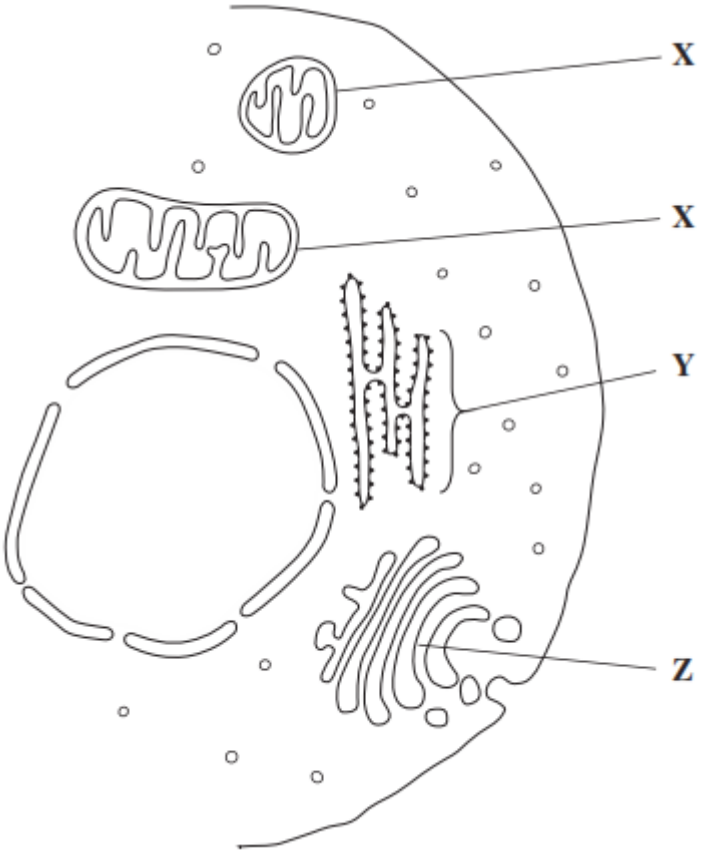
2.5 STUDYING CELLS 2 – QUESTIONS

Q1. The drawing shows part of a human cell.



(a) Name organelles

X _____

Y _____ **(2)**

(b) (i) The organelles labelled **X** all have very similar shapes in this cell.
Explain why they appear to have different shapes in this drawing.

_____

_____

(Extra space) _____

_____ **(1)**

(ii) Large numbers of organelles **X** and **Z** are found in mucus-secreting cells.
Explain why.

_____

_____

_____

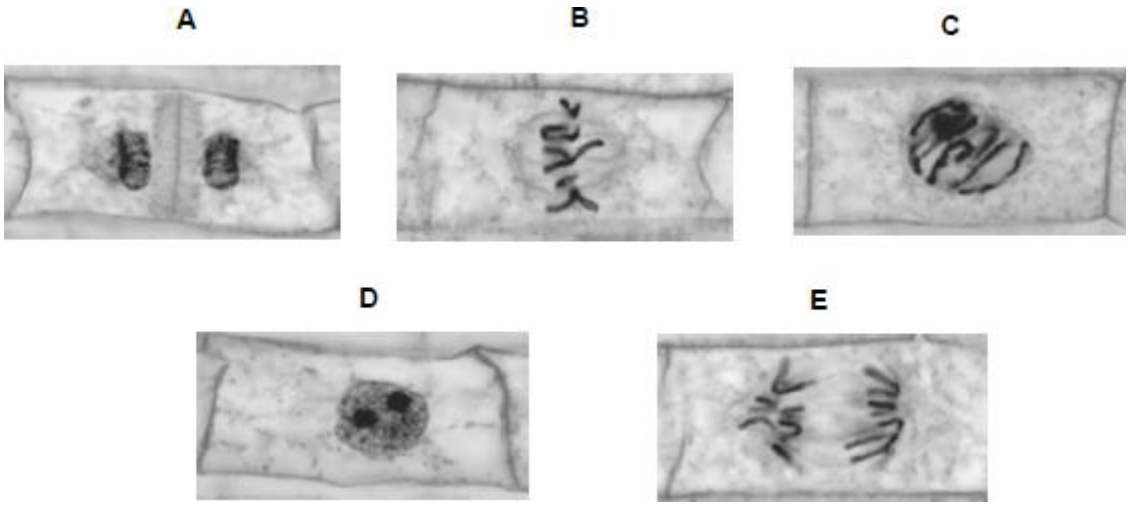
_____

(Extra space) _____

_____ **(2)**

(Total 5 marks)

Q2. The figure below shows some cells from an onion root tip at different stages of the cell cycle.



(a) Place stages **A** to **E** in the correct order. Start with stage **D**.

