

**Q1.**

Cell division is needed for growth and for reproduction.

(a) The table below contains three statements about cell division.

Complete the table.

Tick **one** box for each statement.

Statement	Statement is true for		
	Mitosis only	Meiosis only	Both mitosis and meiosis
All cells produced are genetically identical			
In humans, at the end of cell division each cell contains 23 chromosomes			
Involves DNA replication			

(2)

Bluebell plants grow in woodlands in the UK.

- Bluebells can reproduce sexually by producing seeds.
  - Bluebells can also reproduce asexually by making new bulbs.
- (b) One advantage of asexual reproduction for bluebells is that only **one** parent is needed.

Suggest **two** other advantages of asexual reproduction for bluebells.

1. \_\_\_\_\_

\_\_\_\_\_

2. \_\_\_\_\_

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(2)

(c) Explain why sexual reproduction is an advantage for bluebells.

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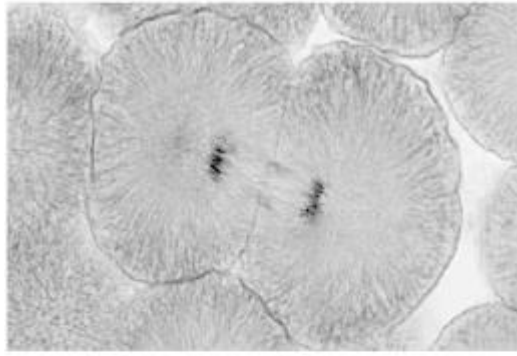
(4)  
(Total 8 marks)

**Q2.**

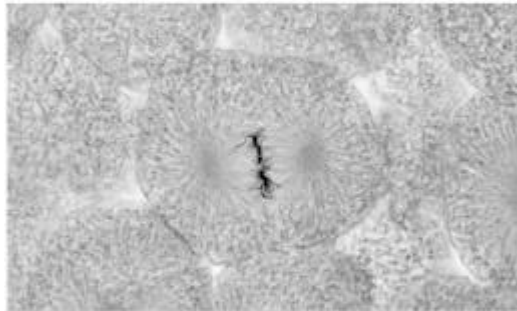
**Figure 1** shows photographs of some animal cells at different stages during the cell cycle.

**Figure 1**

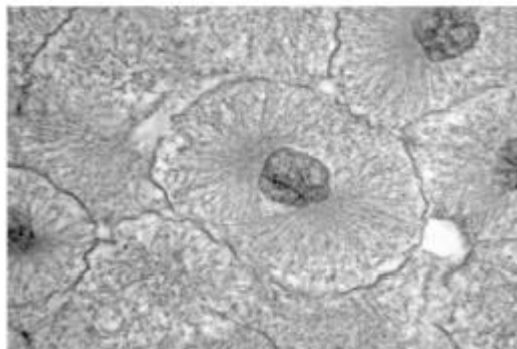
**A**



**B**



**C**



A © Ed Reschke/Photolibary/Getty Images  
B © Ed Reschke/Oxford Scientific/Getty Images  
C © Ed Reschke/Photolibary/Getty Images

(a) Which photograph in **Figure 1** shows a cell that is **not** going through mitosis?

Tick **one** box.

**A**     **B**     **C**

(1)

(b) Describe what is happening in photograph **A**.

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(2)

(c) A student wanted to find out more about the cell cycle.

The student made a slide of an onion root tip.

She counted the number of cells in each stage of the cell cycle in one field of view.

The table below shows the results.

		Stages in the cell cycle				
	Non-dividing cells	Stage 1	Stage 2	Stage 3	Stage 4	Total
Number of cells	20	9	4	2	1	36

Each stage of the cell cycle takes a different amount of time.

Which stage is the fastest in the cell cycle?

Give a reason for your answer.

Stage \_\_\_\_\_

Reason \_\_\_\_\_

(2)

(d) The cell cycle in an onion root tip cell takes 16 hours.

Calculate the length of time **Stage 2** lasts in a typical cell.

Give your answer to 2 significant figures.

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\_\_\_\_\_

\_\_\_\_\_

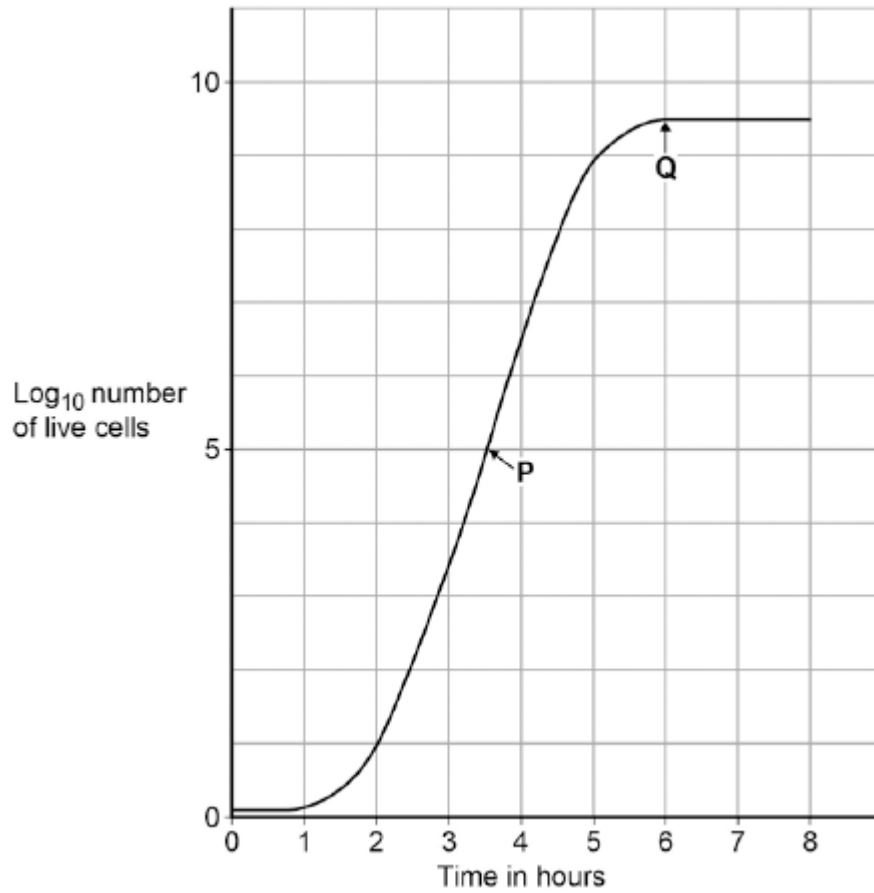
Time in **Stage 2** = \_\_\_\_\_ minutes

(3)

(e) Bacteria such as *Escherichia coli* undergo cell division similar to mitosis.

