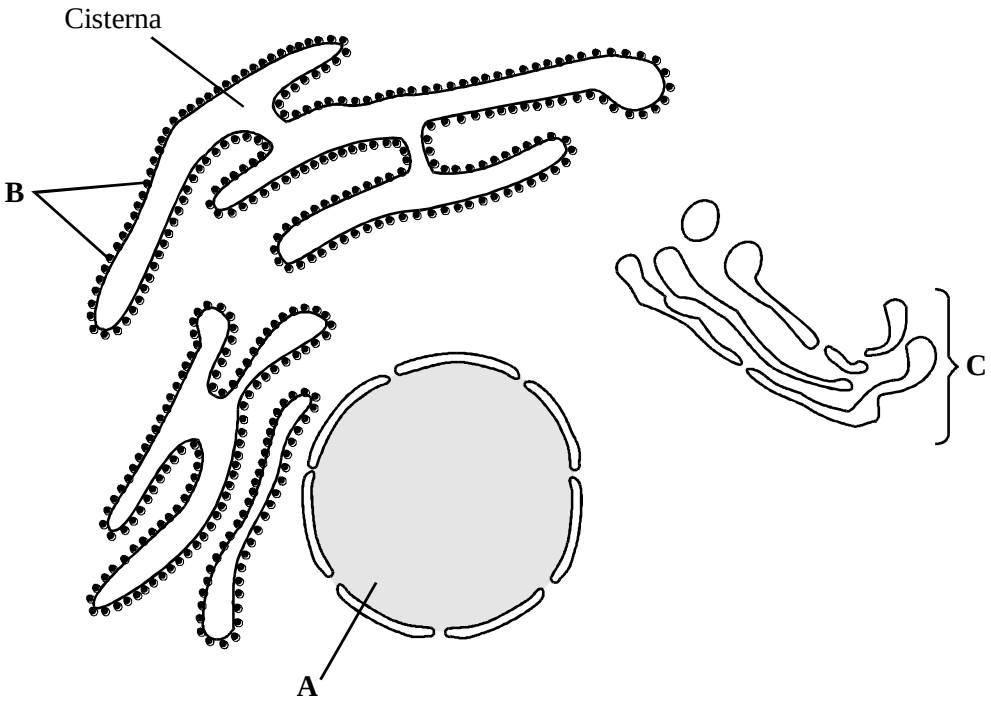
1. The diagram shows a section through part of a cell as it would appear when seen with an electron microscope.



(a) This cell produces and secretes a protein. Describe the part played by organelles **A**, **B** and **C** in producing and secreting this protein.

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(3)

(b) The table shows information about the different parts of this cell.

Part of cell	Percentage of total cell volume	Number in the cell
Cytoplasm surrounding cell organelles	54	1
Mitochondria	22	about 1700
Nucleus	6	1
Lysosomes	1	about 300
Cisternae of rough endoplasmic reticulum	9	1

(i) Which organelle is larger, a mitochondrion or a lysosome?
Use calculations based on figures from the table to support your answer.

Larger organelle; .....

(2)

(ii) In the drawing there appear to be a number of separate cisternae in the rough endoplasmic reticulum. The table gives the approximate number of cisternae as one. Suggest an explanation for the apparent difference.

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(2)

(iii) This cell produces a large amount of protein. Explain how the number of mitochondria in the cell may be linked to this.

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(3)
(Total 10 marks)

2. Read the following passage.

A red blood cell is packed full of haemoglobin. When mature, it contains none of the organelles usually found in an animal cell. The nucleus, endoplasmic reticulum. mitochondria and ribosomes are all absent.

More is known about the plasma membrane of a human red blood cell than about any other eukaryotic cell membrane. One reason for this is that the plasma membrane surrounding a red blood cell can be isolated without being contaminated by internal cell membranes. Red blood cell plasma membranes or "ghosts" can be prepared by putting the cells in a dilute salt solution. This causes the cells to swell and burst, leaving only the plasma membrane.

Red blood cell ghosts have been investigated and found to contain several different proteins. One of these proteins is spectrin. It is made up of long polypeptide chains which form a network on the inside of the membrane. Spectrin strengthens the membrane and is involved in maintaining the three-dimensional shape of the red blood cell.

