

1. (a) An electron microscope has a much greater resolving power than an optical microscope.

(i) Explain the meaning of the term *resolving power*.

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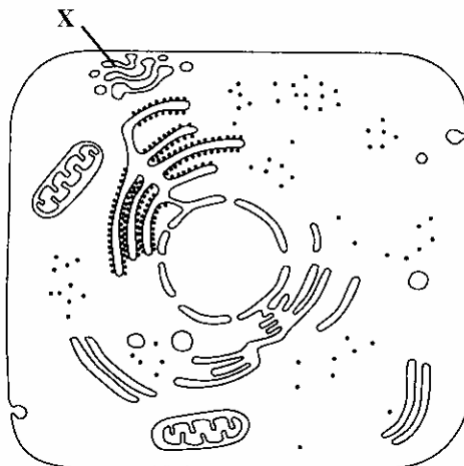
(1)

(ii) Explain the reason for this difference in resolving power.

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(1)

The diagram represents the structure of an animal cell as it would appear when seen with an electron microscope.



(b) Name **one** structure:

(i) that is present in this cell but would **not** be in a bacterial cell;

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(1)

(ii) that is **not** present in this cell but may be present in a bacterial cell.

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(1)

(c) Describe **one** function of the organelle labelled **X**.

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(1)
(Total 5 marks)

2. (a) The table shows some features of cells. Complete the table with ticks to show those features which are present in an epithelial cell from the small intestine and those features which may be present in a prokaryotic cell.

Feature	Epithelial cell from small intestine	Prokaryotic cell
Golgi apparatus		
Mitochondrion		
Nuclear envelope		
Plasmid		
Ribosome		

(2)

(b) (i) Explain why it is possible to see the detailed structure of a prokaryotic cell with an electron microscope but not with a light microscope.

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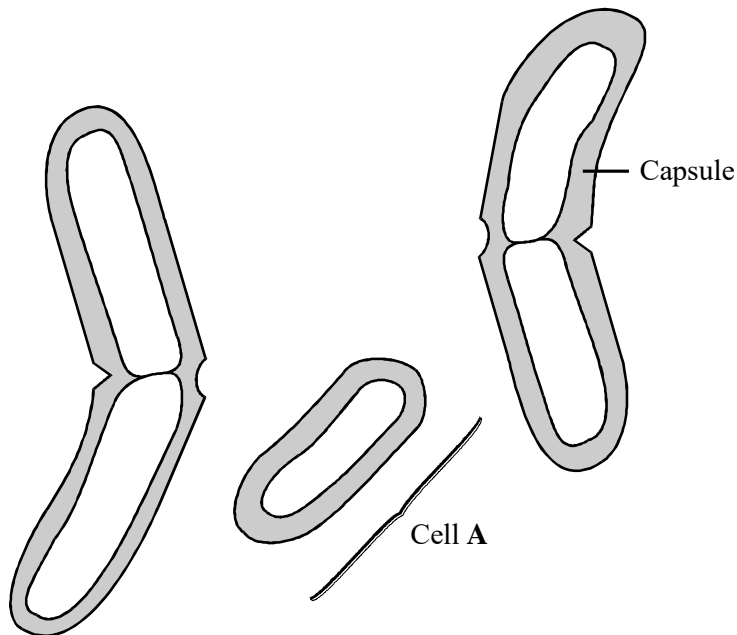
(2)

- (ii) Care must be taken in interpreting electron micrographs. Some features visible in an electron micrograph may not be present in the living cell. Explain why.

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(1)
 (Total 5 marks)

3. The drawing shows some bacterial cells.



- (a) This drawing has been magnified 6000 times. Calculate the actual length, in micrometres, of cell A. Show your working.

Answer μm

(2)

- (b) Each of these bacterial cells is surrounded by a capsule. The main chemical constituent of this capsule is a nitrogenous polysaccharide. List the elements present in this compound.

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(1)

- (c) Give **one** way in which:

- (i) the genetic material in this bacterial cell would differ from that in an animal cell;

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(1)

- (ii) the distribution of membranes in this bacterial cell would differ from the distribution of membranes in a plant cell.

