EXAM PAPERS PRACTICE

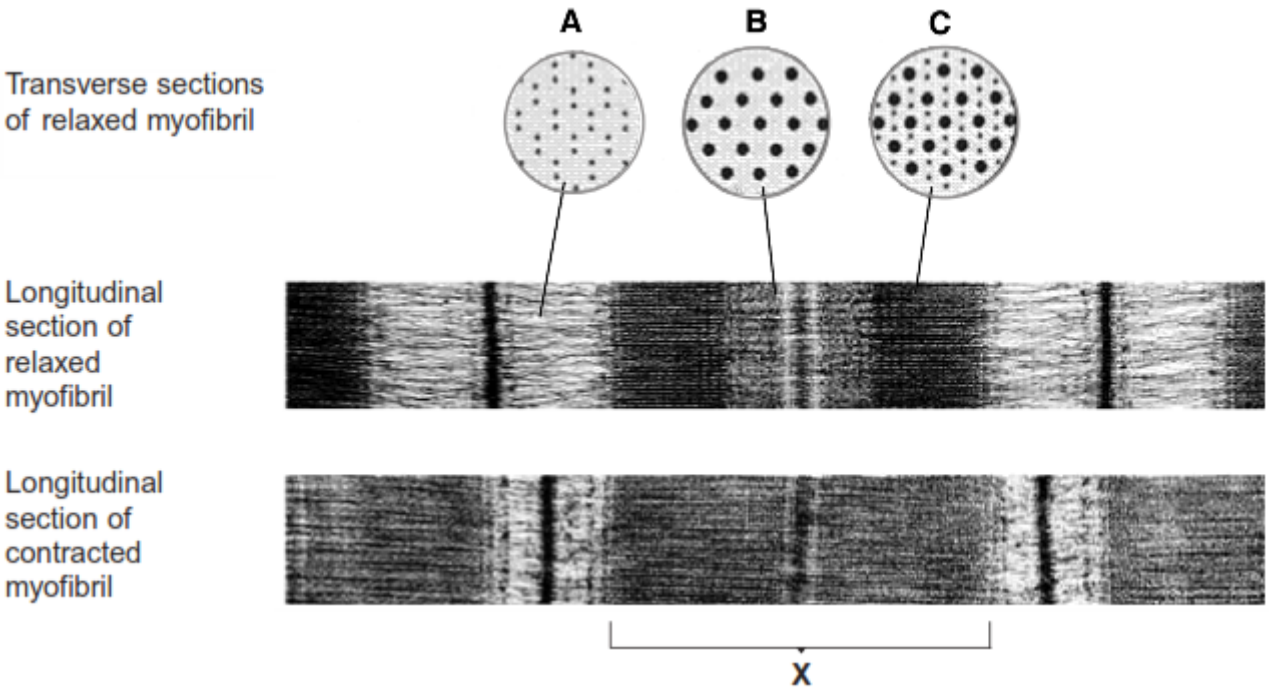
Studying cells 2

Level: AQA AS 7401
Subject: Biology
Exam Board: Suitable for all boards
Topic: Studying cells 2
Type: Questionnaire

To be used by all students preparing for AQA AS Biology 7401 foundation or higher tier but also suitable for students of other boards.

1 **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)

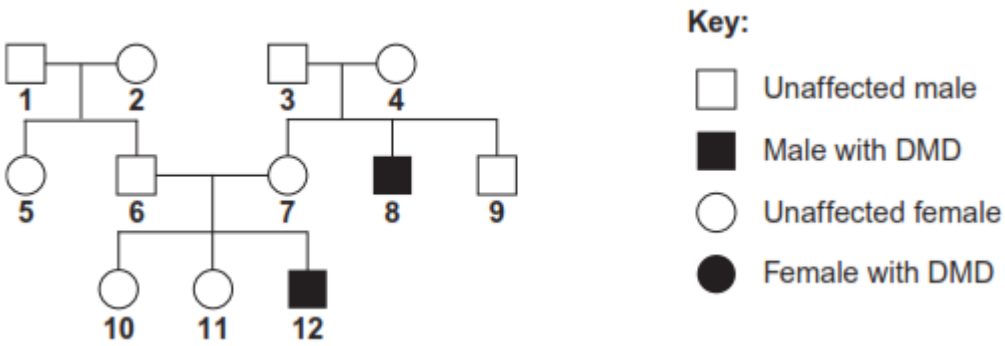
(b) Explain what leads to the differences in appearance between the relaxed myofibril and the contracted myofibril.

(*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:

X^D = normal X chromosome
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.

(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.