D

_____ **(1)**

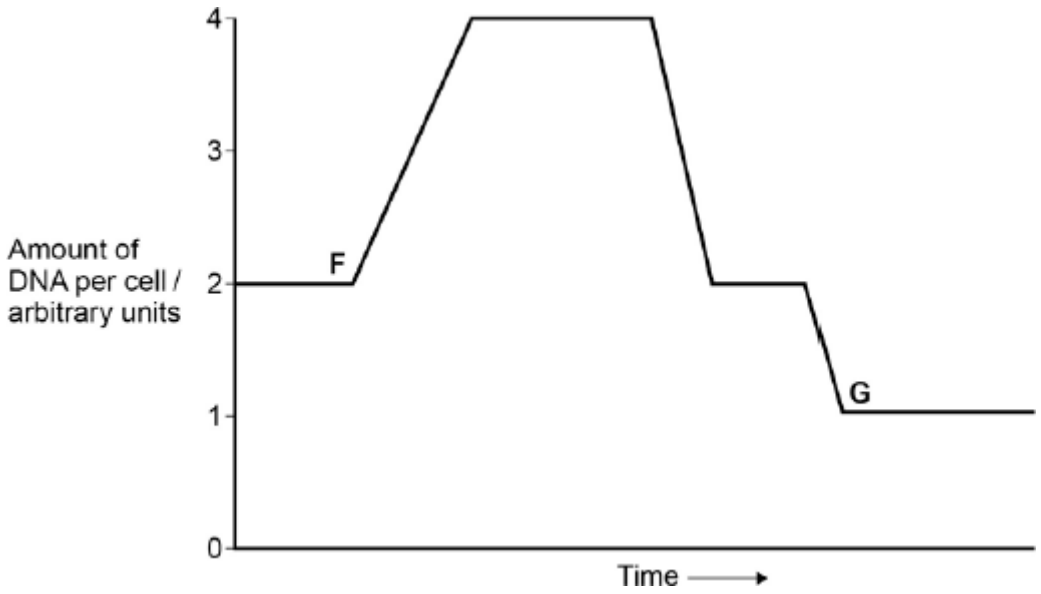
To obtain these images, the onion root tip was cut off, stained and put on a microscope slide. A cover slip was placed on top. The root tip was then firmly squashed and viewed under an optical microscope.

(b) Complete the table below to give **one** reason why each of these steps was necessary.

Step	Reason
Taking cells from the root tip	
Firmly squashing the root tip	

(2)

The figure below shows how the amount of DNA per cell changed during interphase and meiosis in an animal.



(c) Explain how the behaviour of chromosomes causes these changes in the amount of DNA per cell between **F** and **G**.

_____

_____

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(Extra space) _____

_____

_____ **(3)**

(d) What would happen to the amount of DNA per cell at fertilisation of cell **G?**

_____

_____ **(1)**

(Total 7 marks)

Q3. A student investigated the distribution of stomata on leaves from two species of plant. She removed small pieces from the lower surface of the leaves of each plant species. She mounted these pieces on separate microscope slides. She then counted the number of stomata in several parts of the epidermis on each piece of leaf tissue using an optical microscope.

(a) Suggest appropriate units the student should use to compare the distribution of stomata on leaves.

_____ **(1)**

(b) The pieces of leaf tissue examined were very thin.

Explain why this was important.

_____

_____

_____

_____

_____ **(2)**

(c) Give **two** reasons why it was important that the student counted the number of stomata in several parts of each piece of leaf tissue.

1. _____

_____

2. _____

_____ **(2)**

(d) One of the two plant species used by the student in this investigation was a xerophyte.

Other than the distribution of stomata, suggest and explain **two** xerophytic features the leaves of this plant might have.

1. _____

_____

2. _____

_____ **(2)**

(e) The student then compared the rate of transpiration (evaporation of water) from the two species of plant. She did this by measuring the rate of water uptake by each plant species.

Suggest **two** reasons why the rate of water uptake by a plant might not be the same as the rate of transpiration.

1. _____

_____

2. _____

_____ **(2)**

(Total 9 marks)

Q4. Researchers investigated whether the blood supply to slow and fast muscle fibres in a muscle changes with age. They used diaphragms taken from hamsters (*Mesocricetus auratus*). The diaphragm is in constant use for breathing. They took diaphragms from groups of young, adult and old hamsters.

They removed the diaphragm from each animal and took a sample of muscle tissue. They

examined it under an optical (light) microscope. For each sample they selected several fields of view at random. In each field of view, they then counted the number of capillaries associated with each type of muscle fibre.

This allowed the researchers to calculate the mean number of capillaries for each type of muscle fibre, for each age group.

The table below shows the researchers' results which include standard deviation (SD).

Hamster age group	**Number of hamsters in group**	**Mean number of capillaries associated with each type of muscle fibre**	
		Slow fibres (± SD)	**Fast fibres (± SD)**
Young	9	3.4 (±0.8)	4.0 (±0.8)
Adult	10	4.7 (±0.2)	6.3 (±0.4)
Old	8	4.6 (±0.9)	6.8 (±0.6)

(a) Give **four** precautions that the researchers took to make their calculations of mean number of capillaries per fibre reliable.

1. _____

_____

2. _____

_____

3. _____

_____

4. _____

_____ **(4)**

(b) The researchers examined the muscle of an animal in the **old** age group. They found one field of view containing only slow muscle fibres. They counted 69 capillaries in this field of view.

(i) Use a calculation to estimate how many slow muscle fibres were visible in this field of view. Show your working.

Number of slow muscle fibres = _____

(2)

(ii) The actual number of slow muscle fibres in the field of view was **not** the same as the number you calculated in question (i).

Give **one** reason why.

_____

_____

_____ **(1)**

(c) A student read the report of the researchers' investigation. She thought that the investigation was unethical but that a conclusion could still be made.

(i) Suggest why she thought the investigation was unethical.

_____

_____

_____ **(1)**

(ii) She concluded that age had a significant effect on the mean number of capillaries per fibre.

Evaluate this conclusion.