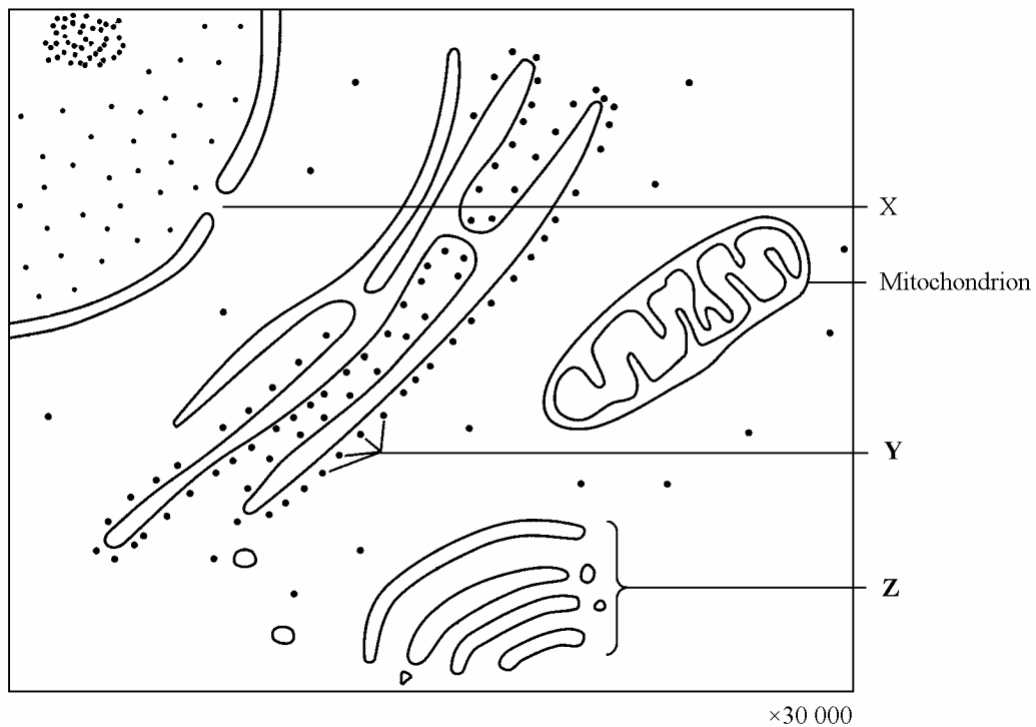
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(1)

(Total 5 marks)

4. The drawing shows part of an animal cell.



- (a) Name feature **X**.

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(1)

- (b) Describe the function of organelle **Y**.

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(1)

- (c) Describe **one** way in which the function of organelle **Z** is related to the function of organelle **Y**.

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(1)

- (d) Calculate the actual length of the mitochondrion in micrometres. Show your working.

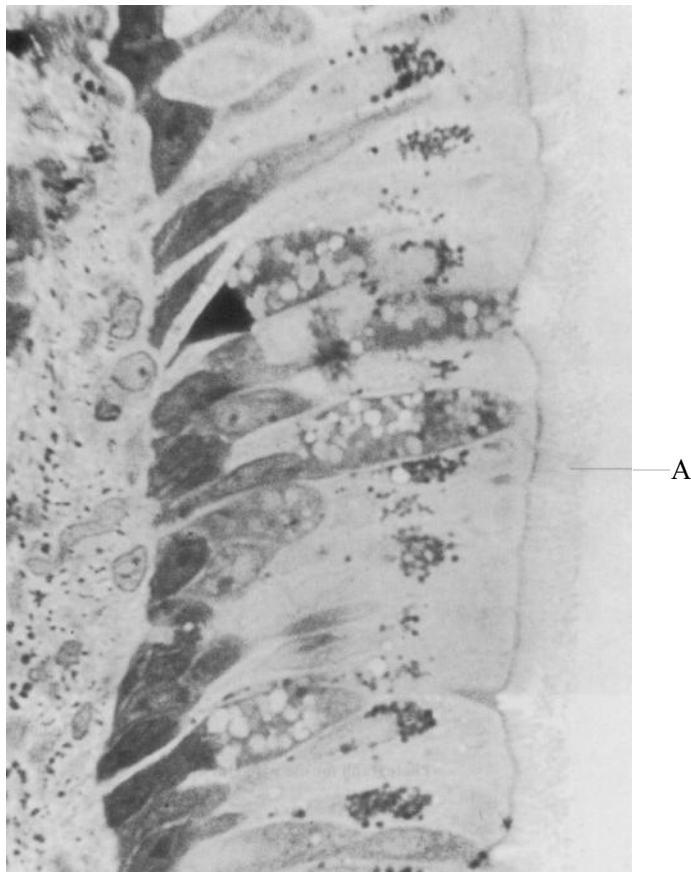
Answer μm

(2)

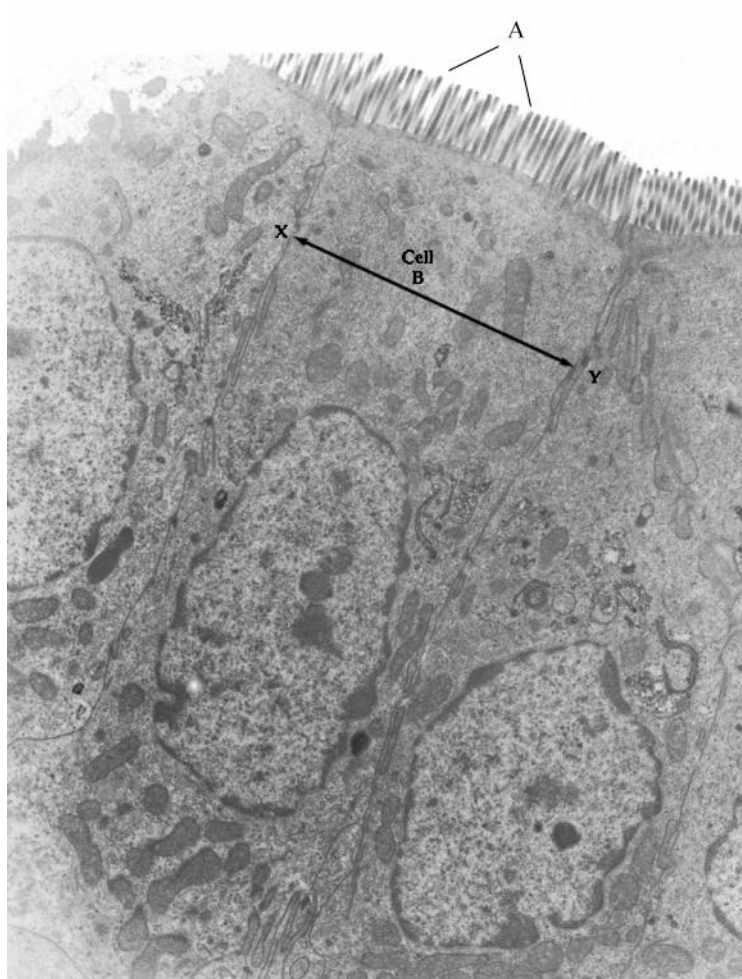
(Total 5 marks)