(*Extra space*) _____

(4)

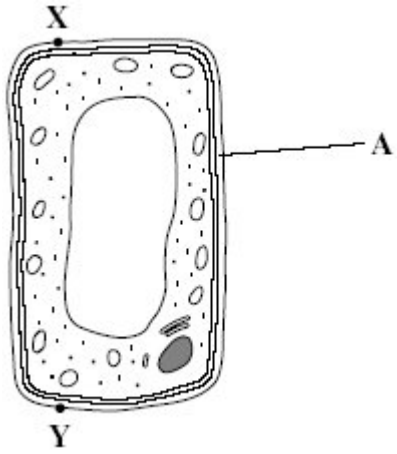
(Total 25 marks)

2 (a) Name the process in which cells become adapted for different functions.

_____

(1)

(b) Palisade cells are found in leaves. The diagram shows a palisade cell.



(i) Name structure **A**.

_____

(1)

(ii) The real length of this cell between **X** and **Y** is 20 micrometres (µm). By how many times has it been magnified? Show your working.

Answer _____

(2)

(iii) Explain **one** way in which this cell is adapted for photosynthesis.

_____

_____

(1)

(Total 5 marks)

3 A student found the number of stomata per cm^2 on the lower surface of a daffodil leaf.
He removed a small, thin piece of lower epidermis and mounted it on a microscope slide.

He examined the slide using an optical microscope.

(a) Explain why it was important that the piece of the epidermis that the student removed was thin.

_____

_____

_____

_____

(2)

(b) Suggest how the student could have used his slide to find the number of stomata per cm^2.

_____

_____

_____

_____

_____

_____

(3)

(c) The stomata on the leaves of pine trees are found in pits below the leaf surface. Explain how this helps to reduce water loss.

_____

_____

_____

_____

(2)

(Total 7 marks)

4 (a) What is a tissue?

_____

_____

(1)

(b) A student cut a thin section of tissue from a potato and examined it with an optical microscope.

(i) Starch was present in the cells of this tissue. Describe how the student could find out where in the cells the starch was present.

_____

_____

_____

_____

_____

(2)

(ii) The student cut a thin section of the tissue. Explain why it was important that the section was thin.

_____

_____

_____

_____

_____

(2)

(c) The cell walls of potato cells contain cellulose. Cellulose and starch are both carbohydrates. Describe **two** ways in which molecules of cellulose are similar to molecules of starch.

_____

_____

_____

_____

(2)

(Total 7 marks)

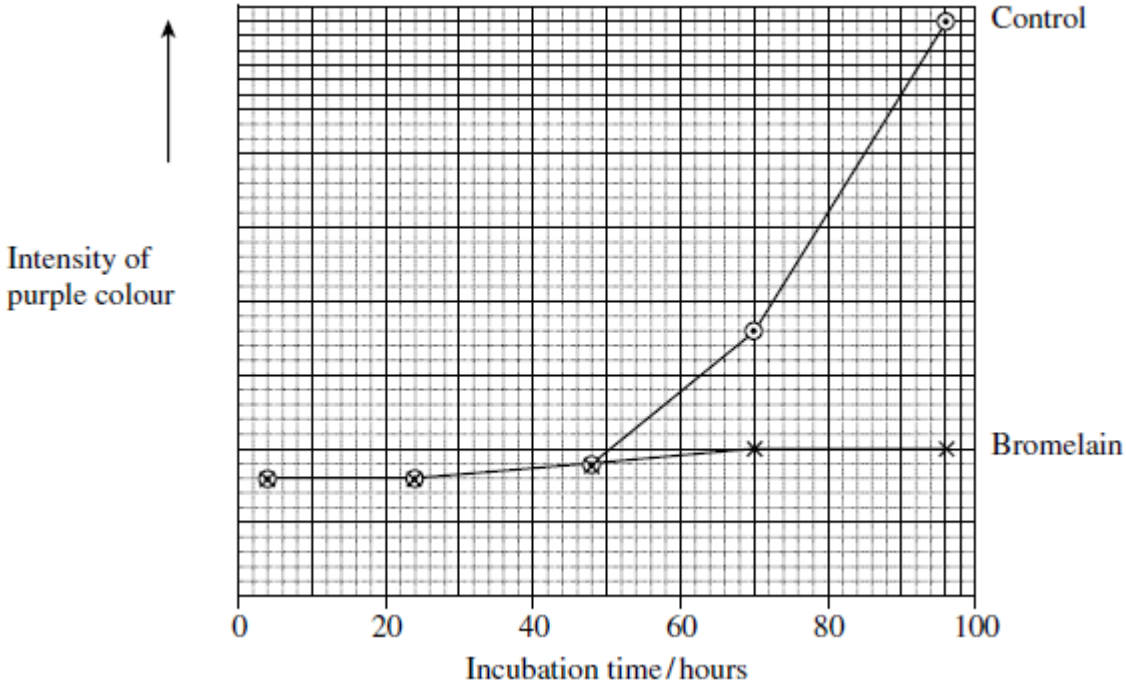
5 Scientists use optical microscopes and transmission electron microscopes (TEMs) to investigate cell structure. Explain the advantages and the limitations of using a TEM to investigate cell structure.