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

(a) Complete the table by giving **two** ways in which the structure of a red blood cell differs from the structure of a bacterial cell.

Red blood cell	Bacterial cell
Contains haemoglobin	Does not contain haemoglobin
Contains spectrin	Does not contain spectrin

(2)

(b) Haemoglobin is a protein. Explain why a mature red blood cell cannot make haemoglobin.

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(2)

(c) (i) Plasma membranes that have been isolated from red blood cells are not contaminated by internal cell membranes (lines 6 - 7). Explain why.

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(1)

(ii) When red blood cells are put in a dilute salt solution they swell (line 8). Use your knowledge of water potential to explain why.

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(2)

(d) Some people have red blood cells that do not contain spectrin. These red blood cells are spherical in shape. They also burst more quickly when put in distilled water.

(i) Explain why more oxygen is taken up by normal red blood cells than by these spherical cells.

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(1)

(ii) Explain why red blood cells that do not contain spectrin burst more quickly when put into distilled water.

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(1)

(e) Polypeptides such as spectrin are formed from amino acids. Describe the structure of an amino acid molecule and explain how amino acids link together.

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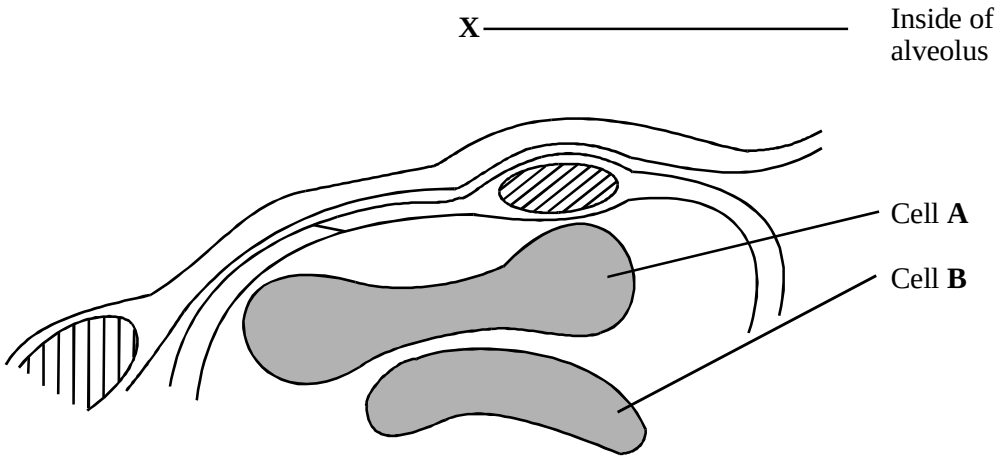
(6)
(Total 15 marks)

3. The drawing shows an electron micrograph of a section through part of an alveolus from a lung.



(a) Describe the path of a molecule of oxygen from the air in the alveolus at **X** to the plasma membrane of cell **A**.

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(1)

(b) Cell **A** is a eukaryotic cell. Give **two** features that may be found in a prokaryotic cell which are not found in cell **A**.

1 .....

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2 .....

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(2)

(c) Cells **A** and **B** are biconcave discs. Explain **one** advantage of a biconcave disc over a spherical cell of the same volume in transporting oxygen.

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(2)

(d) The diameter of a human red blood cell is 7 μm.

(i) Calculate the magnification of the drawing. Show your working.

Magnification = ...

(2)

(ii) In calculating the magnification, what assumption did you have to make about how the section was cut?

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(1)

(Total 8 marks)

4. Read the following passage.

Human milk contains all the nutrients a young baby needs in exactly the right proportions. It is formed in the mammary glands by small groups of milk-producing cells. These cells absorb substances from the blood and use them to synthesise the lipids, carbohydrates and proteins found in milk. Milk-producing cells are roughly cube-shaped and have a height to breadth ratio of approximately 1.2 : 1.

The main carbohydrate in milk is lactose. Lactose is a disaccharide formed by the condensation of two monosaccharides, glucose and galactose. (A molecule of galactose has the same formula as a molecule of glucose – the atoms are just arranged in a different way.)

Lactose is synthesised in the Golgi apparatus and transported in vesicles through the cytoplasm. Because lactose is unable to escape from these vesicles, they increase in diameter as they move towards the plasma membrane. The vesicle membranes fuse with the plasma membrane and the vesicles empty their contents out of the cell.