5. Photographs **a** and **b** show epithelial cells from the small intestine. They were taken with different types of microscope.

Photograph a



Photograph b



- (a) Feature **A** is visible in both photographs.
- (i) Name feature **A**. (1)
- (ii) Explain how the type of microscope used resulted in the difference in the appearance of feature **A** in the two photographs. (2)
- (b) Explain **two** ways in which the cells shown in these photographs are adapted for their function of absorbing the products of digestion. (4)

(c) The magnification of photograph **b** is 10 000 times.

(i) Calculate the actual width, in micrometres (μm), of cell **B** between points **X** and **Y**.
Show your working.

(2)

(ii) Explain how you could calculate the approximate magnification of photograph **a**.

(2)

(Total 11 marks)

6. (a) An extract of mitochondria was made by centrifuging a liver preparation that had been ground up in a blender (homogeniser).

Suggest and explain precautions that could have been taken to:

(i) prevent damage by enzymes released in the processing;

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(2)

(ii) prevent osmotic damage to the mitochondria.

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(2)

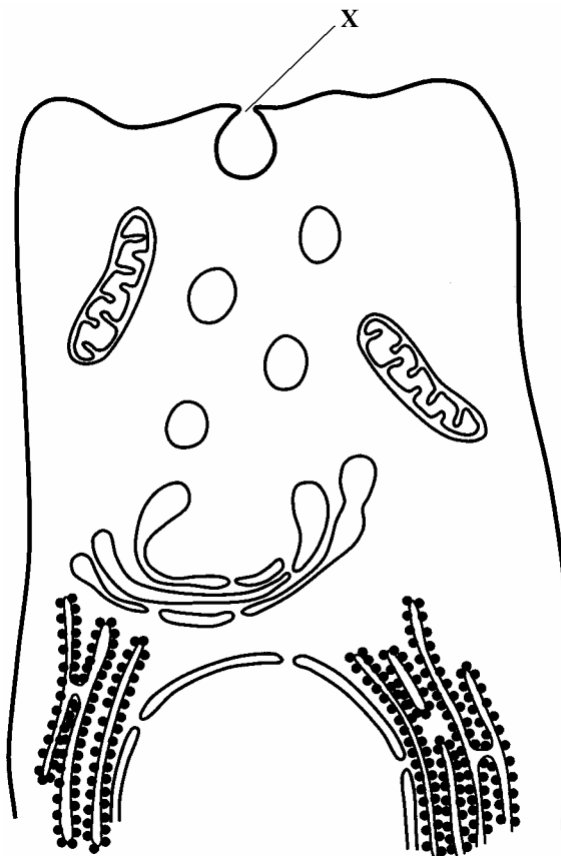
- (b) If the cell preparation had been contaminated with bacteria, why might it have been difficult to separate the mitochondria from the bacteria?

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(1)
(Total 5 marks)

7. The diagram shows part of a cell that secretes enzymes.



- (a) Give **one** piece of evidence, visible in the diagram, which shows that this cell is a eukaryotic cell.

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(1)

- (b) Some cells similar to that shown in the diagram were grown in a culture. Radioactive amino acids were added to the solution in which they were being grown. The radioactivity acts as a label on the amino acid so that it can be detected wherever it is. This radioactive label allows amino acids to be followed through the cell. At various times, samples of the cells were taken and the amount of radioactivity in different organelles was measured. The results are shown in the table.

Time after radioactive amino acids were added to the solution/minutes	Amount of radioactivity present/arbitrary units		
	Golgi apparatus	Rough endoplasmatic reticulum	Vesicles
1	21	120	6
20	42	68	6
40	86	39	8
60	76	28	15
90	50	27	28
120	38	26	56

- (i) What happens to the amino acids in the rough endoplasmic reticulum?

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(2)

- (ii) Use the information in the table to draw arrows on the diagram showing the path of radioactivity through and out of the cell at **X**.

