1. Cell Structure

1.2 Cells as the Basic Units of Living Organisms

Paper 2

Question Paper

1 Fig. 1.1 is a diagram showing part of a cell surface membrane of an animal cell.

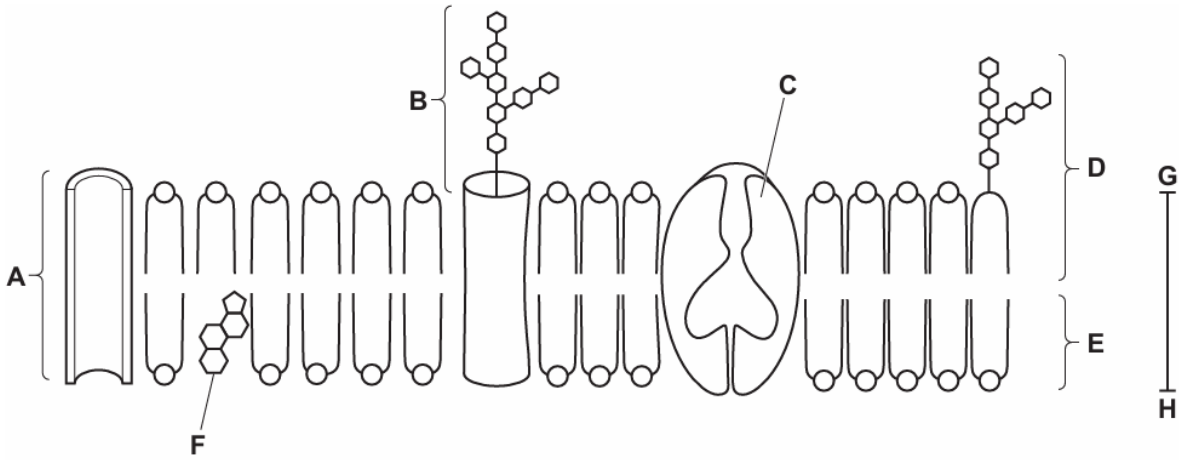


Fig. 1.1

(b) Fig. 1.2 is a drawing of a transmission electron micrograph (TEM) of a cell from the palisade mesophyll of a leaf.

The drawing does **not** show all of the organelles visible in a transmission electron micrograph.

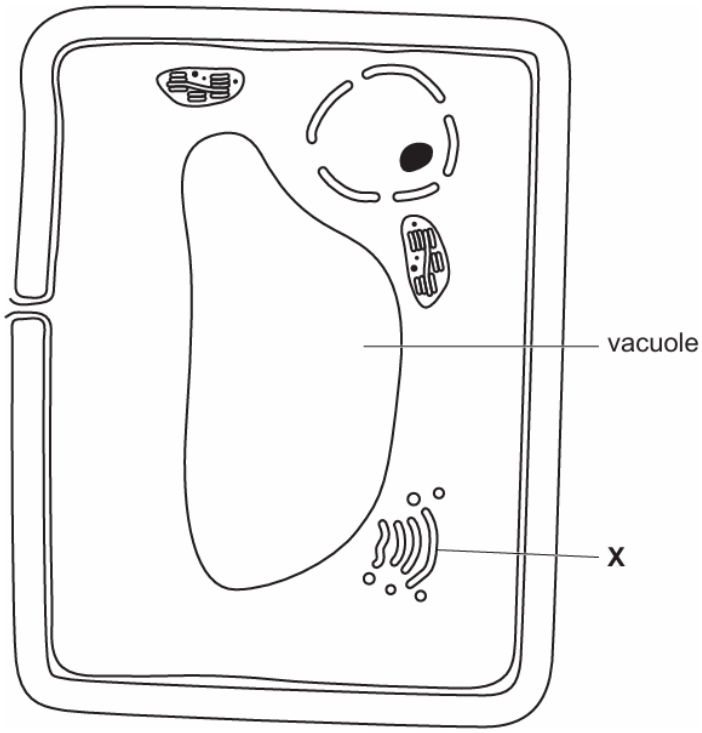


Fig. 1.2

(i) Complete Fig. 1.2 by drawing **and** labelling:

- a mitochondrion
- rough endoplasmic reticulum
- smooth endoplasmic reticulum.