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

(a) (i) The breadth of a milk-producing cell is 26 μm. Calculate the height of this cell.

Height = ... μm

(1)

(ii) Describe and explain how you would expect the height to breadth ratio of an epithelial cell from a lung alveolus to differ from the height to breadth ratio of a milk-producing cell.

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(2)

(b) How many oxygen atoms are there in a molecule of

(i) galactose;

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(1)

(ii) lactose?

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(1)

(c) The lactose-containing vesicles increase in diameter as they move towards the plasma membrane of the milk-producing cell (lines 11-12). Use your knowledge of water potential to explain why.

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(2)

(d) Suggest **one** advantage of milk-producing cells containing large numbers of mitochondria.

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(2)

(e) Some substances pass through the plasma membrane of a milk-producing cell by diffusion. Describe the structure of a plasma membrane and explain how different substances are able to pass through the membrane by diffusion.

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(6)
(Total 15 marks)

5. (a) Explain how the shape of a red blood cell allows it to take up a large amount of oxygen in a short time.

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(2)

Samples of blood were mixed with equal volumes of different liquids. A drop of each mixture was put on a slide and examined with an optical microscope. The table shows the appearance of each slide.

Slide	Liquid added	Appearance of slide
A	Distilled water	No cells seen. Slide appears a uniform pale red colour
B	Sucrose solution	Cells are smaller in diameter than in an untreated sample of blood
C	Detergent (dissolves lipids)	No cells seen. Slide appears a uniform pale red colour

(b) (i) What does the appearance of slide **B** tell you about the plasma membrane surrounding a red blood cell?

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(1)

(ii) Explain the appearance of slide **C**.

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(2)

(c) The blood from which these samples were taken also contained monocytes and granulocytes. How could you use the appearance of a nucleus to

(i) distinguish between a monocyte and a red blood cell;

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(1)

(ii) identify a granulocyte?

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(1)
(Total 7 marks)

6. 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, for 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);

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(3)

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

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(2)

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

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(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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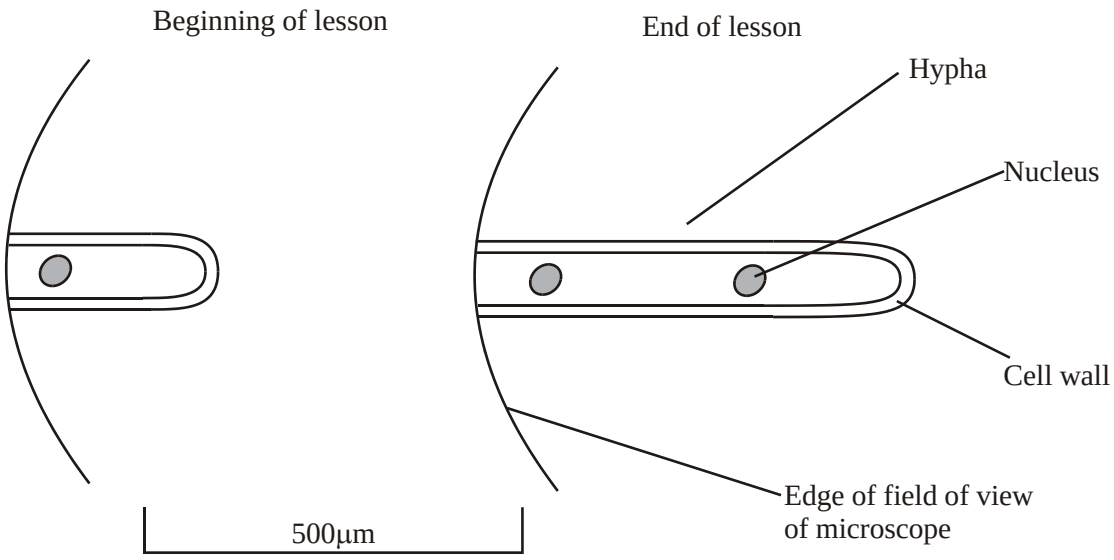
(6)
(Total 13 marks)

7. Moulds belong to a group of organisms called fungi. When mould is examined with a microscope it is seen to consist of long, colourless threads called hyphae.