(3)

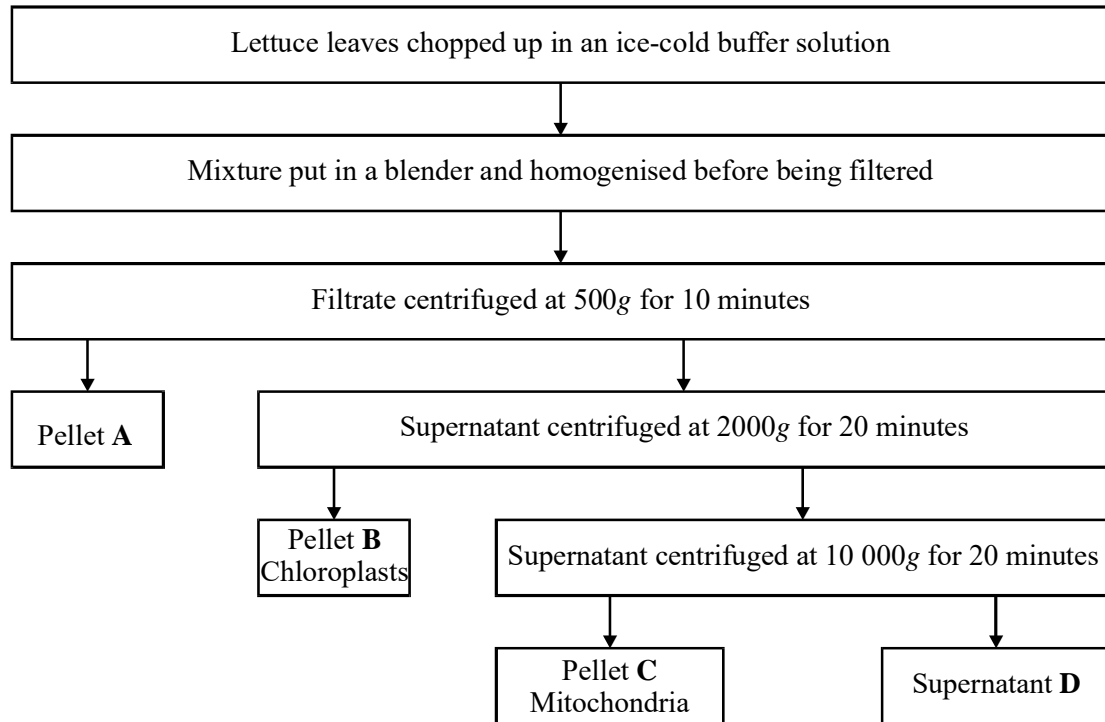
- (iii) Name the process which is occurring at point **X** on the diagram.

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(1)

(Total 7 marks)

8. Ultracentrifugation was used to separate the components of cells from lettuce leaves. The flow chart summarises the steps in the process.



- (a) Explain why the mixture was filtered before it was centrifuged.

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(1)

- (b) (i) Name the organelle present in the largest numbers in pellet A.

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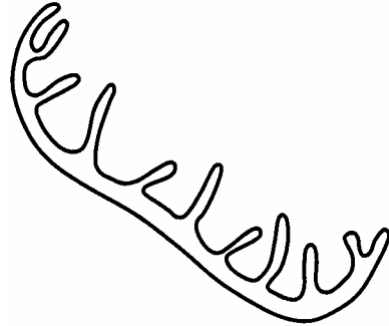
(1)

- (ii) Name an organelle likely to be present in supernatant D.

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(1)

- (c) The mitochondria from pellet C were observed with an electron microscope. They had all burst and appeared as shown in the diagram.



What does this suggest about the water potential of the solution in which the chopped leaves were put? Explain your answer.

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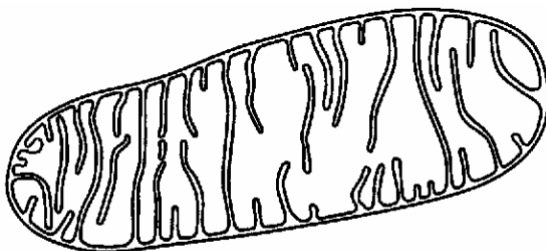
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(2)
(Total 5 marks)

9. The drawing has been made from a photograph. It shows an organelle.



1 μm

(a) Optical microscopes, transmission electron microscopes and scanning electron microscopes may be used to investigate the structure of cells

(i) What type of microscope was used in taking the photograph from which this drawing was made

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(1)

(ii) Give **one** piece of evidence for your answer.

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(1)

(b) Explain why a cell involved in active transport would contain a large number of these organelles.

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(2)

(c) The scale bar on this drawing represents a length of 1 μm . Calculate the magnification of the drawing. Show your working.

Magnification =

(2)

(Total 6 marks)

10. Read the following passage.

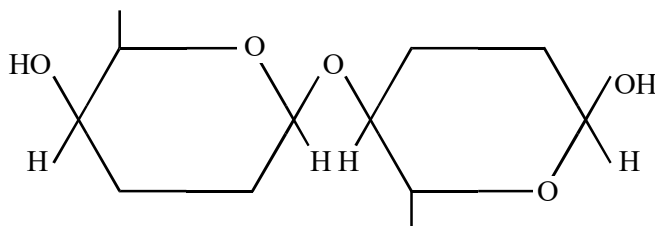
If you are lactose intolerant, drinking cow's milk will make you ill. This is the case for about half of the world's adult human population. These people lack an enzyme called lactase.