**Figure 2** shows a growth curve for *E. coli* grown in a nutrient broth.

**Figure 2**



What type of cell division causes the change in number of *E. coli* cells at **P**?

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(1)

(f) Suggest why the number of cells levels out at **Q**.

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(2)

(Total 11 marks)

**Q3.**

The heart pumps blood to the lungs and to the cells of the body.

(a) Name the blood vessel that transports blood from the body to the right atrium.

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(1)

(b) The aorta transports blood from the heart to the body.

In a person at rest:

- blood travels at a mean speed of 10 cm/s in the aorta
- blood travels at a mean speed of 0.5 mm/s in the capillaries
- the speed of blood decreases at a rate of 0.4 cm/s<sup>2</sup> as blood travels from the aorta to the capillaries.

Calculate the time it takes for blood to travel from the aorta to the capillaries.

Assume that the speed of blood decreases at a constant rate.

Use the equation:

$$\text{rate of decrease in speed} = \frac{\text{change in speed}}{\text{time}}$$

Give your answer to 2 significant figures.

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Time = \_\_\_\_\_ s

(4)

(c) Describe the route taken by oxygenated blood from the lungs to the body cells.

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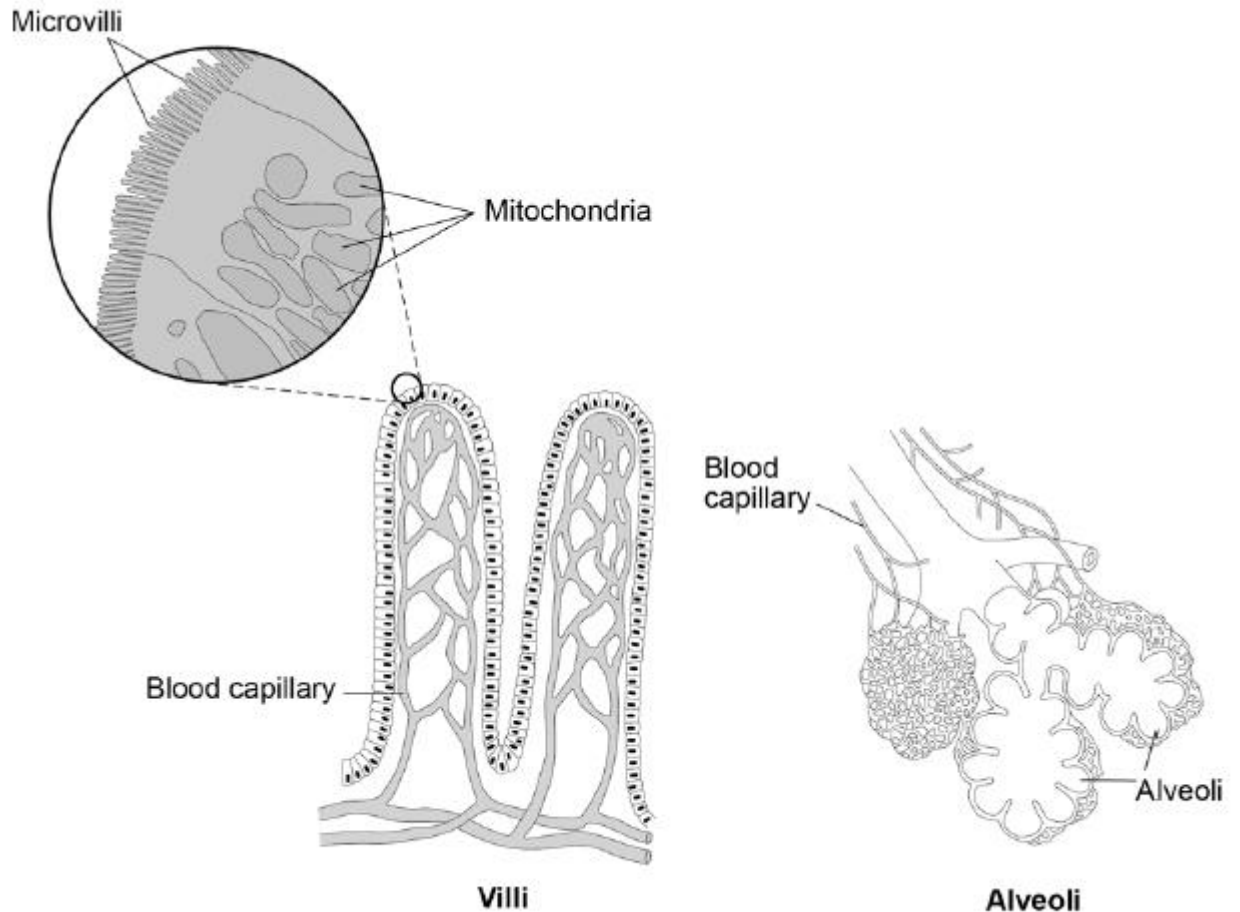
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(4)

(d) The digestive system and the breathing system both contain specialised exchange surfaces.

- In the digestive system, digested food is absorbed into the blood stream in structures called villi.
- In the breathing system, gases are absorbed into the blood stream in the alveoli.

The diagram below shows the structure of villi and alveoli.



Explain how the villi and the alveoli are adapted to absorb molecules into the bloodstream.

(6)  
(Total 15 marks)

**Q4.**

Explain how the human circulatory system is adapted to:

- supply oxygen to the tissues
- remove waste products from tissues.

