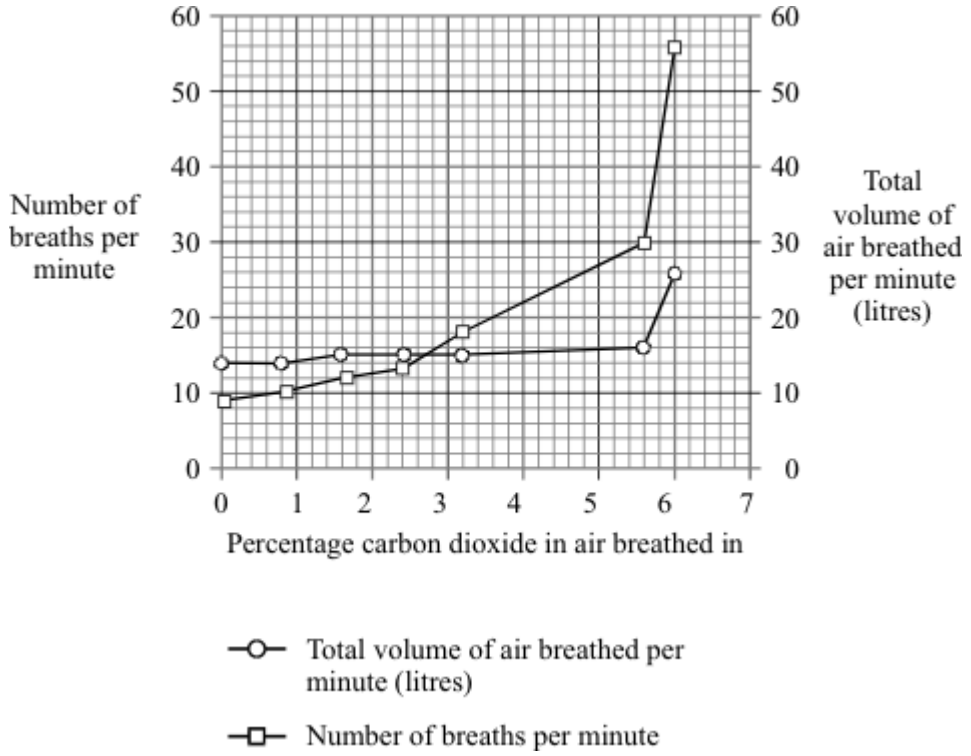
.....

(2)

(Total 8 marks)

Q27. The graph shows the effect of increasing the carbon dioxide content of the inhaled air on:

- the number of breaths per minute;
- the total volume of air breathed per minute.



(i) Describe the effect of increasing the percentage of carbon dioxide in the inhaled air on the total volume of air breathed.

.....

.....

.....

.....

(2)

(ii) Suggest why the total volume of inhaled air is **not** directly proportional to the number of breaths per minute.

.....

.....

.....

.....

(2)

(Total 4 marks)

Q28. The black pigment in human skin and eyes is called melanin. Production of melanin is controlled by a single pair of genes. A person who is homozygous for a recessive allele of the gene has no melanin and is said to be albino.

(a) A man is albino. His wife is heterozygous for the melanin-producing allele.

(i) The fertilised egg cell produced by the couple divides to form two cells.

Name the process of cell division involved.

.....

(1)

(ii) How many albino genes would there be in each of these two cells?

.....

Explain you answer.

.....

.....

.....

(3)

(b) (i) Albino people are more likely than people with melanin to suffer mutations that cause cancer in their skin. Suggest why albino people have an increased chance of mutation in their skin cells.

.....

.....

(1)

(ii) Sometimes, mutation in skin cells leads to cancers in other organs, such as the liver.

Explain how.

.....

.....

.....

.....

(2)
(Total 7 marks)

Q29. (a) A food contains protein. Describe, in as much detail as you can, what happens to this protein after the food is swallowed.

.....

.....

.....

.....

.....

.....

.....

.....

(4)

(b) The table shows the activity of lipase on fat in three different conditions.

CONDITION	UNITS OF LIPASE ACTIVITY PER MINUTE
Lipase + acid solution	3.3
Lipase + weak alkaline solution	15.3
Lipase + bile	14.5

Explain, as fully as you can, the results shown in the table.

.....

.....

.....