Lactase is a digestive enzyme normally found on the plasma membranes of epithelial cells in the small intestine. The enzyme hydrolyses lactose, the sugar found in milk, breaking it down to the two six-carbon sugars, galactose and β -glucose. These separate sugars are then absorbed from the intestine, a process which involves active transport.

In people who are lactose intolerant, lactose is not digested. Instead it stays in the intestine where it affects the water potential of the intestinal contents. This results in diarrhoea. Bacteria in the intestine ferment the lactose, producing carbon dioxide, methane and other gases. It is the build up of these gases which produce the other embarrassing symptoms of lactose intolerance - loud abdominal rumblings and lots of wind.

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

(a) The diagram shows a lactose molecule.



(i) Use the diagram to explain why lactose is described as a disaccharide

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(1)

(ii) On the diagram, draw a ring round the chemical bond which is hydrolysed by lactase

(1)

(iii) The molecular formula of galactose is $C_6H_{12}O_6$. What is the molecular formula of lactose

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(2)

(b) Galactose and glucose are absorbed by epithelial cells lining the small intestine but some other monosaccharides are not. Use your knowledge of active transport to explain this difference

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(2)

(c) Diarrhoea involves the production of large amounts of watery faeces. Explain the link between the presence of lactose in the intestine and diarrhoea.

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(3)

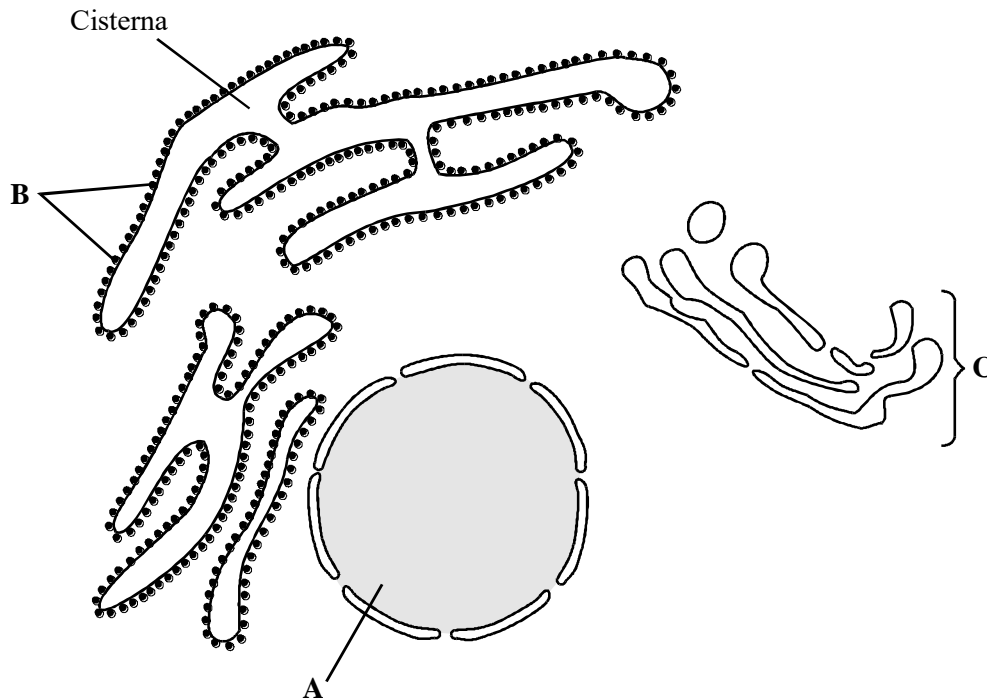
(d) The bacteria in the intestine are prokaryotic cells. The epithelial cells which line the small intestine are eukaryotic cells. Describe the ways in which prokaryotic cells and eukaryotic cells differ

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(6)

(Total 15 marks)

11. 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)

12. Read the following passage.

Many different processes essential to life depend on proteins. These include enzyme controlled reactions, transport across plasma membranes and the binding of hormones to receptor molecules on their target cells. Every protein molecule has a tertiary structure which gives it a precise three-dimensional shape. The function of the protein depends on this shape, and the shape depends on the pH of the surrounding solution.

5

Changes in pH affect different proteins in different ways. This is because the amino acid molecules from which they are built have different structures. Some of these amino acids have different charges at different pH values. Unless they have the correct charges, the protein molecule will not have its correct three-dimensional shape.

- 10 If hydrogen or hydroxyl ions are added to a solution, its pH will normally change. A buffer solution is one which maintains a constant pH when hydrogen or hydroxyl ions are added to it. Buffers also occur naturally and play an important role in keeping conditions inside living organisms constant.

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

(a) The receptor molecules to which hormones bind are proteins. Glucagon is a hormone.

(i) Use the information in the first paragraph to explain why glucagon will only bind to one particular type of receptor molecule.