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(Total 6 marks)

**Q5.**

The circulatory system contains arteries and veins.

- (a) (i) Describe how the structure of an artery is different from the structure of a vein.

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(2)

- (ii) A comparison is made between blood taken from an artery in the leg and blood taken from a vein in the leg.

Give **two** differences in the composition of the blood.

1. \_\_\_\_\_

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2. \_\_\_\_\_

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(2)

- (b) During operations patients can lose a lot of blood. Patients often need blood transfusions to keep them alive.

The text shows information about a new artificial blood product.



**Sea worms give hope for people in need of blood transfusions**

Scientists have carried out a five-year trial using a new artificial blood product. The scientists have used a protein from sea worms to create the new artificial blood and the results from the trial are very positive. Thousands of sea worms can be grown and collected.

During the trial, mice were given blood transfusions of the artificial blood. The bodies of the mice tolerated the artificial blood and the artificial blood did not cause any side effects.

Suggest **two** possible advantages of using the new artificial blood, instead of using human blood for a transfusion in humans.

1. \_\_\_\_\_  
\_\_\_\_\_
2. \_\_\_\_\_  
\_\_\_\_\_

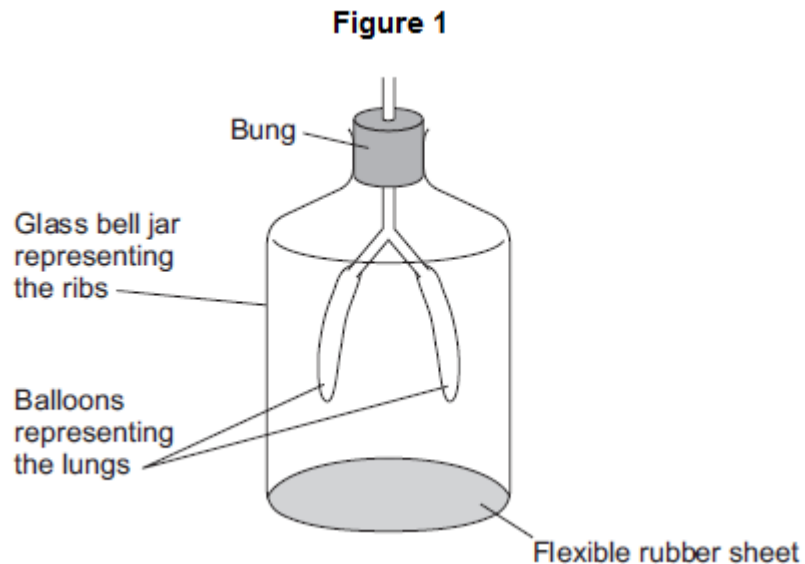
(2)

(Total 6 marks)

**Q6.**

**Figure 1** shows a model representing the human breathing system.

The different parts of the model represent different parts of the human breathing system.



- (a) (i) Which part of the human breathing system does the flexible rubber sheet represent?

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(1)

- (ii) Explain why the balloons inflate when the flexible rubber sheet is pulled down.

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(3)

(b) (i) During breathing, oxygen moves into the blood.

Explain how oxygen moves into the blood.

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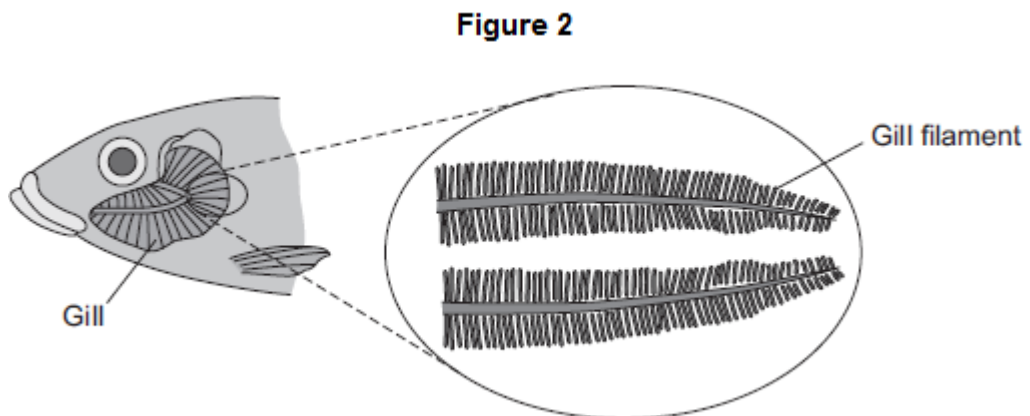
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(2)

(ii) **Figure 2** shows a fish head and gill.



Fish absorb oxygen from the water. Oxygen is absorbed through the gills of the fish.

Explain **one** way in which the gills are adapted for rapid absorption of oxygen.

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(2)

(Total 8 marks)

**Q7.**

The leaves of most plants have stomata.

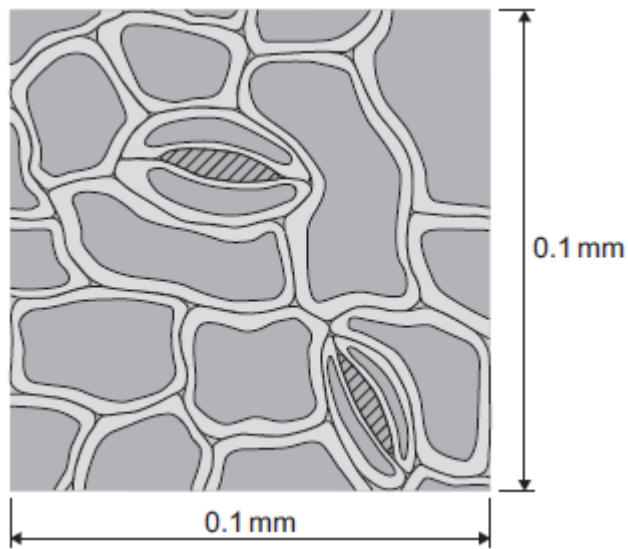
- (a) (i) Name the cells which control the size of the stomata.