(Total 5 marks)

6 Scientists investigated the effect of bromelain on cancer cells. They took cells from skin cancers in mice and added them to a liquid growth medium in two dishes.

Four hours later they added a solution of bromelain to one of the dishes. They left the other dish as a control. They also added a substance to both dishes that is turned purple by respiring cells.

Both dishes were placed in an incubator. The scientists measured the intensity of the purple colour at intervals over a period of 100 hours.



(a) The scientists put the same number of skin tumour cells in each dish at the start of this investigation. Explain why it was important to put the same number of cells in each dish.

(1)

(b) The scientists concluded that bromelain did not kill cancer cells but stopped them dividing. Does the graph support this conclusion? Explain your answer.

(2)

(c) An article in a newspaper claimed that these data show that bromelain can be used to treat cancer.

Give **three** reasons why we should be careful about accepting this claim.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(d) The rate of cell division is important in investigations into cancer. Suggest why.

_____

_____

_____

_____

(2)

(e) Scientists have investigated the effects of bromelain on cancer growth in humans. Suggest why they gave bromelain in addition to, rather than instead of, the usual treatment.

_____

_____

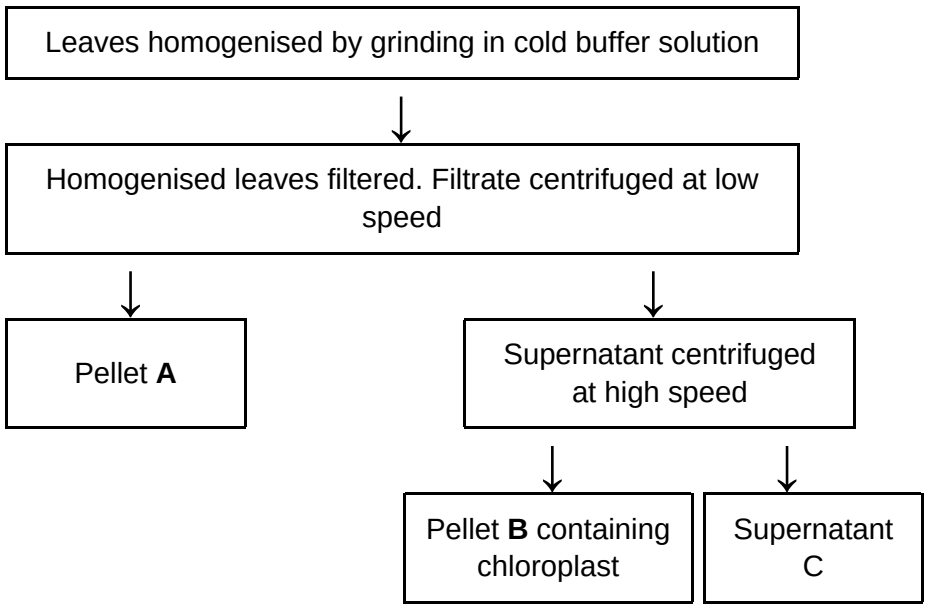
_____

_____

(2)

(Total 10 marks)

7 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)

8 Read the following passage.

During the course of a day, we come into contact with many poisonous substances. These include industrial and household chemicals. The skin acts as a barrier and prevents many of these substances entering and harming the body.

The skin is one of the largest organs in the body. It is composed of several layers of tissue. The outer layer consists of dead cells packed with keratins. Keratins are a group of proteins that differ from each other in their primary structure. Each keratin molecule consists of several polypeptide chains, each individual chain wound into a spiral or helix. The polypeptide chains include many sulphur-containing amino acids and these help to give the keratin molecules their characteristic strength.

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

(a) What is the evidence from the passage that keratin molecules have a quaternary structure?

_____

_____

(1)

(b) Explain how sulphur-containing amino acids help to give keratin molecules their characteristic strength (lines 8–9).

_____

_____

_____

_____

(2)

(c) Explain why differences in primary structure result in keratins with different properties (line 6).

(2)

(d) The skin prevents poisonous substances entering and harming the body (line 3). Explain why these substances are unable to pass through the outer layer of skin cells by active transport.