Your drawings should show the detail that can be seen in a transmission electron micrograph. [3]

(ii) Identify the organelle labelled **X and** state **one** function of this organelle.

name .....

function .....

.....

[2]

2 Fig. 4.1 is a scanning electron micrograph showing the tissue that lines the bronchi in the gas exchange system.

Fig. 4.2 is a transmission electron micrograph of a horizontal section made at the position indicated by the two arrows in Fig. 4.1.

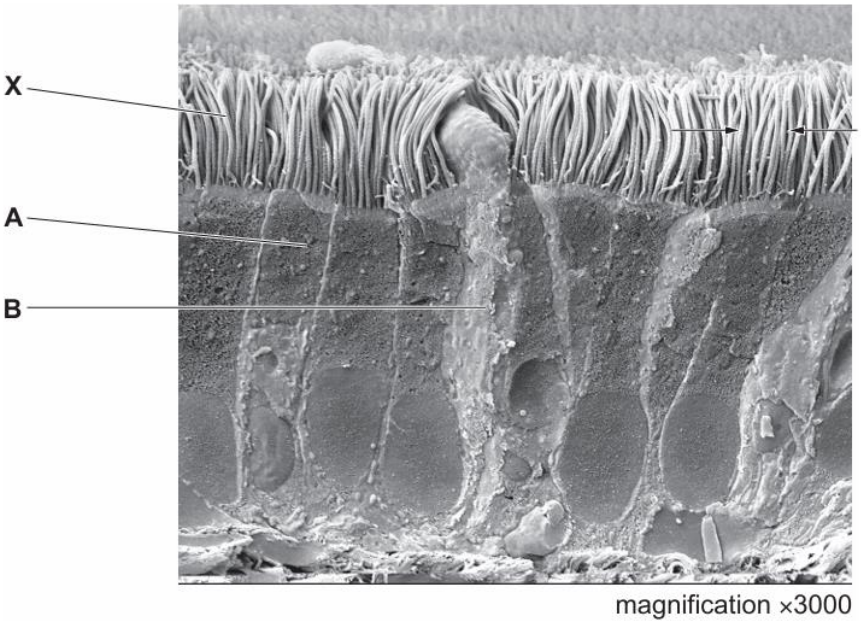


Fig. 4.1

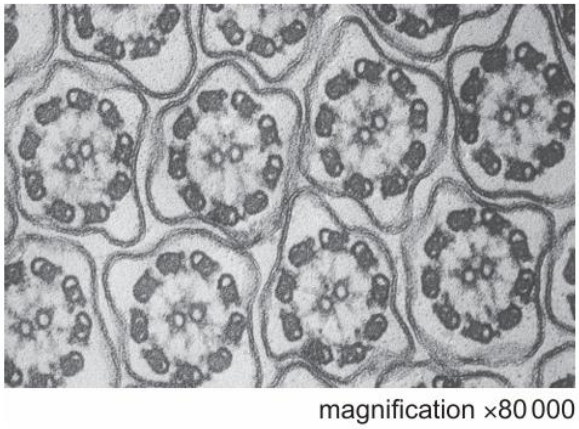


Fig. 4.2

(b) (i) The structures labelled **X** in Fig. 4.1 have a characteristic internal appearance, as seen in Fig. 4.2.

Describe the internal appearance of the structures labelled **X**.

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..... [2]

(ii) Explain how Fig. 4.2 shows that each of the structures labelled **X** are intracellular.

.....

..... [1]

3 Alveolar macrophages are cells of the immune system that remain in the alveolar region of the gas exchange system. The macrophages protect against infection caused by pathogens that have been inhaled.