_____

_____

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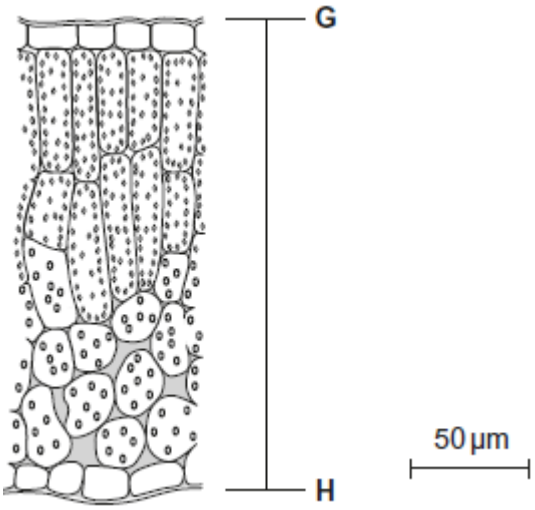
_____ **(4)**

(Total 12 marks)

Q5. A scientist examined the structure of mustard plant leaves. He viewed temporary mounts of leaf tissues with an optical microscope. The figure below shows a drawing of typical results.



(a) Describe how temporary mounts are made.

_____

_____

_____

_____

_____ **(2)**

(b) Calculate the distance in micrometres between **G** and **H** on the leaf.

Answer = _____ µm

(2)

(c) Describe how the scientist could have used the temporary mounts of leaves to determine the mean number of chloroplasts in mesophyll cells of a leaf.

_____

_____

_____

_____

_____

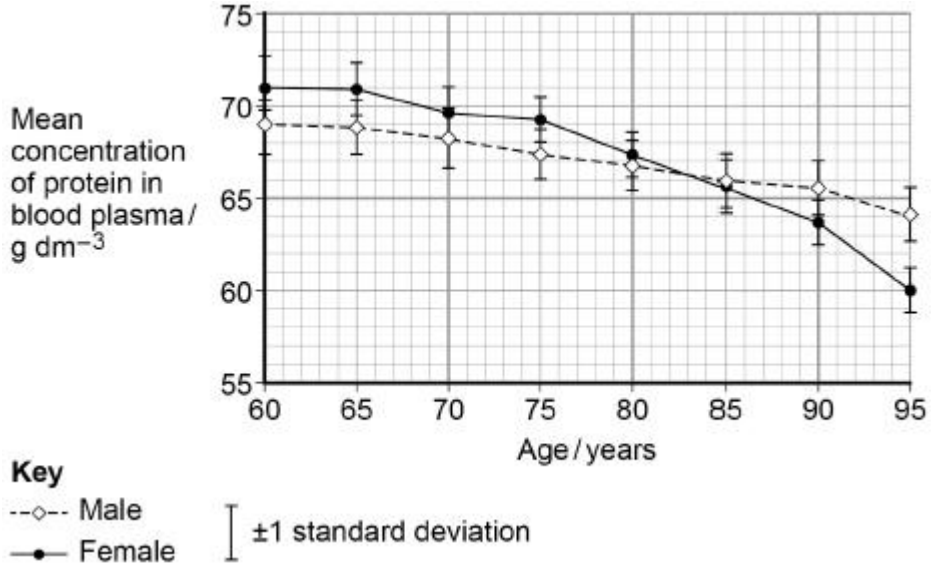
_____

_____ **(3)**

(Total 7 marks)

Q6. Scientists investigated how the concentration of protein in blood plasma changes in people between the ages of 60 and 95.

The graph shows the scientists' results. The bars show ±1 standard deviation.



(a) What is the difference between males and females in the fall in mean concentration of protein in blood plasma between 60 and 95 years?

Answer = _____ g dm^{-3}

(1)

(b) Use the graph above to calculate the rate of change of the mean concentration of protein in the blood plasma of males between the ages of 60 and 95.

Show your working.

Answer = _____ g dm^{-3} $year^{-1}$

(2)

(c) What can you conclude from the graph above about the effect of ageing on the mean concentration of protein in the blood plasma in males and females?

_____

_____

_____

_____

_____

_____ **(2)**

(d) The scientists measured the absorption of each sample of blood plasma using a colorimeter. They used a calibration curve to find the concentration of protein in samples of blood plasma.

Describe how the scientists could obtain data to produce a calibration curve and how they would use the calibration curve to find the concentration of protein in a sample of blood plasma.

_____

_____

_____

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_____

_____ **(3)**

(e) Older people are more likely to suffer from infectious diseases.

Suggest how this may be linked to the decrease in the mean concentration of protein in the blood as people get older.