\_\_\_\_\_ (1)

- (ii) Give **one** function of stomata.

\_\_\_\_\_  
\_\_\_\_\_ (1)

- (b) The image below shows part of the surface of a leaf.



The length and width of this piece of leaf surface are both 0.1 mm.

- (i) Calculate the number of stomata per  $\text{mm}^2$  of this leaf surface.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ per  $\text{mm}^2$  (2)

- (ii) A different plant species has 400 stomata per  $\text{mm}^2$  of leaf surface.

Having a large number of stomata per  $\text{mm}^2$  of leaf surface can be a disadvantage to a plant.

Give **one** disadvantage.

\_\_\_\_\_  
\_\_\_\_\_ (1)

(c) A student investigated the loss of water from plant leaves.

The student did the following:

- Step 1: took ten leaves from a plant
- Step 2: weighed all ten leaves
- Step 3: hung the leaves up in a classroom for 4 days
- Step 4: weighed all ten leaves again
- Step 5: calculated the mass of water lost by the leaves
- Step 6: repeated steps 1 to 5 with grease spread on the upper surfaces of the leaves
- Step 7: repeated steps 1 to 5 with grease spread on both the upper and lower surfaces of the leaves.

All the leaves were taken from the same type of plant.

The table below shows the student's results.

Treatment of leaves	Mass of water the leaves lost in g
No grease was used on the leaves	0.98
Grease on upper surfaces of the leaves	0.86
Grease on upper and lower surfaces of the leaves	0.01

(i) What mass of water was lost in 4 days through the upper surfaces of the leaves?

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Mass = \_\_\_\_\_ g

(1)

(ii) Very little water was lost when the lower surfaces of the leaves were covered in grease.

Explain why.

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(3)  
(Total 9 marks)

**Q8.**

Plants exchange substances with the environment.

- (a) Plant roots absorb water mainly by osmosis.  
Plant roots absorb ions mainly by active transport.

Explain why roots need to use the two different methods to absorb water and ions.

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(4)

- (b) What is meant by the *transpiration stream*?

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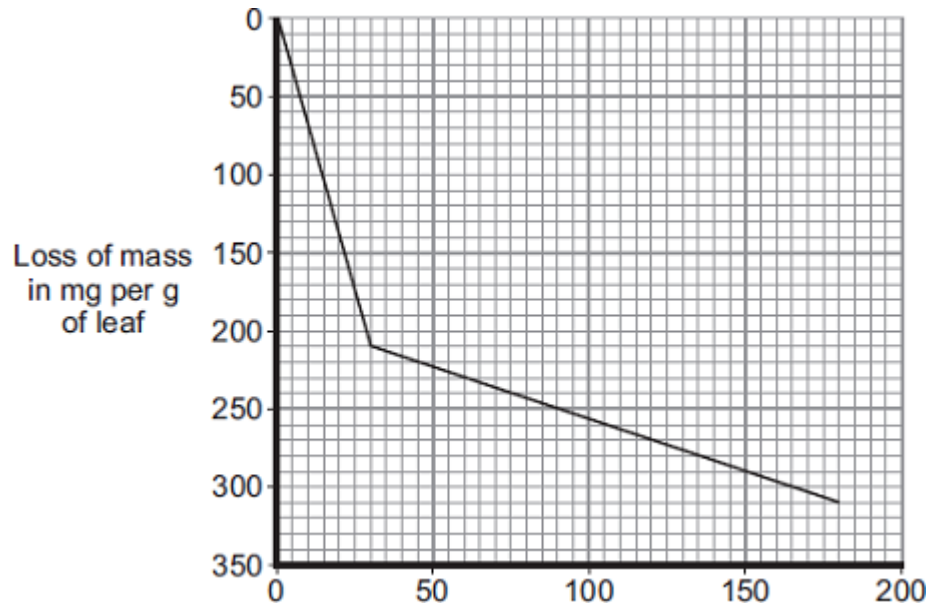
(3)

- (c) Students investigated the loss of water vapour from leaves.

The students:

- cut some leaves off a plant
- measured the mass of these leaves every 30 minutes for 180 minutes.

The graph shows the students' results.



- (i) The rate of mass loss in the first 30 minutes was 7 milligrams per gram of leaf per minute.

Calculate the rate of mass loss between 30 minutes and 180 minutes.

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Rate of mass loss = \_\_\_\_\_ milligrams per gram of leaf per minute

(2)

- (ii) The rate of mass loss between 0 and 30 minutes was very different from the rate of mass loss between 30 and 180 minutes.

Suggest an explanation for the difference between the two rates.

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(2)

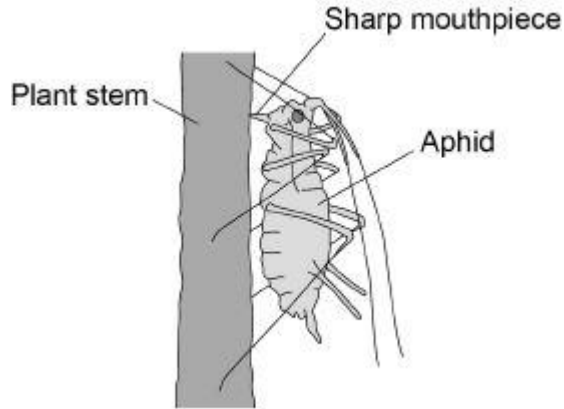
(Total 11 marks)

### Q9.

Plants can be infected by fungi, viruses and insects.

Aphids are small insects that carry pathogens.

The diagram below shows an aphid feeding from a plant stem.



- (a) An aphid feeds by inserting its sharp mouthpiece into the stem of a plant.

Give the reason why the mouthpiece of an aphid contains a high concentration of dissolved sugars after feeding.

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(1)

- (b) Plants infected with aphids may show symptoms of magnesium deficiency.

Magnesium deficiency symptoms include:

- yellow leaves
- stunted growth.

Explain how a deficiency of magnesium could cause these symptoms.

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(5)

(c) A farmer thinks a potato crop is infected with potato virus Y (PVY).

The farmer obtains a monoclonal antibody test kit for PVY.