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(2)

(ii) Suggest why glucagon is able to bind to liver cells but not to cells in other parts of the body.

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(1)

(b) Explain how the amino acids from which proteins are built (lines 6–7) differ in structure from each other.

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(1)

(c) Amylase is an enzyme, found in saliva, which breaks down starch. It works best at a pH of 8. Explain why amylase does not function in the stomach where the pH is approximately 3.

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(3)

- (d) When a suspension of mitochondria is prepared from liver, the tissue is ground in a buffer solution, then centrifuged. Explain why a buffer solution is used.

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(2)

- (e) Describe how proteins are arranged in a plasma membrane and the part they play in transporting substances into and out of cells.

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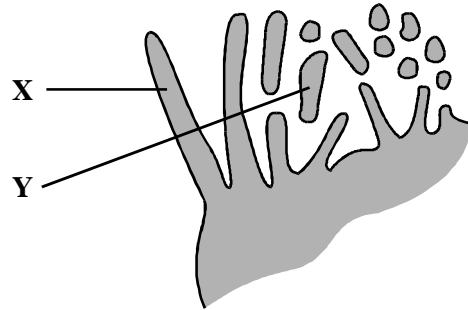
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(6)

(Total 15 marks)

13. (a) The drawing was made from an electron micrograph. It shows some microvilli on an epithelial cell from the small intestine.



- (i) A transmission electron microscope uses a beam electrons. Explain how a beam of electrons allows the microvilli to be seen in detail.

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(2)

- (ii) Explain why the microvilli labeled **X** and **Y** differ in appearance.

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(1)

- (b) Different cells contain different numbers of mitochondria. Suggest the advantage of large numbers of mitochondria in

- (i) a cell from a plant root which absorbs mineral ions from the soil;

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(ii) a muscle cell.

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(3)
(Total 6 marks)

14. A plasma membrane surrounds an animal cell. Cell membranes are also found in the cytoplasm. The table shows the distribution of membranes around and in the cytoplasm of two different types of animal cell.

Type of membrane	Percentage of total cell membrane	
	Cell A	Cell B
Plasma membrane surrounding cell	2	5
Rough endoplasmic reticulum	35	60
Golgi apparatus	7	10
Outer mitochondrial membrane	7	4
Inner mitochondrial membrane	32	17

(a) (i) Explain why the figures for cell A do not add up to 100%.

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(1)

(ii) The figures for the inner mitochondrial membrane are greater than the figures for the outer mitochondrial membrane. Use your knowledge of the structure of mitochondria to explain why.

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(1)

- (b) (i) The total area of the membranes in and surrounding cell **B** is 13 000 μm^2 . Calculate the area of the plasma membrane of cell **B**.

Area = μm^2 (1)

- (ii) Some cells whose main function is absorption of small molecules have structural features on the plasma membrane which increase its surface area. Name these features.

..... (1)

- (c) (i) Cell **A** takes up large amounts of substances by active transport. Explain the evidence from the table which supports this statement.

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..... (2)

- (ii) Cell **B** synthesises large amounts of enzymes. Explain the evidence from the table which supports this statement.

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..... (3)

- (d) Describe the structure of a phospholipid molecule and explain how phospholipids are arranged in a plasma membrane.

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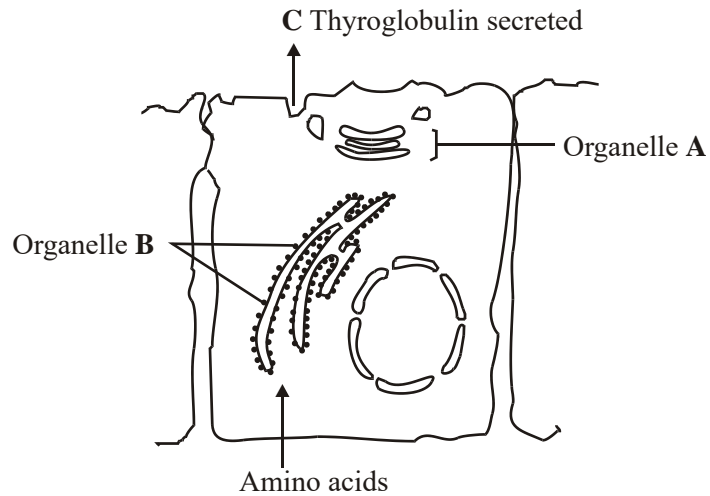
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(6)
(Total 15 marks)

15. 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;

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(1)

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

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(1)

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

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(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.

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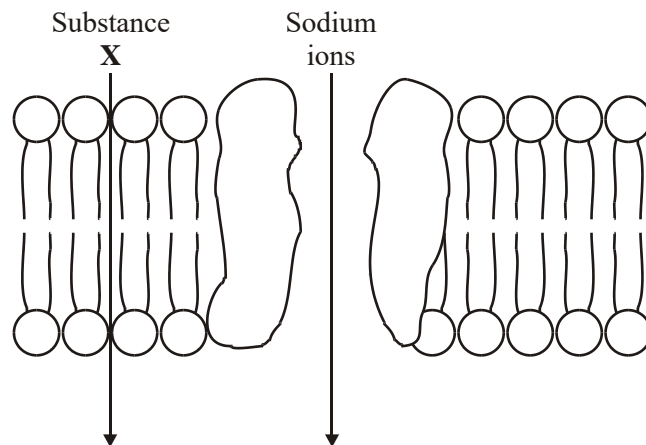
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(2)
 (Total 5 marks)

16. The diagram shows part of a plasma membrane. The arrows show the path taken by sodium ions and by substance **X** when they diffuse through the membrane into a cell.