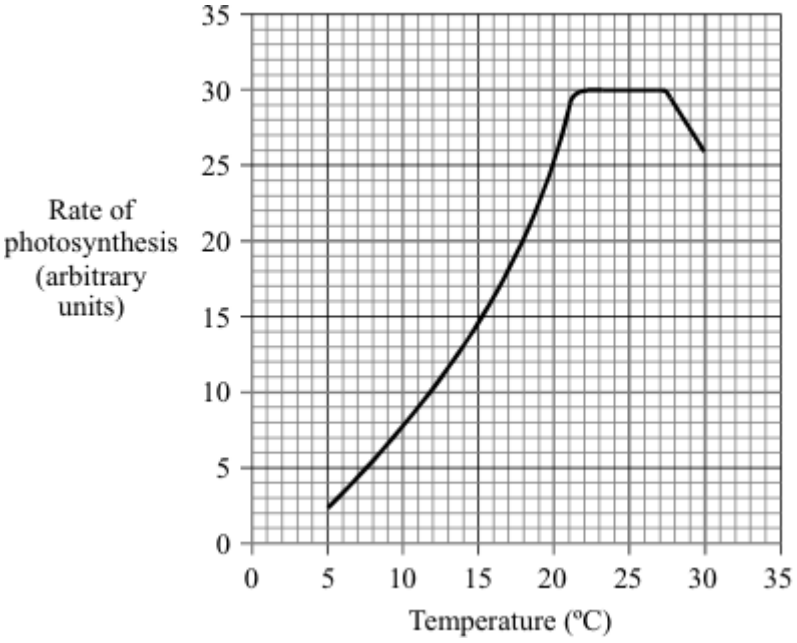
.....

.....

.....

(3)
(Total 7 marks)

Q30. The graph shows the effect of temperature on photosynthesis.



(a) Between which temperatures is the rate of photosynthesis fastest?

..... and ..... °C

(1)

(b) Suggest why the rate of photosynthesis stays the same between these two temperatures.

.....

.....

.....

.....

(2)

(c) A greenhouse owner wants to grow lettuces as quickly and cheaply as possible in winter.

At what temperature should he keep his greenhouse in order to grow the lettuces as quickly and cheaply as possible?

..... °C

Explain your answer.

.....

.....

.....

.....

(3)
(Total 6 marks)

Q31. Most people have a gene which produces a protein called CFTR that enables the cells lining the lungs to work efficiently. In people suffering from cystic fibrosis this gene is faulty; it produces a protein which lacks just one of the 1480 amino acids found in CFTR.

(i) Name the molecule which carries the genetic information for producing proteins such as CFTR.

.....

(1)

(ii) Explain how this molecule is responsible for the structure of proteins such as CFTR.

.....

.....

.....

.....

.....

.....

(3)
(Total 4 marks)

Q32. Read the extract.

Super-bug may hit the price of coffee

The coffee bean borer, a pest of the coffee crop, can be controlled by the pesticide endosulphan However, strains of the insect that are up to 100 times more resistant to the pesticide have emerged on the South Pacific island of New Caledonia.

For full resistance to be passed on to an offspring two copies of the new resistance allele should be inherited, one from each parent. There is much inbreeding with brother-sister matings happening in every generation, so it takes only a few generations before all the descendants of a single resistant female have inherited two copies of the resistance allele.

If this resistance spreads from New Caledonia, it will mean the loss of a major control method. This will present a serious threat to the international coffee industry.

(a) Suggest how the allele for resistance to endosulfan may have arisen.

.....

.....

(1)

(b) (i) How would you expect the proportion of normal coffee bean borers on New Caledonia to change over the next few years?

.....

(ii) Explain why this change will take place.

.....

.....

.....

.....

.....

.....

(3)

(c) Explain why “it takes only a few generations before all the descendants of a single resistant female have inherited two copies of the resistance allele.” (lines 6-8)

.....

.....

.....

.....

.....

.....

(3)
(Total 7 marks)

Q33. In an investigation four groups of athletes were studied. The maximum rate of oxygen consumption for each athlete was measured and the mean for each group was calculated. The athletes then ran 10 mile races and the mean of the best times was calculated for each group. The results are shown in the table below.

GROUP OF ATHLETES	MAXIMUM RATE OF OXYGEN CONSUMPTION (cm^3 per kg per min)	BEST TIME IN 10 MILE RACE (minutes)
A	78.6	48.9
B	67.5	55.1
C	63.0	58.7
D	57.4	64.6

(i) What is the relationship between maximum rate of oxygen consumption and time for a 10 mile race?

.....

.....

(1)

(ii) Suggest an explanation for this relationship.

.....

.....

.....