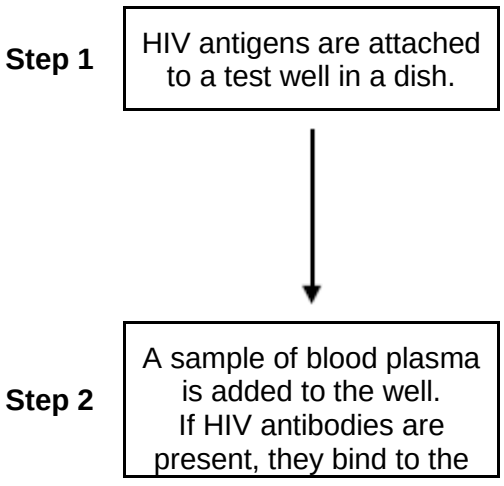
_____

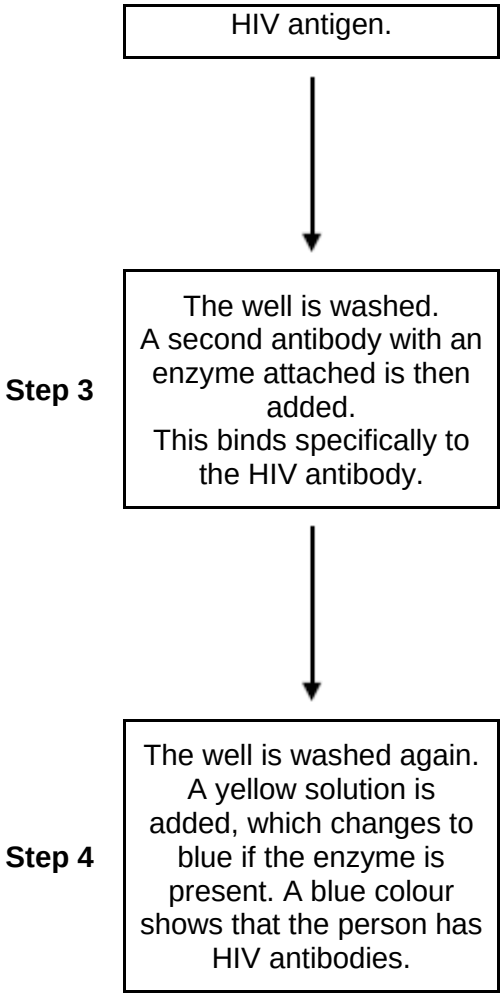
_____

_____ **(1)**

(Total 9 marks)

Q7. The figure below shows a test that has been developed to find out if a person has antibodies to the human immunodeficiency virus (HIV) antigen.





(a) This test only detects the presence of HIV antibodies. Give **two** reasons why it cannot be used to find out if a person has AIDS.

1. _____

_____

2. _____

_____ **(2)**

(b) The solution will remain yellow if a person is **not** infected with HIV. Explain why.

_____

_____

_____

_____ **(2)**

(c) A mother who was infected with HIV gave birth to a baby. The baby tested positive using this test. This does not prove the baby is infected with HIV.
Explain why.

_____

_____

_____

_____ **(2)**

(d) A control well is set up every time this test is used. This is treated in exactly the same way as the test wells, except that blood plasma is replaced by a salt solution.

Use information from the figure above to suggest **two** purposes of the control well.

1. _____

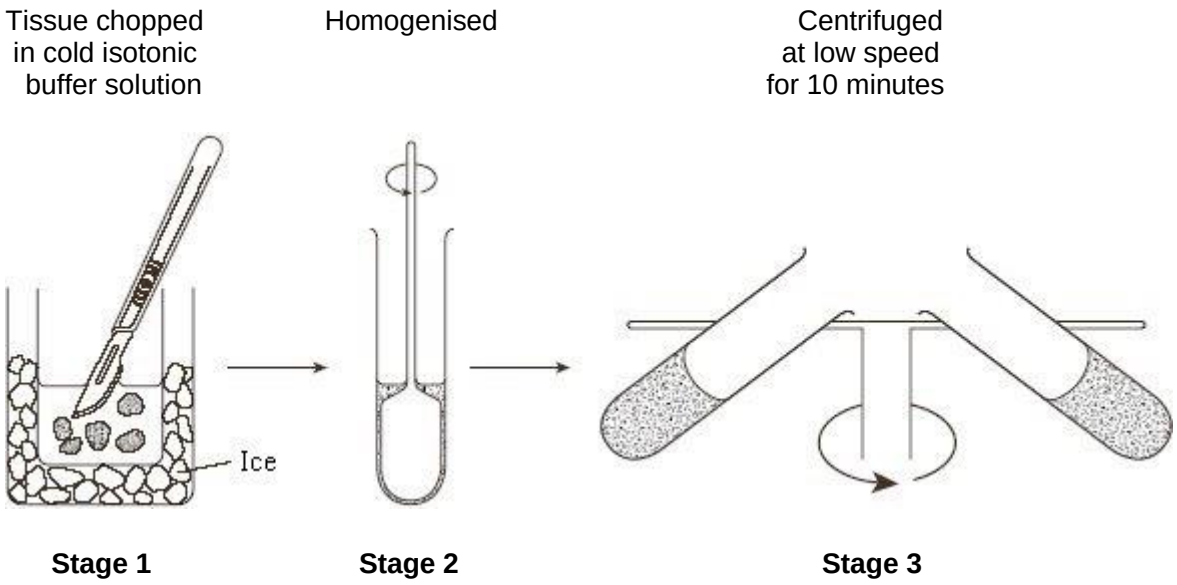
_____

2. _____

_____ **(2)**

(Total 8 marks)

Q8. Mitochondria were isolated from the liver tissue using differential centrifugation. The tissue was chopped in cold, isotonic buffer solution. A buffer solution maintains a constant pH. The first stages in the procedure are shown in the diagram.



(i) The tissue was chopped in cold, isotonic buffer solution. Explain the reason for using

a *cold* solution;

_____

_____

an *isotonic* solution;

_____

_____

a *buffer* solution.

_____

_____ **(3)**

(ii) Why is the liver tissue homogenised?

_____

_____ **(1)**

(iii) Describe what should be done after **Stage 3** to obtain a sample containing only mitochondria.

_____

_____

_____

_____ **(2)**

(Total 6 marks)

Q9. Read the following passage.

In a human, there are over 200 different types of cell clearly distinguishable from each other. What is more, many of these types include a number of different varieties. White blood cells, Wfor example, include lymphocytes and granulocytes.

Although different animal cells have many features in common, each type has adaptations. associated with its function in the organism. As an example, most cells contain the same organelles, but the number may differ from one type of cell to another. Muscle cells contain many mitochondria, while enzyme-secreting cells from salivary glands have particularly large amounts of rough endoplasmic reticulum.