- (a) An optical microscope cannot be used to see a plasma membrane. Explain why.

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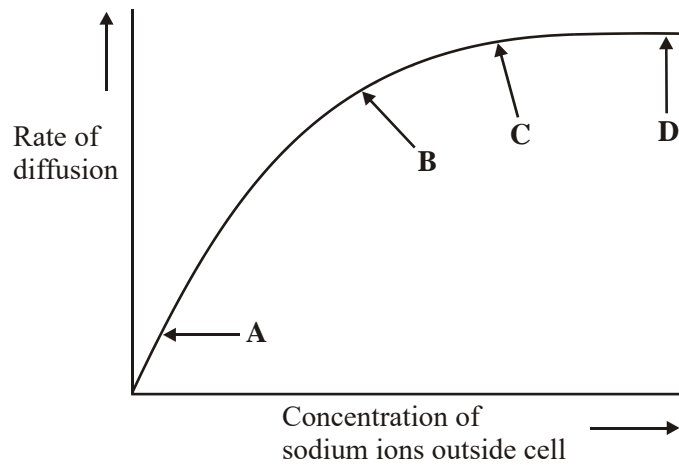
(2)

- (b) Give **one** property of the molecules of substance **X** which allows them to diffuse through the membrane at the position shown.

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(1)

- (c) The effect of the concentration of sodium ions in the surrounding solution on their rate of diffusion across the membrane was investigated. The graph shows the results.



- (i) What limits the diffusion of sodium ions across the membrane between **A** and **B** on the graph? Give the evidence for your answer.

Limiting factor

Evidence

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(2)

- (ii) Explain the shape of the curve between **C** and **D**.

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(2)

(Total 7 marks)

17. Read the following passage.

The plasma membrane plays a vital role in microorganisms. It forms a barrier between the cell and its environment, controlling the entry and exit of solutes. This makes bacteria vulnerable to a range of antiseptics and antibiotics

- 5 When bacteria are treated with antiseptics, the antiseptics bind to the proteins in the membrane and create tiny holes. Bacteria contain potassium ions at a concentration many times that outside the cell. Because of the small size of these ions and their concentration in the cell, the first observable sign of antiseptic damage to the plasma membrane is the leaking of potassium ions from the cell. Some antibiotics damage the plasma membrane in a similar way. One of these is tyrocidin. This is a cyclic polypeptide consisting of a ring of ten amino acids. Tyrocidin and other polypeptide antibiotics are of little use in medicine.
- 10

- Other antibiotics also increase the rate of potassium movement from cells. It is thought that potassium ions are very important in energy release and protein synthesis, and a loss of potassium ions would lead to cell death. Gramicidin A coils to form a permanent pore passing through the plasma membrane. This pore enables potassium ions to be conducted from the inside of the cell into the surrounding medium. Vanilomycin also facilitates the passage of potassium ions from the cell. A molecule of vanilomycin forms a complex with a potassium ion and transports it across the membrane. The potassium ion is released on the outside and the vanilomycin is free to return and pick up another potassium ion. Vanilomycin depends on the fluid nature of the plasma membrane in order to function.
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- 20 Polyene antibiotics have flattened, ring-shaped molecules. The two sides of the ring differ from each other. One side consists of an unsaturated carbon chain. This part is strongly hydrophobic and rigid. The opposite side is a flexible, strongly hydrophilic region. It has been shown that polyene antibiotics bind only to sterols. Sterols are lipids found in the membranes of eukaryotes but not in the membranes of prokaryotic organisms. It is thought that several sterol-polyene complexes come together. The plasma membranes of eukaryotic cells treated with these polyene antibiotics lose the ability to act as selective barriers and small ions and molecules rapidly leak out
- 25

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

- (a) (i) By what process do potassium ions normally enter a bacterial cell? Explain the evidence for your answer.

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(2)

- (ii) Use Fick's law to explain why leakage of potassium ions occurs following antiseptic damage to the plasma membrane (lines 7 - 8).

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(2)

- (b) (i) Draw a peptide bond showing how the COOH group of one amino acid joins to the NH₂ group of another.

(1)

- (ii) How many peptide bonds are there in a molecule of tyrocidin (lines 9 - 10)?

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(1)

- (c) Experiments have shown that vanilomycin is unable to transport potassium ions across a membrane when it is cooled. Gramicidin A continues to facilitate the movement of potassium ions at these low temperatures. Explain these results.

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(3)

- (d) Draw a simple diagram of one of the phospholipid layers to show how polyene antibiotics allow small ions and molecules to leak rapidly through a plasma membrane. Use the following symbols to represent the different molecules.