(a) Alveolar macrophages have the same cell structures as typical animal cells.

(i) Complete Table 2.1 to **name** the cell structures that match the functions stated.

Do **not** use abbreviations.

Table 2.1

cell structure	function
.....	manufactures ribosomal subunits from proteins and ribosomal RNA
.....	synthesises triglycerides and other lipids
pair of	organise microtubules of the cell cytoskeleton

[3]

(ii) Fig. 2.1 is a diagram of an alveolar macrophage showing:

- some of the cell structures that would be visible using an electron microscope
- a newly formed phagocytic vacuole (phagosome) containing two cells of *Mycobacterium tuberculosis*.

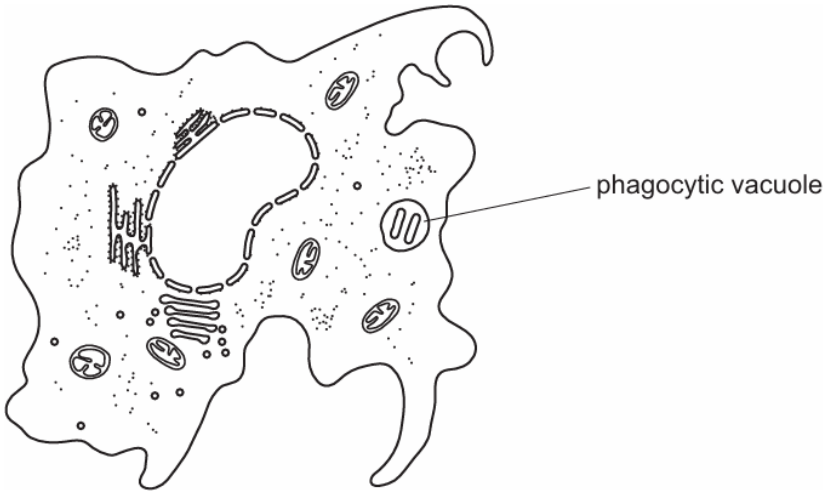


Fig. 2.1

The cell structures with the functions described in Table 2.1 are **not** shown in Fig. 2.1.

Complete Fig. 2.1 by drawing **and** labelling the cell structures described in Table 2.1. [2]

4 People who become infected with human immunodeficiency virus (HIV) are at risk of developing HIV/AIDs, particularly if antiretroviral therapy (ART) is not available.

In people with HIV/AIDs, a serious lung disease known as pneumocystis pneumonia can result from infection by an opportunistic pathogen known as *Pneumocystis jirovecii*.

Fig. 2.1 shows *P. jirovecii* cells in one stage of their life cycle, as seen using a light microscope at a magnification of ×600.

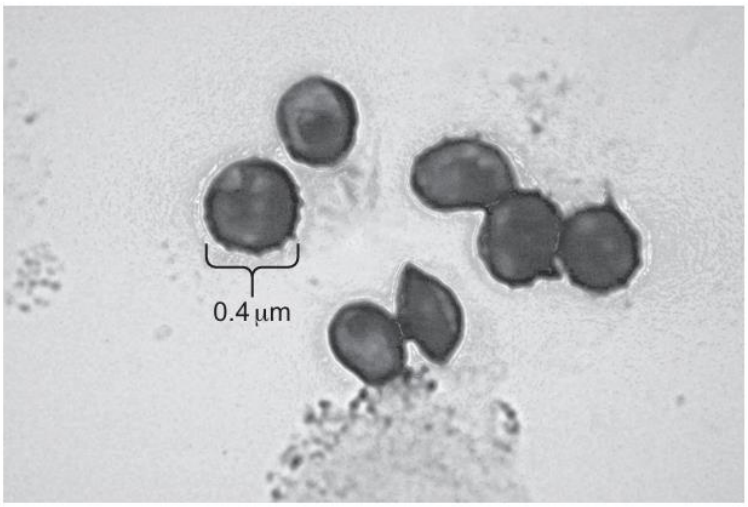


Fig. 2.1

(c) Fig. 2.1 shows that *P. jirovecii* is a unicellular organism. Although the cells of many species of bacteria are the same size as those of *P. jirovecii*, research concluded that the organism is a eukaryote and is **not** a bacterium.