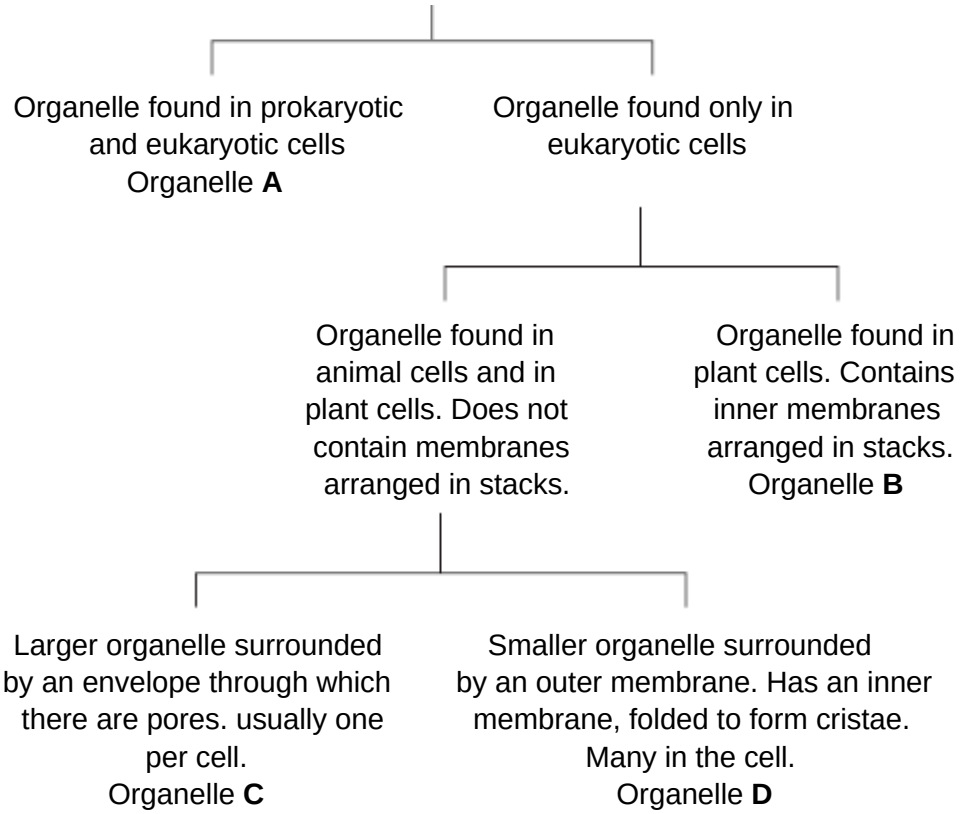
(3)

(e) Skin cells may be studied with a transmission electron microscope or an optical microscope. Explain the advantages and limitations of using a transmission electron microscope to study cells.

(6)

(Total 14 marks)

9 The diagram shows how some organelles may be distinguished from each other.



(a) (i) Name organelle **B**.

_____

(1)

(ii) Describe the function of organelle **B**.

_____

_____

_____

_____

(2)

(b) Which of organelles **A**, **B**, **C** or **D**

(i) is a ribosome;

_____

(1)

(ii) contains most of the DNA found in a plant cell?

_____

(1)

(c) Some liver tissue was ground, filtered and centrifuged to make a suspension of organelle **D**.

(i) Explain why the solution in which the liver tissue was ground should be ice-cold.

_____

_____

(1)

(ii) The ground liver was centrifuged at low speed. The pellet that formed at the bottom of the centrifuge tube was thrown away and the supernatant centrifuged again at higher speed. Explain why it was necessary to first centrifuge the ground liver at low speed in order to obtain a suspension of organelle **D**.