The number of a particular kind of organelle may change during the life of the cell. An example of this change is provided by cells in the tail of a tadpole. As a tadpole matures into a frog, its tail is gradually absorbed until it disappears completely. Absorption is associated with an increase in the number of lysosomes in the cells of the tail.

Use information from the passage and your own knowledge to answer the following questions.

(a) Explain the link between.

(i) mitochondria and muscle cells (lines 6 - 7);

_____

_____

_____

_____

_____ **(3)**

(ii) rough endoplasmic reticulum and enzyme-secreting cells from salivary glands (lines 7 - 8).

_____

_____

_____

_____ **(2)**

(b) Use information in the passage to explain how a tadpole's tail is absorbed as a tadpole changes into a frog.

_____

_____

_____

_____ **(2)**

(c) Starting with some lettuce leaves, describe how you would obtain a sample of undamaged chloroplasts. Use your knowledge of cell fractionation and ultracentrifugation to answer this question.

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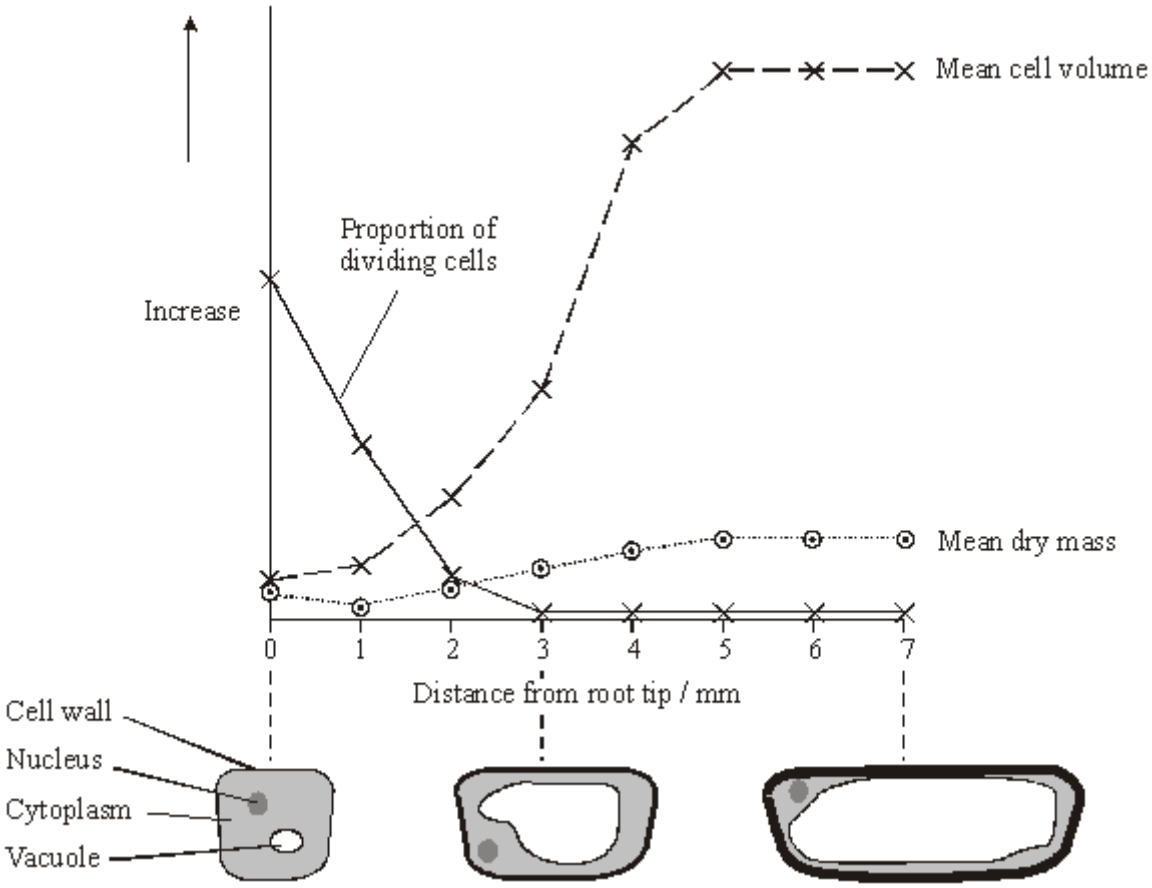
_____

_____ **(6)**

(Total 13 marks)

Q10. A large number of roots from many genetically identical bean plants were cut into short pieces. The pieces were sorted into groups, depending upon their distance from the root tip. Some pieces from each group were used to find the mean dry mass of their cells. Thin sections cut from other pieces were examined with a light microscope to find the proportion of dividing cells and the mean volume of the cells.

The graph shows the results. The diagrams below the graph show the appearance of cells in light microscope sections at different distances from the root tip.



(a) Suggest **two** variables, other than genotype, which need to be controlled to ensure similar root growth in different plants. In each case give the reason for your answer.

1. _____

_____

_____

2. _____

_____

_____ **(2)**

(b) Suggest how the proportion of dividing cells in a thin section could be determined.

_____

_____

_____

_____ **(2)**

(c) Explain the change in the proportion of dividing cells with increasing distance from the root tip.

_____

_____

_____

_____ **(2)**

(d) Using the graph and diagrams, suggest how a root tip gets longer.