In 1988, analysis of ribosomal RNA (rRNA) resulted in *P. jirovecii* being classified as a fungus.

(i) Studies of the structure of *P. jirovecii* have identified that the cell wall is made of polysaccharides such as chitin and 1,3-β-D-glucan.

Explain why this feature helped scientists to confirm that *P. jirovecii* is **not** a bacterium.

.....

.....

..... [1]

(ii) Scientists have identified other features of the cell structure of *P. jirovecii*. Some of these are listed in Table 2.1.

Complete each row of Table 2.1 so that the table shows:

- four structural features identified in *P. jirovecii*
- one function for each structural feature
- whether the structural feature is present (✓) or absent (✗) in bacterial cells.

Table 2.1

structural feature of *P. jirovecii*	**function**	**present (✓) or absent (✗) in bacterial cells**
ribosomes	protein synthesis	
smooth endoplasmic reticulum		
Golgi body	modification of proteins and lipids	
	aerobic respiration	

[3]

5 **(a)** Animal cells, plant cells and prokaryotic cells have similarities and differences in their structure.

Table 1.1 lists five organelles found in cells.

Complete Table 1.1 by placing a tick (✓) to show whether the organelle is present in animal cells, plant cells and prokaryotic cells or a cross (✗) if the organelle is absent.

Put a tick (✓) or a cross (✗) in every box.

The first row has been completed for you.

Table 1.1

organelle	cell type		
	animal cells	plant cells	prokaryotic cells
nucleus	✓	✓	✗
large permanent vacuole			
rough endoplasmic reticulum			
Golgi body			
centrioles			

[4]

(b) Fig. 1.1 shows a section through part of an epithelial cell found in the digestive system of an animal.

The cell is specialised for absorption of digested food.

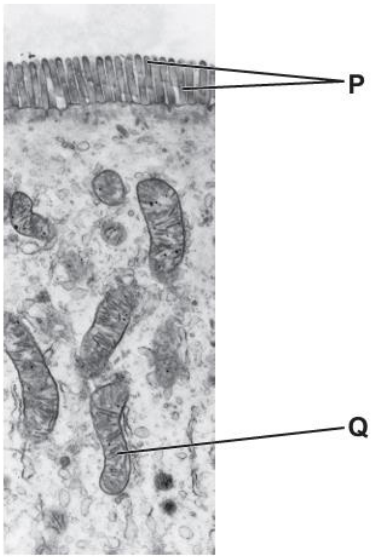


Fig. 1.1

The structures labelled **P** and **Q** in Fig. 1.1 are involved in the absorption of digested food.

(i) Name the structures labelled **P**.

..... [1]

(ii) Explain how the organelle labelled **Q** in Fig. 1.1 is involved in this process.

.....

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.....

.....

..... [2]

6 Fig. 2.1 is a photomicrograph of a longitudinal section (LS) through a root tip. Two different regions are visible:

- the root apical meristem
- the root cap.

Cells in the root cap synthesise a gel-like, sticky secretion known as mucilage, which is important in reducing friction between soil and the growing root. It is composed mainly of polysaccharides and also contains some amino acids and enzymes.