_____

_____

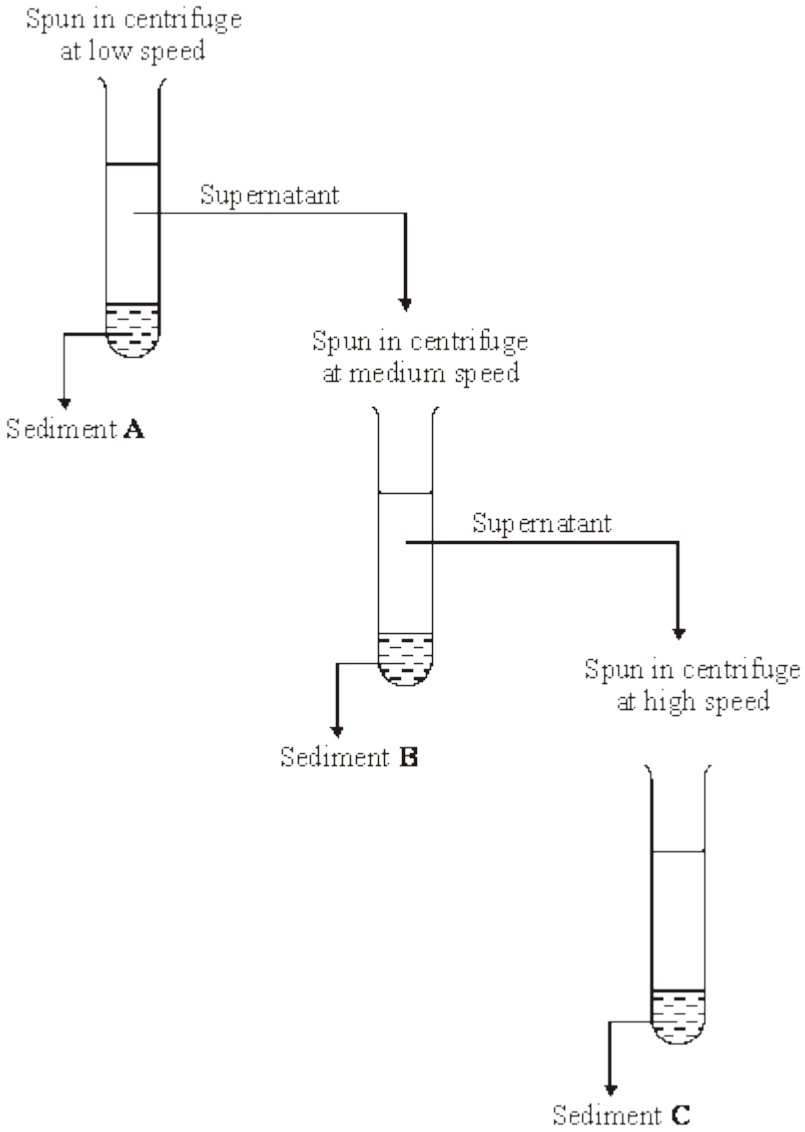
_____

_____

(2)

(Total 8 marks)

10 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)

11 The flow chart outlines an investigation to determine from where the calcium ions involved in muscle contraction are released.

Calcium ion transport proteins were isolated from human tissue.

↓

These proteins were injected into a rabbit.

↓

The rabbit formed antibodies to the proteins. These antibodies were collected and labelled with gold particles.

↓

Muscle tissue was treated with the labelled antibodies and examined with an electron microscope. High concentrations of gold particles were observed attached to the sarcoplasmic reticulum.

S (a) Labelled antibodies and an electron microscope can be used to produce images locating proteins on the surface of organelles, but cannot be used to observe cross bridge cycling in muscle cells. Explain why.

(5)

(b) Describe the role of calcium ions and ATP in muscle contraction.

(5)

(Total 10 marks)

12 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.

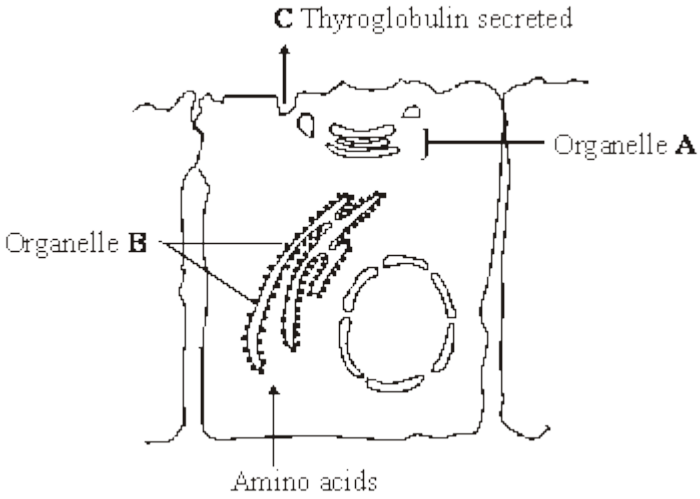
(2)

(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.

(6)

(Total 13 marks)

13 The thyroid gland is an organ in the neck. The diagram shows the process in which epithelial cells from the thyroid gland make and secrete a protein called thyroglobulin.



(a) Name

(i) organelle **A**;

_____

(1)

(ii) the process by which thyroglobulin is secreted from the cell at **C**.

_____

(1)

(b) (i) Describe the part played by the organelles labelled **B**.

_____

_____

(1)

(ii) Organelle **B** is very small. It cannot be seen when thyroid cells are examined with an optical microscope but it can be seen with an electron microscope. Explain why this organelle can be seen with an electron microscope.

_____

_____

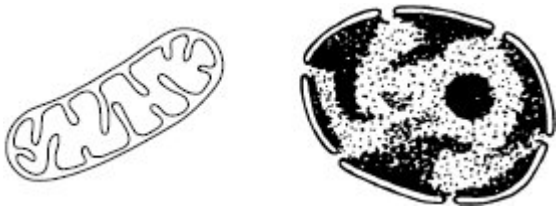
_____

_____

(2)

(Total 5 marks)

14 (a) The diagram shows two organelles found in a eukaryotic cell.



A **B**

(i) Name the organelles.

A _____

B _____

(1)

(ii) Explain how the inner membrane is adapted to its function in organelle **A**.

_____

_____

_____

_____

(2)

(b) Give **one** feature of a prokaryotic cell that is not found in a eukaryotic cell.

_____

(1)

(c) Describe how a sample consisting only of chloroplasts could be obtained from homogenised plant tissue.