_____

_____

_____

_____

_____

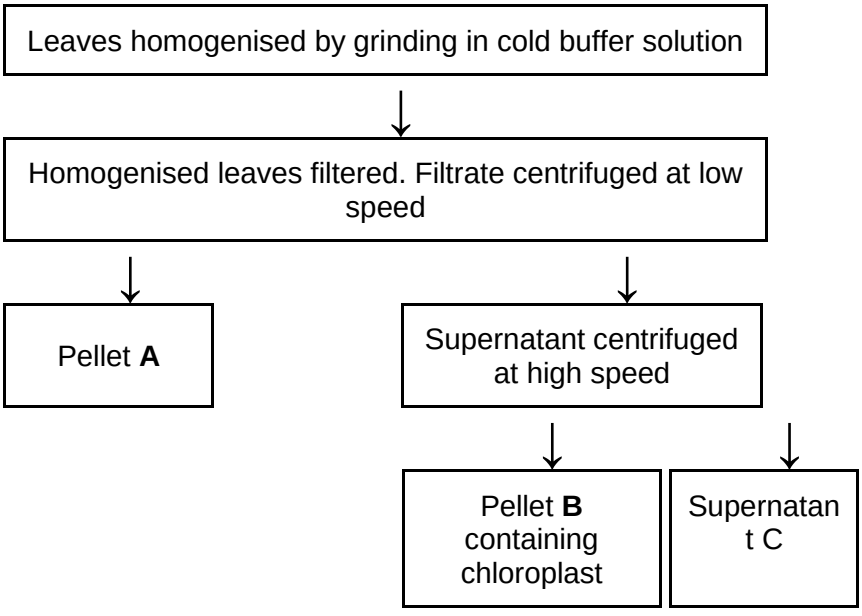
_____

_____

_____ **(3)**

(Total 9 marks)

Q11. The flowchart shows how chloroplasts may be obtained from leaves.



(a) In the first step in this procedure, the leaves were homogenised by grinding in cold buffer solution. Explain why

(i) the leaves were homogenised,

_____

_____ **(1)**

(ii) a buffer solution was used.

_____

_____

_____

_____ **(2)**

(b) The table shows some of the organelles present in the leaf cells.

Organelle	**X** 	**Y** 	**Z** 
Fraction containing organelle			

(i) Complete the table to show in which of pellet **A**, pellet **B** or supernatant **C** you would expect to find each of these organelles.

(2)

(ii) Organelle **X** is found in large numbers in cells which take up substances by active transport. Explain why.

_____

_____

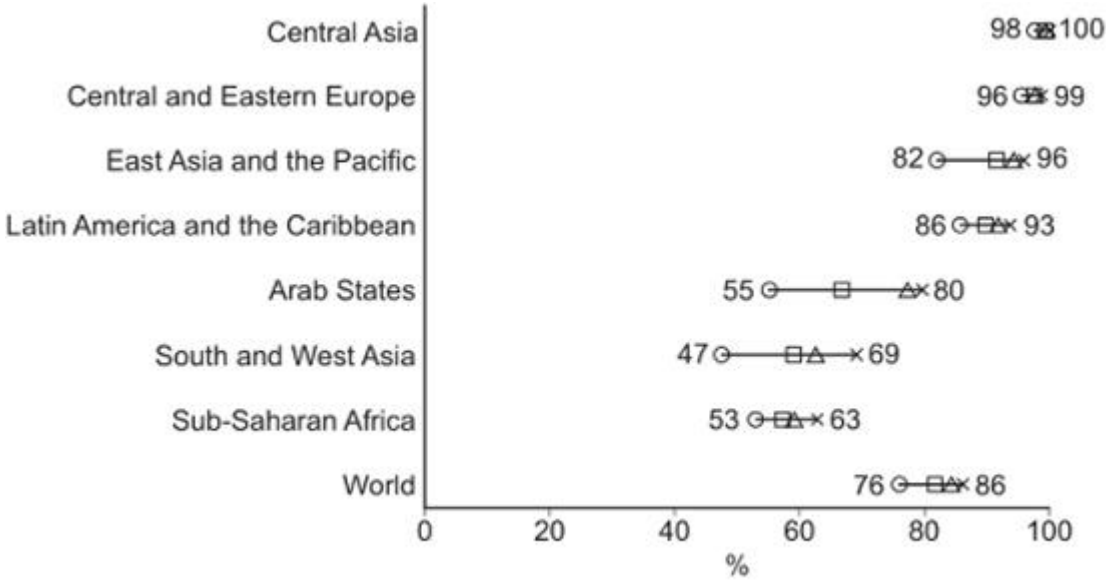
_____

_____

(2)

(Total 7 marks)

Q12. Liver was ground to produce a homogenate. The diagram shows how fractions containing different cell organelles were produced from the filtered homogenate.



(a) Explain why the homogenate was filtered before spinning at low speed in the centrifuge.

_____

_____

_____

_____ **(2)**

(b) The main organelles present in sediment **B** were mitochondria. Suggest the main organelles present in

(i) sediment **A**;

_____ **(1)**

(ii) sediment **C**.

_____ **(1)**

(c) What property of cell organelles allows them to be separated in this way?

_____

_____ **(1)**

(d) Explain why the organelles in sediment **C** could be seen with a transmission electron microscope but not with an optical microscope.

_____

_____

_____

_____ **(2)**

(Total 7 marks)

Q13. A stomach ulcer is caused by damage to the cells of the stomach lining. People with stomach ulcers often have the bacterium *Helicobacter pylori* in their stomachs.

A group of scientists was interested in trying to determine how infection by *H. pylori* results in the formation of stomach ulcers.