To make the monoclonal antibodies a scientist first isolates the PVY protein from the virus.

Describe how the scientist would use the protein to produce the PVY monoclonal antibody.

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(4)  
(Total 10 marks)

**Q10.**

A student carried out an investigation using leaf epidermis.

This is the method used.

1. Peel the lower epidermis from the underside of a leaf.
2. Cut the epidermis into six equal sized pieces.
3. Place each piece of lower epidermis into a different Petri dish.
4. Add 5 cm<sup>3</sup> of salt solution to the six Petri dishes. Each Petri dish should have a different concentration of salt solution.
5. After 1 hour, view each piece of epidermis under a microscope at x400 magnification.
6. Count and record the total number of stomata present and the number of open stomata that can be seen in one field of view.

The student's results are shown in the table.

Concentration of salt	Number of stomata in	Number of open	Percentage (%) of open
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solution in mol / dm <sup>3</sup>	field of view	stomata in field of view	stomata in field of view
0.0	7	7	100
0.1	8	8	100
0.2	7	6	<b>X</b>
0.3	9	6	67
0.4	10	4	40
0.5	9	2	22

(a) Calculate value **X** in the table above.

\_\_\_\_\_

\_\_\_\_\_

**X** = \_\_\_\_\_ %

(1)

(b) Give **one** conclusion from the results in the table above.

\_\_\_\_\_

\_\_\_\_\_

(1)

(c) How could the student find out what concentration of salt solution would result in half of the stomata being open?

\_\_\_\_\_

\_\_\_\_\_

(1)

(d) The student measured the real diameter of the field of view to be 0.375 mm.

Calculate the number of open stomata per mm<sup>2</sup> of leaf for the epidermis placed in 0.4 mol / dm<sup>3</sup> salt solution.

Use information from the table above.

Take  $\pi$  to be 3.14

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\_\_\_\_\_

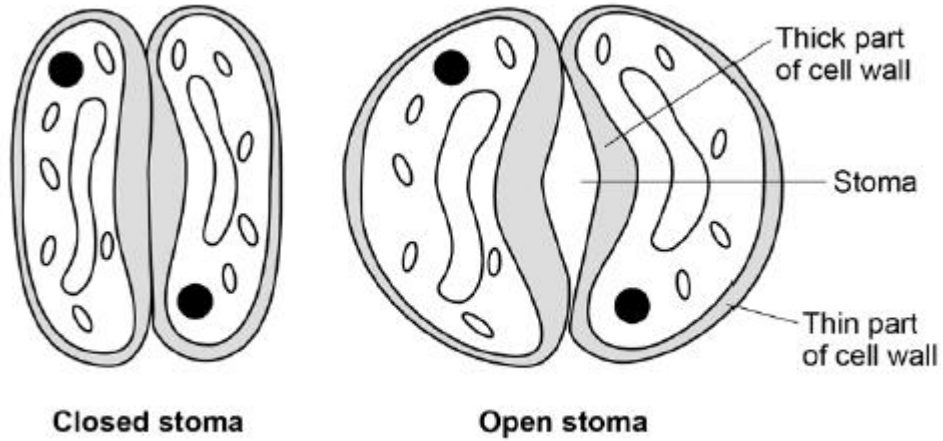
\_\_\_\_\_

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Number of open stomata = \_\_\_\_\_ per mm<sup>2</sup>

(3)

- (e) The diagram below shows two guard cells surrounding a closed stoma and two guard cells surrounding an open stoma.



When light intensity is high potassium ions are moved into the guard cells.

Describe how the movement of potassium ions into the guard cells causes the stoma to open.

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(4)

(Total 10 marks)

**Q11.**

People may be immunised against diseases using vaccines.

- (a) (i) Which part of the vaccine stimulates the body's defence system?

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(2)

- (ii) A person has been vaccinated against measles. The person comes in contact with the measles pathogen. The person does **not** catch measles.

Explain why.

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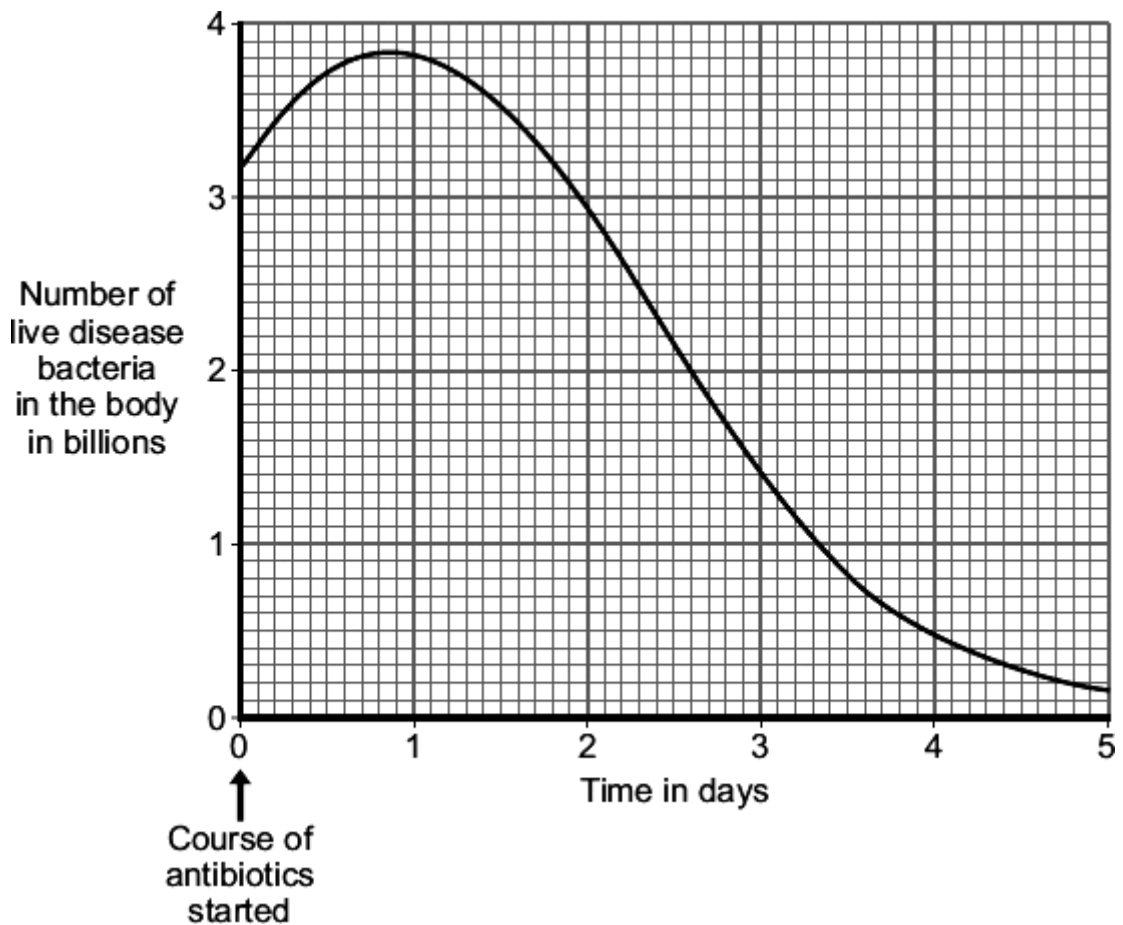
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(3)