_____

_____

_____

_____

_____

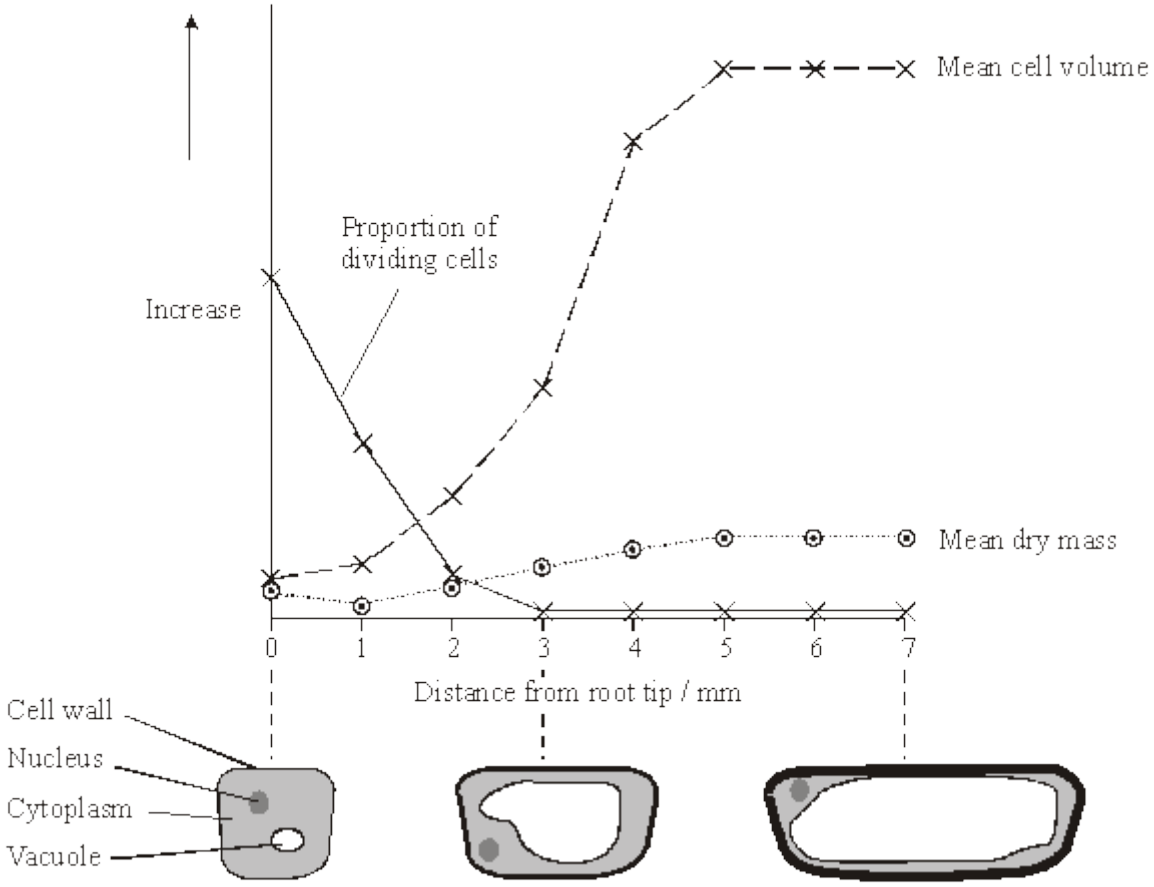
_____

(3)

(Total 7 marks)

15 **S** 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.

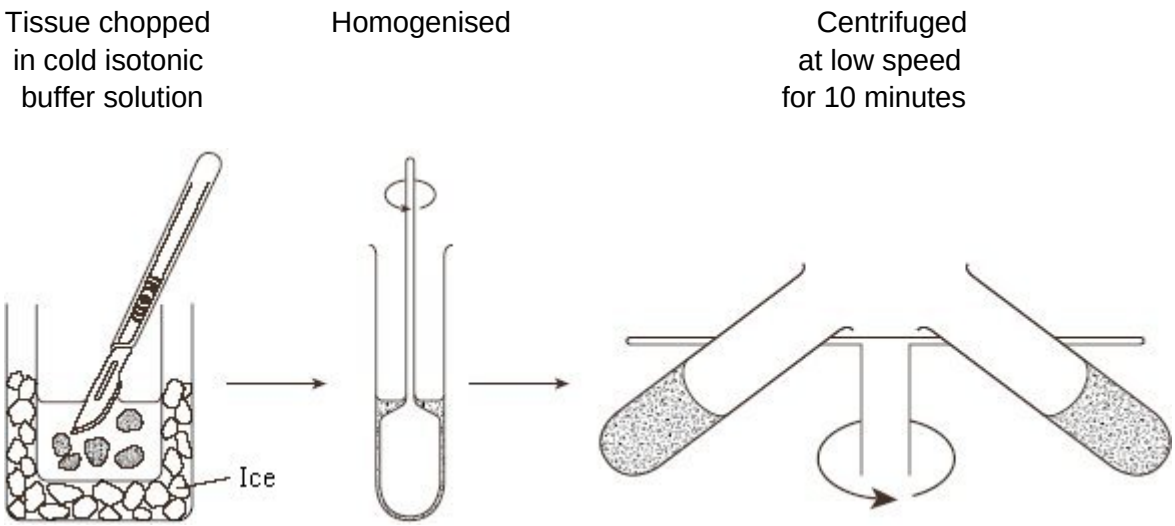
(2)