A student investigated the growth of fungal hyphae. The diagram shows part of a hypha seen under a microscope at the beginning of a lesson and again at the end of the lesson.



(a) Give **one** piece of evidence from the diagram that fungi are eukaryotic.

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(1)

(b) (i) By how much had the hypha grown during the lesson? Show your working.

Answer: ..... µm

(2)

(ii) Explain how you could use your answer to calculate the rate of growth of this hypha.

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(1)

(c) Under the microscope, small granules were seen in the hypha. Describe how you could show that these granules consisted of starch.

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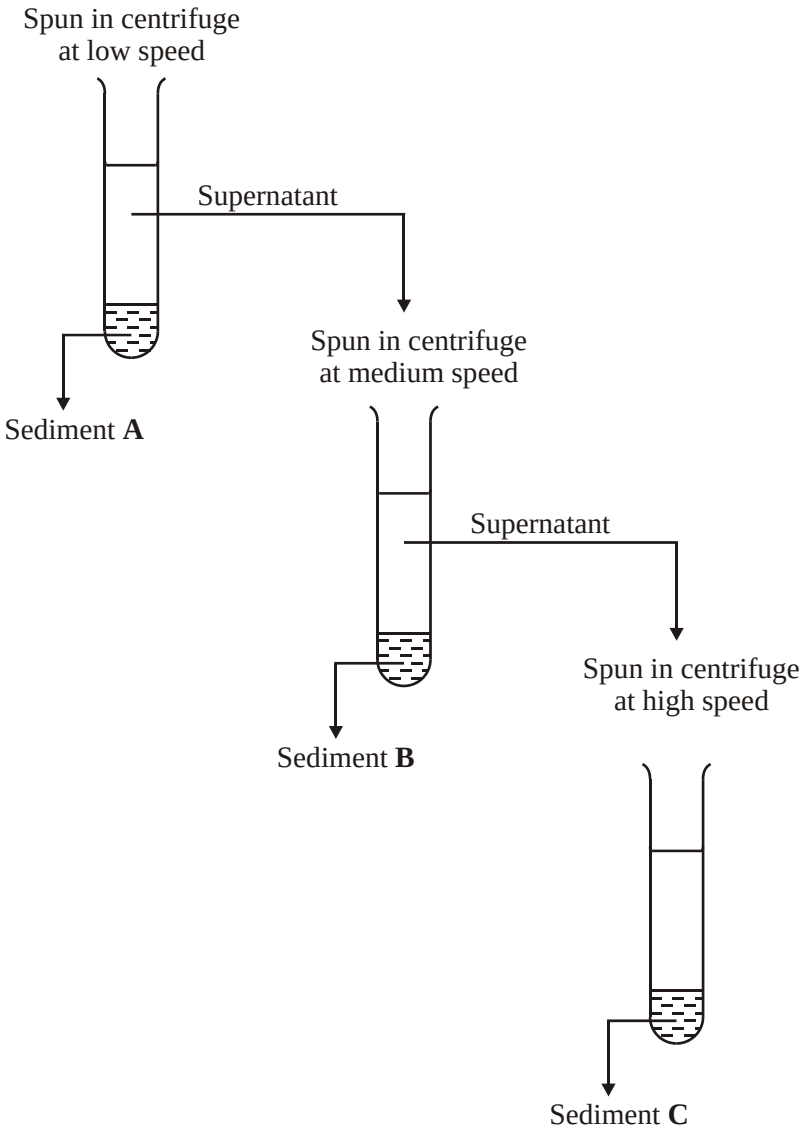
(2)

(Total 6 marks)

8. 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.

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(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?

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(1)

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

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(2)
(Total 7 marks)

9. (a) A plant cell was observed with an optical microscope. Describe how the length of the cell could be estimated.

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(2)

(b) The water potential of a plant cell is –400 kPa. The cell is put in a solution with a water potential of –650 kPa. Describe and explain what will happen to the cell.

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(3)

(c) A group of students investigated the effect of sucrose concentration on the change in length of cylinders of tissue cut from a young carrot. They measured the initial lengths of the carrot cylinders, then placed one in each of a number of sucrose solutions. After 18 hours, they removed the carrot cylinders and measured their final lengths. Some of the results are shown in the table.