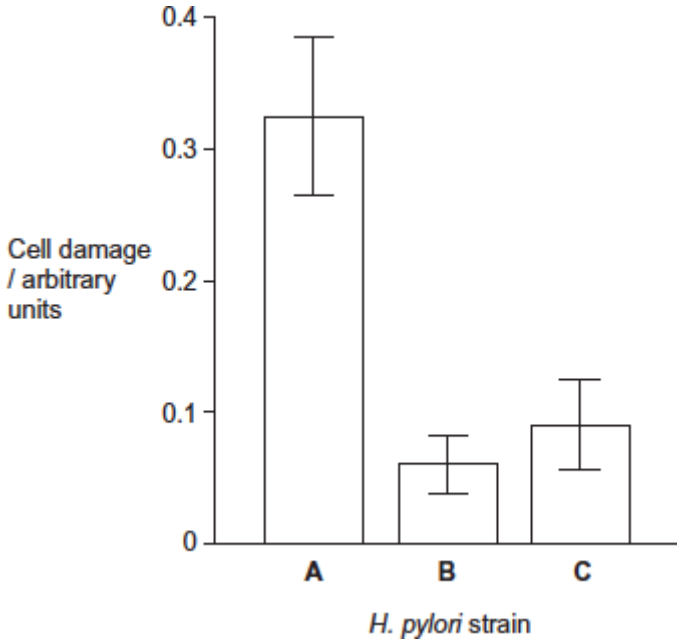
The scientists grew different strains of *H. pylori* in liquid culture.

The table below shows the substances released by each of these strains.

***H. pylori* strain**	**Substances released by the *H. pylori* cells**	
	Toxin	**Enzyme that neutralises acid**
A	✓	✓
B	×	✓
C	✓	×

The scientists centrifuged the cultures of each strain to obtain cell-free liquids. They added each liquid to a culture of human cells. They then recorded the amount of damage to the human cells.

Their results are shown below. The error bars show ± 1 standard deviation.



(a) Describe and explain how centrifuging the culture allowed the scientists to obtain a cell-free liquid.

_____

_____

_____

[Extra space]

(3)

(b) The scientists measured cell damage by measuring the activity of lysosomes.
Give **one** function of lysosomes.

(1)

(c) *H. pylori* cells produce an enzyme that neutralises acid.
Suggest **one** advantage to the *H. pylori* of producing this enzyme.

(2)

(d) What do these data suggest about the damage caused to human cells by the toxin and by the enzyme that neutralises acid?
Explain your answer.

[Extra space]

(3)

(e) The scientists carried out a further investigation. They treated the liquid from **strain A** with a protein-digesting enzyme before adding it to a culture of human cells. No cell damage was recorded.

Suggest why there was no damage to the cells.

_____

_____

_____

_____

_____

_____

[Extra space] _____

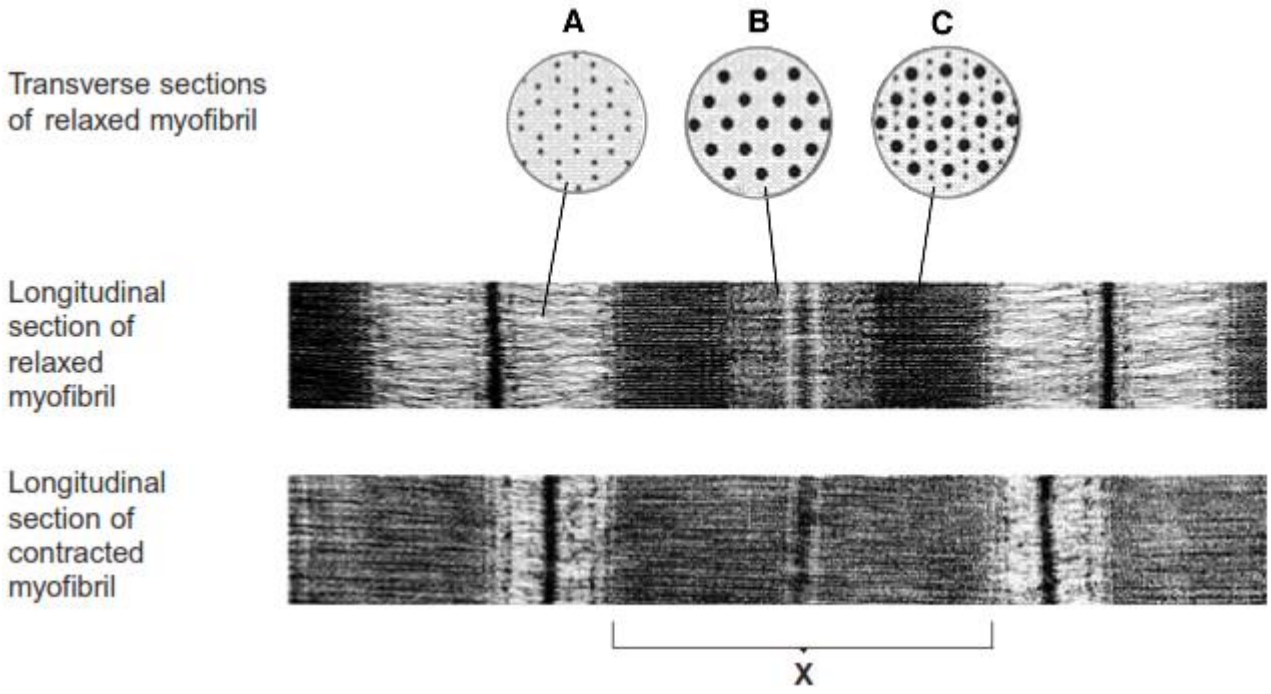
_____

_____ **(3)**

(Total 12 marks)

Q14. **Figure 1** shows sections through relaxed and contracted myofibrils of a skeletal muscle. The transverse sections are diagrams. The longitudinal sections are electron micrographs.