- (b) A man catches a disease. The man has **not** been immunised against this disease. A doctor gives the man a course of antibiotics.

The graph shows how the number of live disease bacteria in the body changes when the man is taking the antibiotics.



- (i) Four days after starting the course of antibiotics the man feels well again. It is important that the man does **not** stop taking the antibiotics.

Explain why.

Use information from the graph.

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(2)

- (ii) Occasionally a new, resistant strain of a pathogen appears.

The new strain may spread rapidly.

Explain why.

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(3)

(Total 10 marks)

## Q12.

White blood cells protect the body against pathogens such as bacteria and viruses.

- (a) (i) Pathogens make us feel ill.

Give **one** reason why.

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(1)

- (ii) White blood cells produce antibodies. This is one way white blood cells protect us against pathogens.

Give **two** other ways that white blood cells protect us against pathogens.

1. \_\_\_\_\_  
\_\_\_\_\_
2. \_\_\_\_\_  
\_\_\_\_\_

(2)

(b) Vaccination can protect us from the diseases pathogens cause.

(i) One type of virus causes measles.

A doctor vaccinates a child against measles.

What does the doctor inject into the child to make the child immune to measles?

\_\_\_\_\_

\_\_\_\_\_

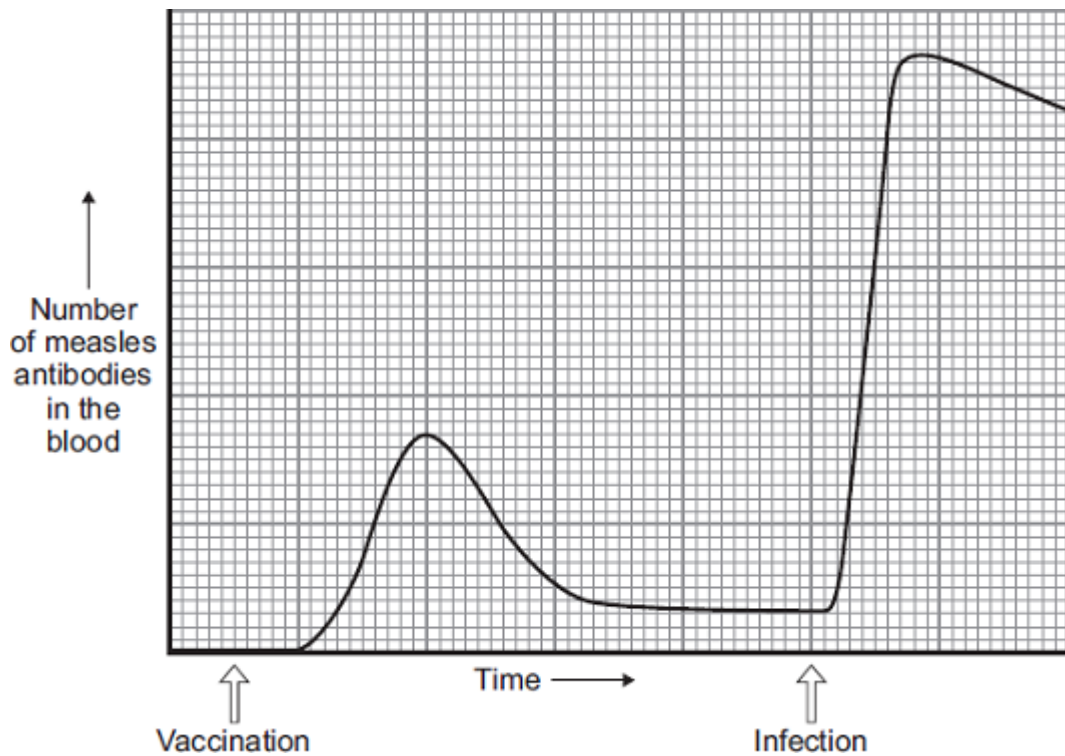
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\_\_\_\_\_

(2)

(ii) A few weeks after the vaccination, the child becomes infected with measles viruses from another person.

The graph shows the number of measles antibodies in the child's blood from before the vaccination until after the infection.



More measles antibodies are produced after the infection than after the

vaccination.

Describe other differences in antibody production after infection compared with after vaccination.

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(3)

(iii) Vaccination against the measles virus will **not** protect the child against the rubella virus.

Why?

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(1)

(c) What is the advantage of vaccinating a large proportion of the population against measles?

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(1)

(Total 10 marks)

**Q13.**

A virus called RSV causes severe respiratory disease.

(a) Suggest **two** precautions that a person with RSV could take to reduce the spread of the virus to other people.

1. \_\_\_\_\_

\_\_\_\_\_

2. \_\_\_\_\_

\_\_\_\_\_

(2)

(b) One treatment for RSV uses monoclonal antibodies which can be injected into the patient.