Note that the zigzag line on the symbol for the polyene antibiotic represents its hydrophobic region.

Phospholipid



Sterol



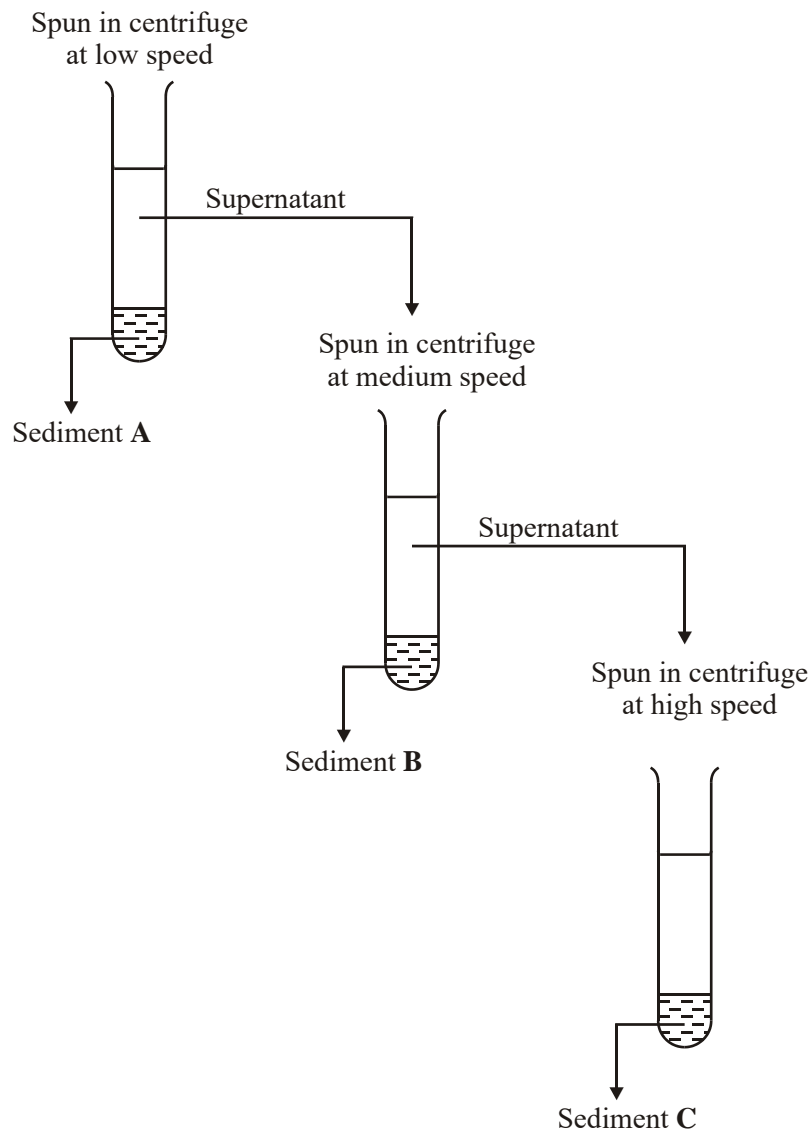
Polyene antibiotic



These symbols have been drawn to the same scale

(2)
(Total 11 marks)

18. 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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(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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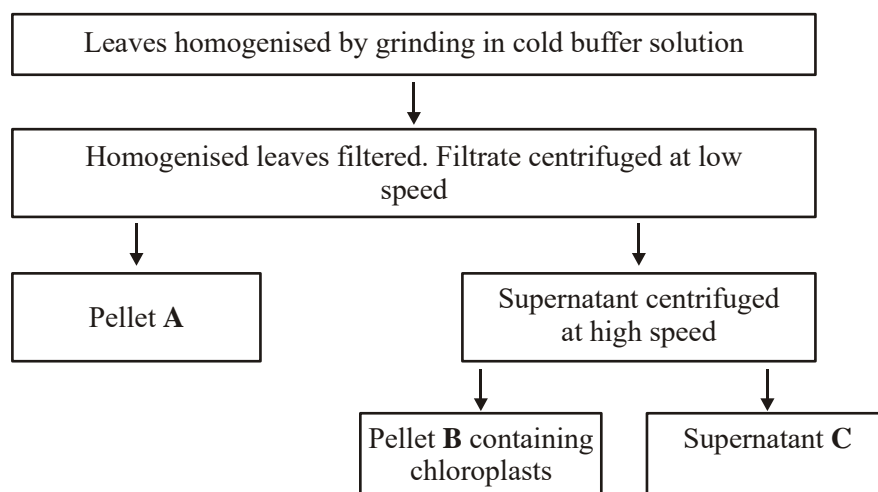
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(2)

(Total 7 marks)

19. 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,

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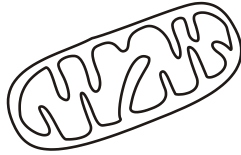

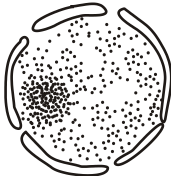
(1)

(ii) a buffer solution was used.

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(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.

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(2)

(Total 7 marks)