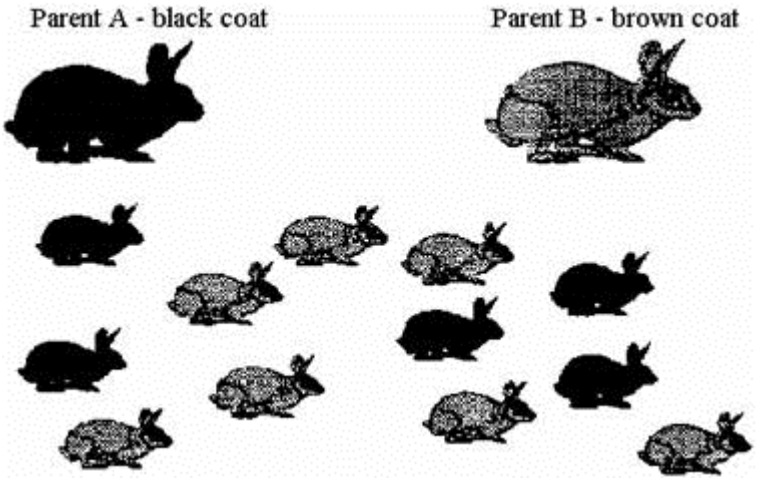
.....

.....

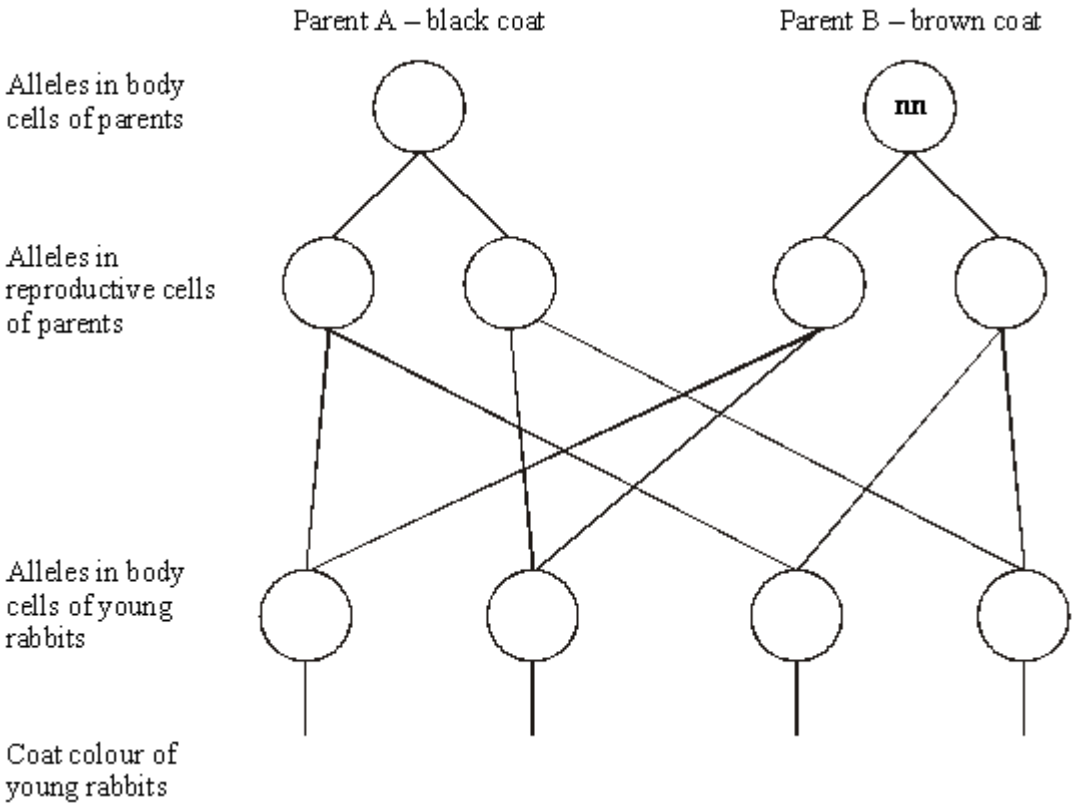
.....

(3)
(Total 4 marks)

Q34. Coat colour in rabbits is controlled by one pair of genes. The allele for black coat (**N**) is dominant to the allele for brown coat (**n**). The drawing shows the result of crossing a black-coated rabbit with a brown-coated rabbit.