Scientists can produce monoclonal antibodies using mice.

The first step is to inject the virus into a mouse.

Describe the remaining steps in the procedure to produce monoclonal antibodies.

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(3)

(c) Describe how injecting a monoclonal antibody for RSV helps to treat a patient suffering with the disease.

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(2)

A trial was carried out to assess the effectiveness of using monoclonal antibodies to treat patients with RSV.

Some patients were given a placebo.

(d) Why were some patients given a placebo?

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(1)

A number of patients had to be admitted to hospital as they became so ill with RSV.

The results are shown in the table below.

<b>Treatment received by patient</b>	<b>% of patients within each group admitted to hospital with RSV</b>
Group <b>A</b> : Monoclonal antibody for RSV	4.8
Group <b>B</b> : Placebo	10.4

The trial involved 1 500 patients.

- Half of the patients (group **A**) were given the monoclonal antibodies.
- Half of the patients (group **B**) were given the placebo.

- (e) Calculate the total number of patients admitted to hospital with RSV during the trial.

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Total number of patients admitted to hospital = \_\_\_\_\_

(2)

- (f) Evaluate how well the data in the table above supports the conclusion:

‘monoclonal antibodies are more effective at treating RSV than a placebo’.

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(2)

(Total 12 marks)

#### Q14.

Some diseases can be cured by using antibiotics or prevented by vaccination.

- (a) (i) Explain fully why antibiotics cannot be used to cure viral diseases.

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(2)

- (ii) There has been a large increase in the populations of many antibiotic-resistant strains of bacteria in recent years.

Explain why.

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(2)

- (b) A person can be immunised against a disease by injecting them with an inactive



form of a pathogen.

Explain how this makes the person immune to the disease.

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(3)  
(Total 7 marks)

**Q15.**

**Figure 1** shows an image of a small section of DNA.

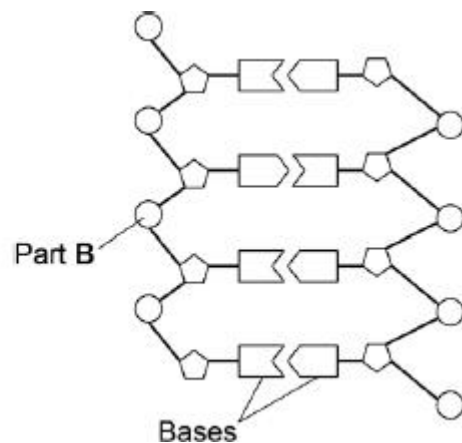
**Figure 2** shows the structure of a small section of DNA.

**Figure 1**



© Svisio/iStock/Thinkstock

**Figure 2**



(a) What is Part **B**?

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(1)

(b) In **Figure 1** the structure of DNA shows four different bases.

There are four different bases and they always pair up in the same pairs.

Which bases pair up together?

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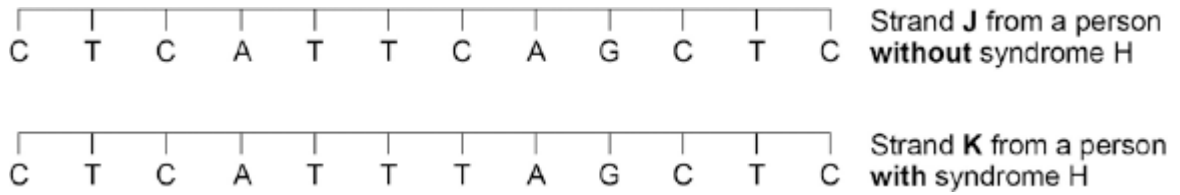
(1)

(c) Syndrome H is an inherited condition.

People with syndrome H do **not** produce the enzyme IDUA.

**Figure 3** shows part of the gene coding for the enzyme IDUA.

**Figure 3**



Strand **K** shows a mutation in the DNA which has caused syndrome H.

The enzyme IDUA helps to break down a carbohydrate in the human body.

The enzyme IDUA produced from Strand **K** will not work.

Explain how the mutation could cause the enzyme **not** to work.

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(5)

(d) A recessive allele causes syndrome H.

A heterozygous woman and a homozygous recessive man want to have a child.

Draw a Punnett square diagram to determine the probability of the child having syndrome H.

Identify any children with syndrome H.

Use the following symbols:

**A** = dominant allele

**a** = recessive allele

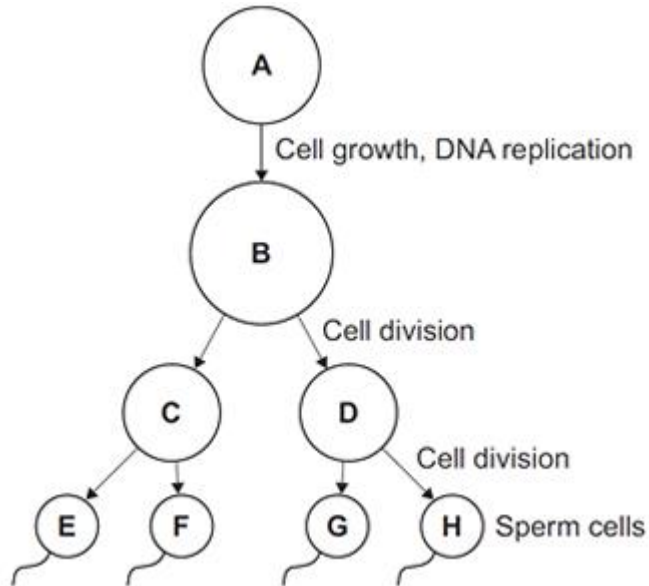
Probability = \_\_\_\_\_ %

(5)

(Total 12 marks)

**Q16.**

The diagram below shows the production of human sperm cells.



(a) Name the organ where the processes shown in the diagram above take place.

\_\_\_\_\_

(1)

(b) (i) Not every cell in the diagram above contains the same amount of DNA.

Cell **A** contains 6.6 picograms of DNA (1 picogram =  $10^{-12}$  grams).

How much DNA is there in each of the following cells?