Concentration of sucrose / mol dm^{-3}	**Percentage decrease in length of carrot cylinder**
0.4	4.2
0.5	8.7
0.6	13.0
0.7	16.8
0.8	18.1
0.9	18.1
1.0	18.1

(i) The carrot cylinders were left for 18 hours in the sucrose solutions. Explain why they were left for a long time.

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(1)

(ii) Explain how you would use a graph to predict the concentration of sucrose that would result in no change in length of the carrot cylinders.

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(2)

(iii) Young carrots store sugars in their tissues but, in older carrots, some of this is converted to starch. How would using cylinders of tissue from older carrots affect the results obtained for a sucrose solution of 0.6 mol dm^{-3}? Give a reason for your answer.

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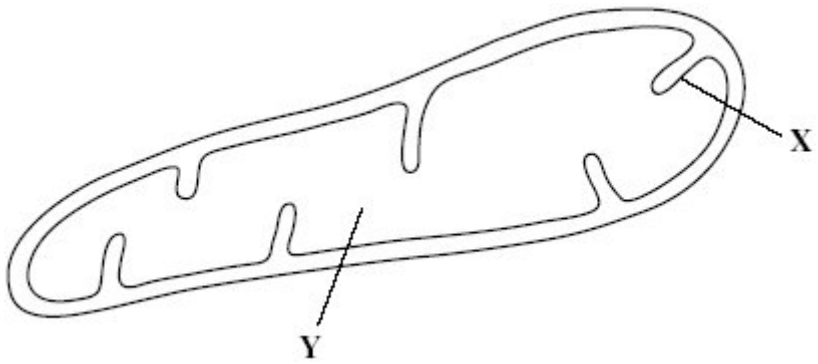
(2)
(Total 10 marks)

10. The diagram shows a mitochondrion.



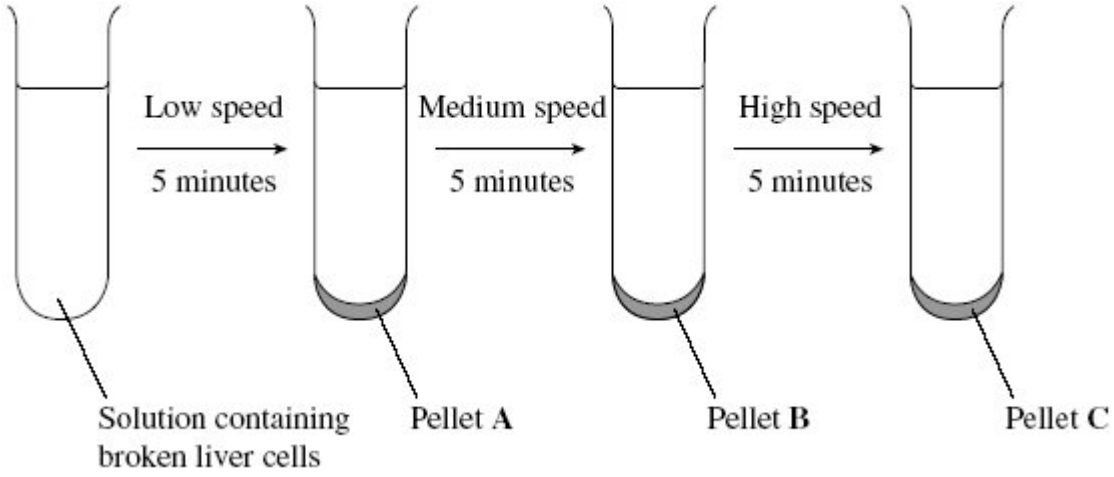
(a) Name the parts labelled **X** and **Y**.

(i) **X** .....

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

(2)

Scientists isolated mitochondria from liver cells. They broke the cells open in an ice-cold, isotonic solution. They then used a centrifuge to separate the cell organelles. The diagram shows some of the steps in the process of centrifugation.



(b) Suggest which pellet, **A**, **B** or **C** contained the mitochondria.

(1)

(c) Explain why the solution used was

(i) ice-cold

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(1)

(ii) isotonic.

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(2)

(d) People with mitochondrial disease have mitochondria that do not function properly. Some people with mitochondrial disease can only exercise for a short time. Explain why a person with mitochondrial disease can only exercise for a short time.

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(2)
(Total 8 marks)