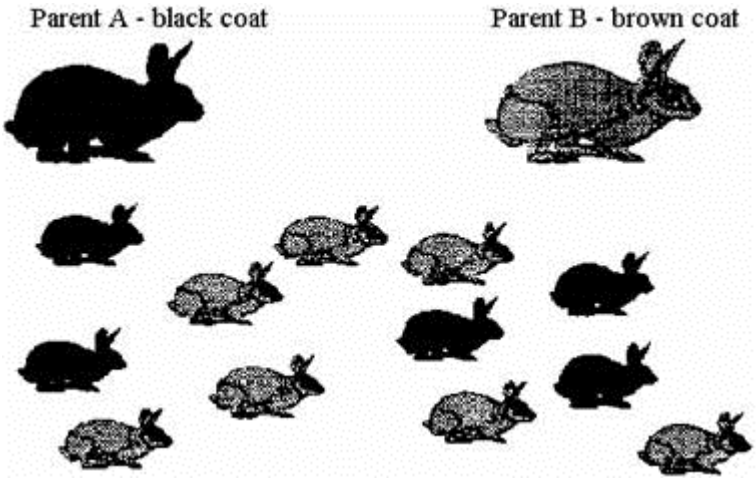


Complete the genetic diagram to show how the young rabbits inherited their coat colour. Use the symbols **N** and **n** for the alleles. The alleles of the brown parent have been inserted for you.

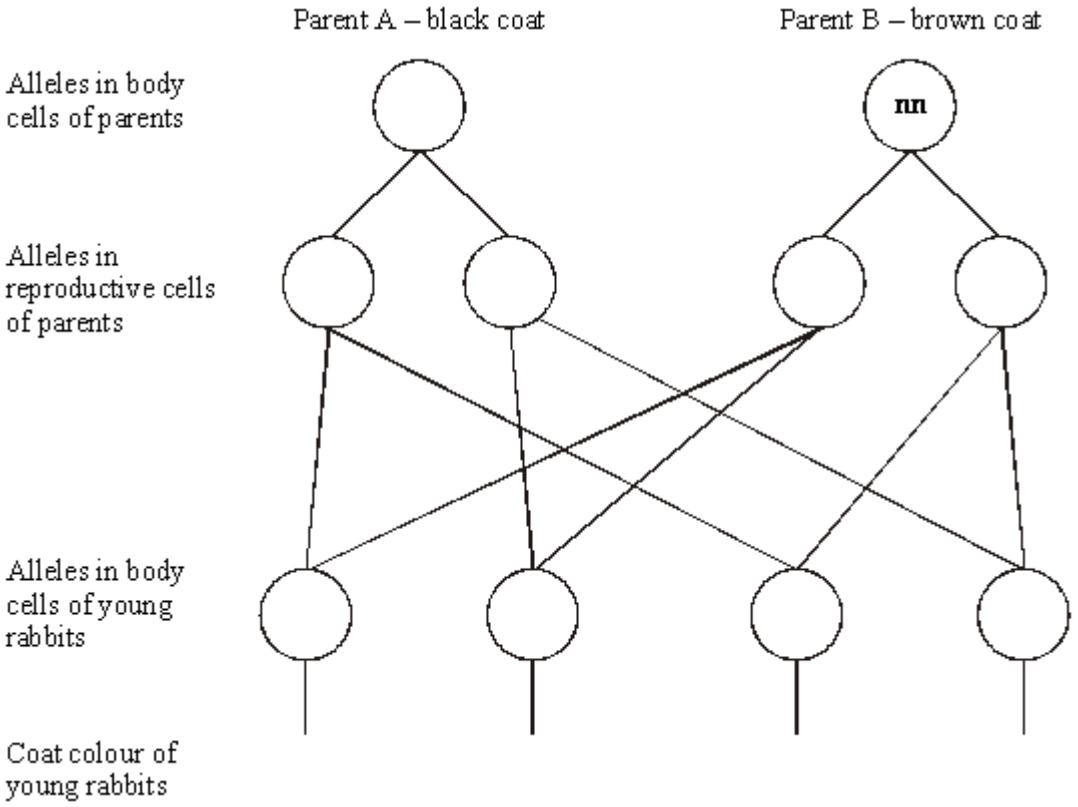


(Total 3 marks)

Q35. Coat colour in rabbits is controlled by one pair of genes. The allele for black coat (**N**) is dominant to the allele for brown coat (**n**). The drawing shows the result of crossing a black-coated rabbit with a brown-coated rabbit.



Complete the genetic diagram to show how the young rabbits inherited their coat colour. Use the symbols **N** and **n** for the alleles. The alleles of the brown parent have been inserted for you.



(Total 3 marks)