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

(3)

(Total 9 marks)

16 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)

17 (a) Small samples of plant tissue were placed in a cold, isotonic solution and then treated to break open the cells to release the organelles. The different organelles were then separated. Describe a technique that could be used to

(i) break open the cells;

_____

_____

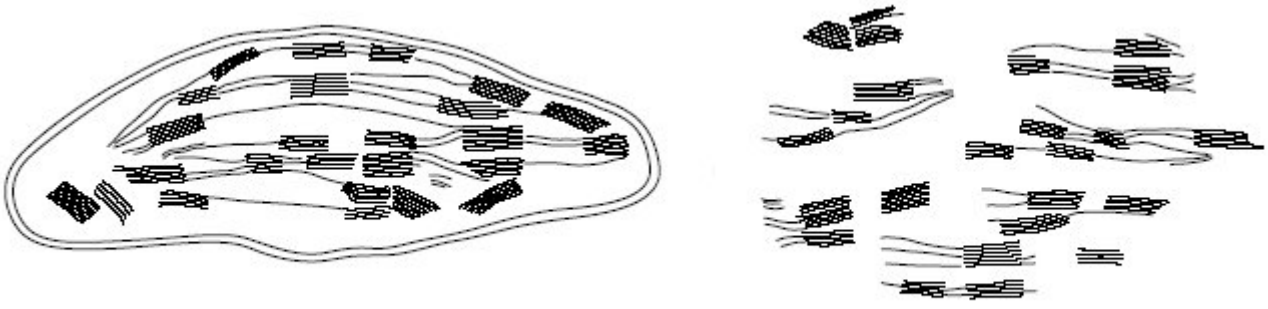
(ii) separate the organelles.

_____

_____

(2)

(b) One group of organelles was placed in a hypotonic solution. The diagram shows one of these organelles seen under an electron microscope before and after it was placed in the hypotonic solution.



Before

After

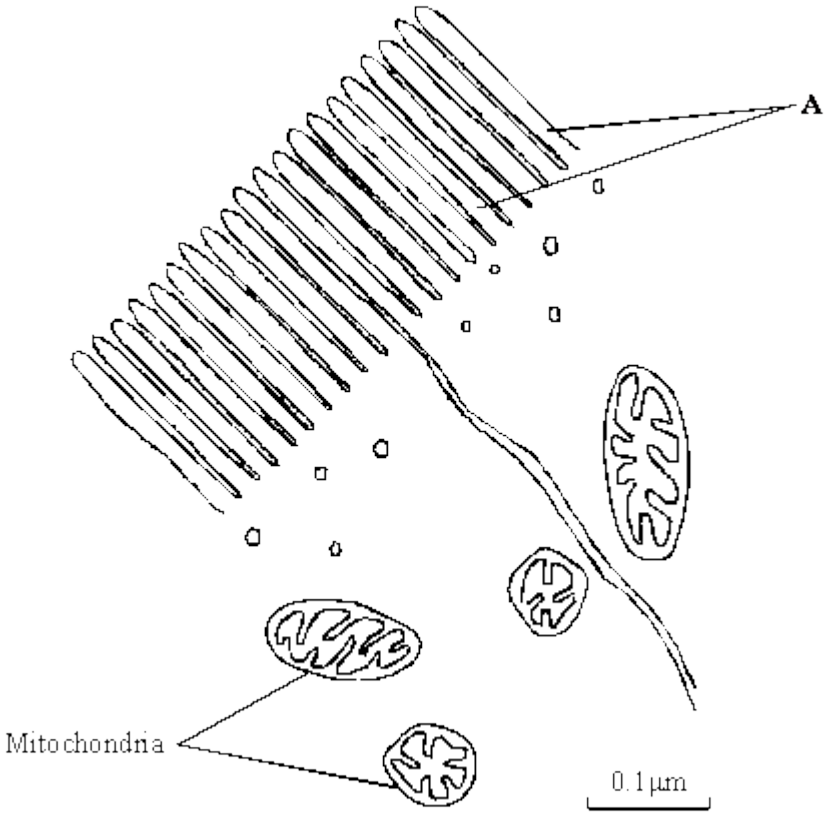
Name the organelle.

_____

(1)

(Total 3 marks)

18 The drawing shows an electron micrograph of parts of epithelial cells from the small intestine.



(a) (i) Name the structures labelled **A**.

_____

(1)

(ii) Explain how these structures help in the absorption of substances from the small intestine.