Cell **B** \_\_\_\_\_ picograms

Cell **C** \_\_\_\_\_ picograms

Cell **E** \_\_\_\_\_ picograms

(2)

(ii) How much DNA would there be in a fertilised egg cell?

\_\_\_\_\_ picograms

(1)

(iii) A fertilised egg cell divides many times to form an embryo.

Name this type of cell division.

\_\_\_\_\_

(1)

(c) After a baby is born, stem cells may be collected from the umbilical cord. These can be frozen and stored for possible use in the future.

(i) What are stem cells?

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(2)

(ii) Suggest why it is ethically more acceptable to take stem cells from an umbilical cord instead of using stem cells from a 4-day-old embryo produced by In Vitro Fertilisation (IVF).

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(1)

(iii) Stem cells taken from a child's umbilical cord could be used to treat a condition later in that child's life.

Give **one** advantage of using the child's own umbilical cord stem cells instead of using stem cells donated from another person.

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(1)

(iv) Why would it **not** be possible to treat a genetic disorder in a child using his own umbilical cord stem cells?

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(1)

(Total 10 marks)

### Q17.

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).

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(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.

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(3)

(Total 7 marks)

**Q18.**

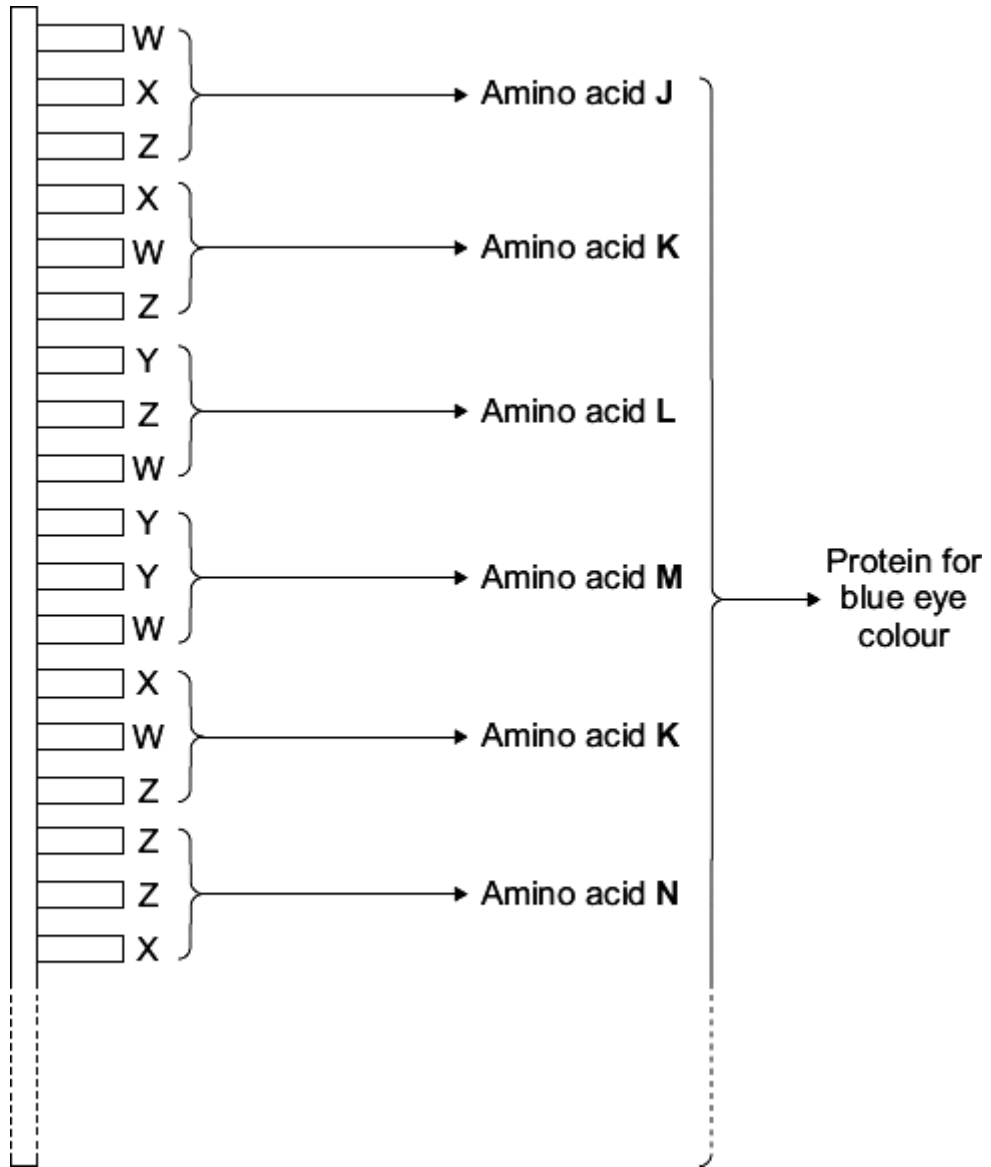
A molecule of DNA contains four different bases, **W**, **X**, **Y** and **Z**.

The four bases are arranged in a long chain.

The chain of bases controls the synthesis of a protein.

The diagram shows a small section of a DNA molecule.

This section is responsible for synthesising the protein for blue eye colour.



(a) What word is used to describe 'a small section of a DNA molecule that controls the synthesis of a protein'?

\_\_\_\_\_ (1)

(b) In the cell, where are proteins synthesised?

\_\_\_\_\_ (1)

(c) Describe how the protein for blue eye colour is synthesised.

To gain full marks you must use information from the diagram.

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(3)

(d) Mistakes sometimes occur when DNA molecules are copied during cell division.

Suppose that one of the **W** bases shown in the diagram was substituted by an **X** base.

(i) What would happen to the structure of the protein synthesised by this part of the DNA molecule?

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(1)

(ii) What might be the effect of this change in structure of the protein?

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(1)

(Total 7 marks)

**Q19.**

In South Asia, forests are being cleared to grow palm oil trees. The palm oil is mainly used to produce fuel for motor vehicles.

The graph shows the production of palm oil in one South Asian country.