Figure 1



(a) (i) The electron micrographs are magnified 40 000 times.
Calculate the length of band **X** in micrometres.
Show your working.

Length of band **X** = _____ µm **(2)**

(ii) Explain the difference in appearance between transverse sections **A** and **C** in **Figure 1**.

_____

_____ **(1)**

(b) Explain what leads to the differences in appearance between the relaxed myofibril and the contracted myofibril.

_____

_____

_____

_____

_____

_____

_____

_____

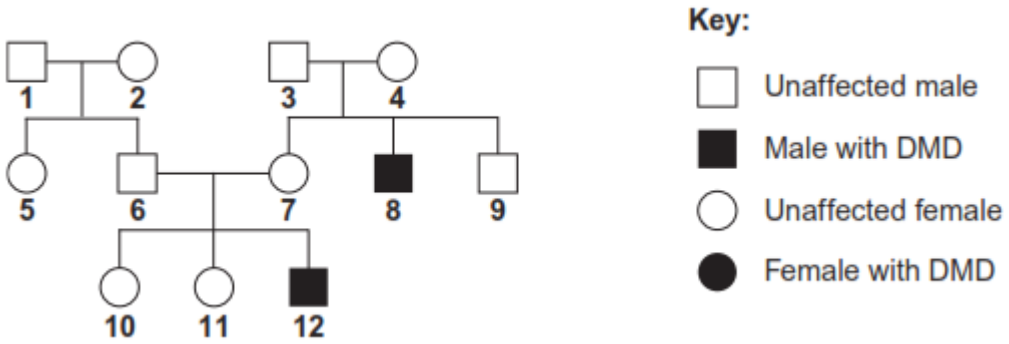
(*Extra space*) _____

_____

_____ **(4)**

(c) Duchenne muscular dystrophy (DMD) is a condition caused by the recessive allele of a sex-linked gene. A couple have a son with DMD. They want to know the probability that they could produce another child with DMD. They consulted a genetic counsellor who produced a diagram showing the inheritance of DMD in this family.
This is shown in **Figure 2**.

Figure 2



The couple who sought genetic counselling are persons **6** and **7**.

(i) Give the evidence to show that DMD is caused by a recessive allele.

_____

_____ **(1)**

(ii) Give the numbers of **two** people in **Figure 2** who are definitely carriers of muscular dystrophy.

_____ **(1)**

(iii) Complete the genetic diagram to find the probability that the next child of couple **6** and **7** will be a son with muscular dystrophy. Use the following symbols:

$\mathbf{X^D}$ = normal X chromosome
$\mathbf{X^d}$ = X chromosome carrying the allele for muscular dystrophy
Y = normal Y chromosome

	6	**7**
Parental phenotypes	Unaffected	Unaffected
Parental genotypes	_____	_____
Gametes	_____	_____

Offspring genotypes _____

Offspring phenotypes _____

Probability of having a son with DMD _____ **(4)**

(d) DMD is caused by a deletion mutation in the gene for a muscle protein called dystrophin. A deletion is where part of the DNA sequence of a gene is lost. People in different families may inherit mutations in different regions of this gene.

Scientists isolated the dystrophin gene from DNA samples taken from children **10**, **11** and **12**. They cut the gene into fragments using an enzyme. The scientists then used two DNA probes to identify the presence or absence of two of these fragments, called **F** and **G**. This allowed them to find the number of copies of each fragment in the DNA of a single cell from each child.

The table shows their results.

Child	**Number of copies of gene fragment per cell**	
	F	**G**
10 (unaffected girl)	2	1
11 (unaffected girl)	2	2
12 (boy with DMD)	1	0

(i) The number of copies of gene fragments **F** and **G** shows that person **12** has DMD. Explain how.

_____

_____ **(1)**

(ii) The number of copies of gene fragments **F** and **G** shows that person **12** is male. Explain how.

_____

_____

_____

_____ **(2)**

(iii) The genetic counsellor examined the scientists' results. He concluded that person **10** is a carrier of DMD but her sister, **11**, is not.

Describe and explain the evidence for this in the table.

_____

_____

_____

_____

_____

_____

(*Extra space*) _____

_____

_____ **(3)**

(e) Person **12** took part in a trial of a new technique to help people with DMD.

Doctors took muscle cells from person **12**'s father and grew them in tissue culture.

They suspended samples of the cultured cells in salt solution and injected them into a muscle in person **12**'s left leg. They injected an equal volume of salt solution into the corresponding muscle in his right leg. Person **12** was given drugs to suppress his immune system throughout the trial.

Four weeks later, the doctors removed a muscle sample from near the injection site in each leg. They treated these samples with fluorescent antibodies. These antibodies were specific for the polypeptide coded for by gene fragment **G** of the dystrophin gene.

The results are shown in the table.

Location and treatment	Percentage of muscle fibres labelled with antibody
Left leg - injected with cultured cells suspended in salt solution	6.8
Right leg - injected with salt solution	0.0

(i) Why was it necessary to treat person **12** with drugs to suppress his immune system?

_____

_____ **(1)**

(ii) Explain why salt solution was injected into one leg and cultured cells suspended in salt solution into the other.

_____

_____

_____ **(1)**

(iii) This technique is at an early stage in its development. The doctors suggested that further investigations need to be carried out to assess its usefulness for treating people with DMD.

Explain why they made this suggestion.

_____

_____

_____

_____

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_____

(*Extra space*) _____

_____

_____

_____ **(4)**

(Total 25 marks)