_____

_____

(1)

(b) (i) The scale bar on this drawing represents a length of 0.1µm. Calculate the magnification of the drawing. Show your working.

Magnification _____

(2)

(ii) Explain why an electron microscope shows more detail of cell structure than a light microscope.

_____

_____

_____

(2)

(c) The length of mitochondria can vary from 1.5 μm to 10 μm but their width never exceeds 1μm. Explain the advantage of the width of mitochondria being no more than 1μm.

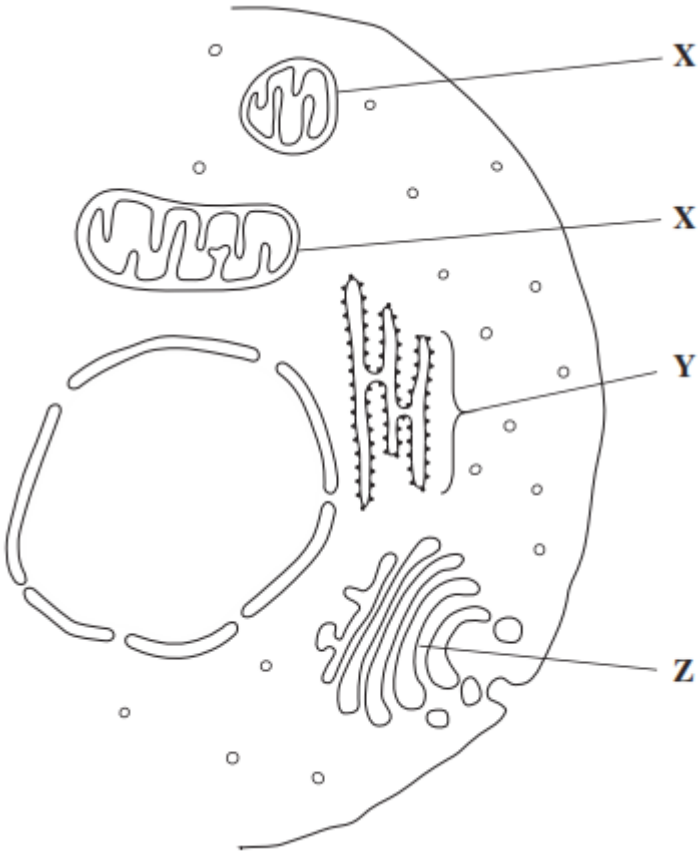
_____

_____

(1)

(Total 7 marks)

19 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.

_____

_____

_____

_____

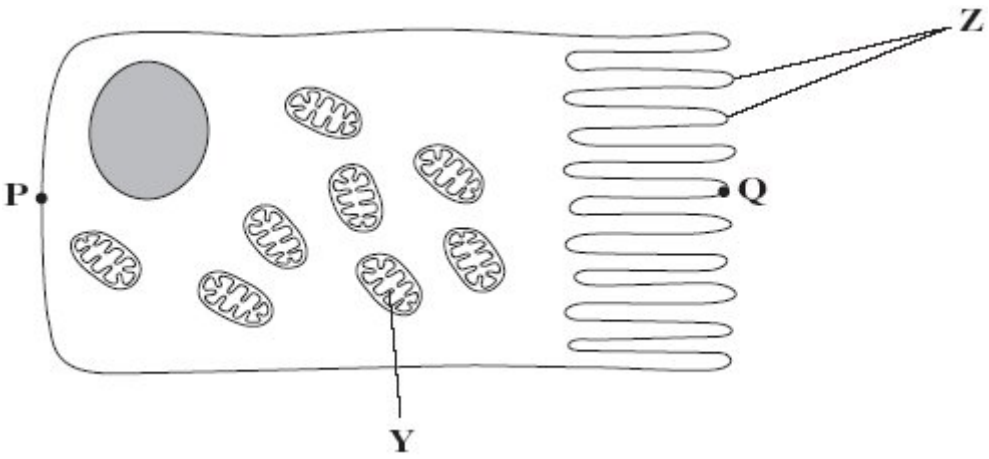
(Extra space) _____

_____

(2)

(Total 5 marks)

20 The diagram shows an epithelial cell from the small intestine.



(a) (i) Name organelle **Y**.

_____

(1)

(ii) There are large numbers of organelle **Y** in this cell. Explain how these organelles help the cell to absorb the products of digestion.

_____

_____

_____

_____

_____

(2)

(b) This diagram shows the cell magnified 1000 times. Calculate the actual length of the cell between points **P** and **Q**. Give your answer in µm. Show your working.

Answer _____ µm

(2)

(c) Coeliac disease is a disease of the human digestive system. In coeliac disease, the structures labelled **Z** are damaged.

Although people with coeliac disease can digest proteins they have low concentrations of amino acids in their blood.

Explain why they have low concentrations of amino acids in their blood.

_____

_____

_____

_____

_____

(2)

(Total 7 marks)