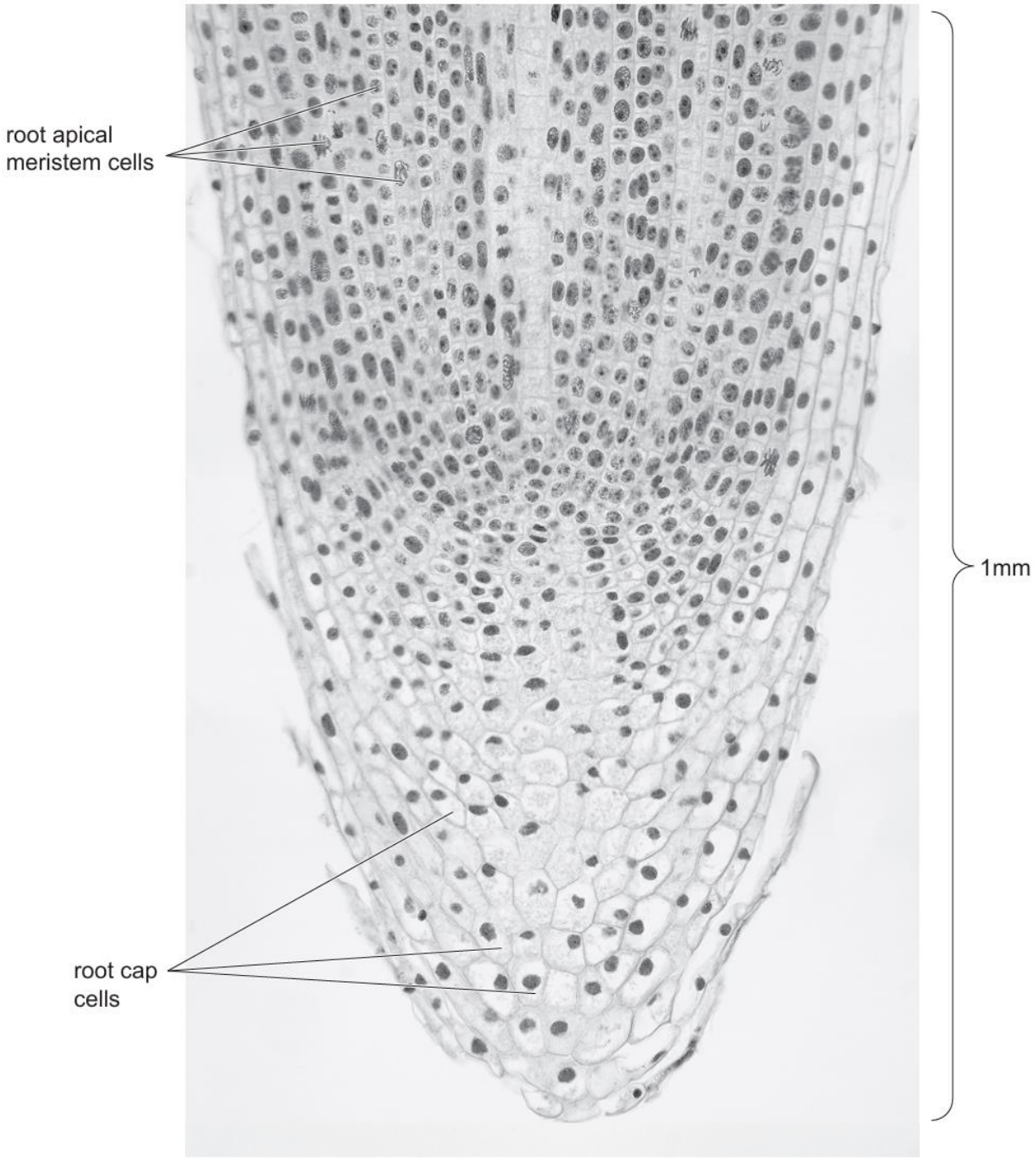


Fig. 2.1

(a) Describe **three** differences, **visible** in Fig. 2.1, between root apical meristem cells and root cap cells.

1 .....

.....

.....

.....

2 .....

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3 .....

.....

.....

.....

[3]

7 *Trypanosoma brucei* is a unicellular organism that causes the infectious disease known as sleeping sickness. Insects known as tsetse flies pass on the organism from infected people to uninfected people when male and female tsetse flies feed on human blood.

(a) Fig. 4.1 is a transmission electron micrograph of the form of *T. brucei* found in human blood.

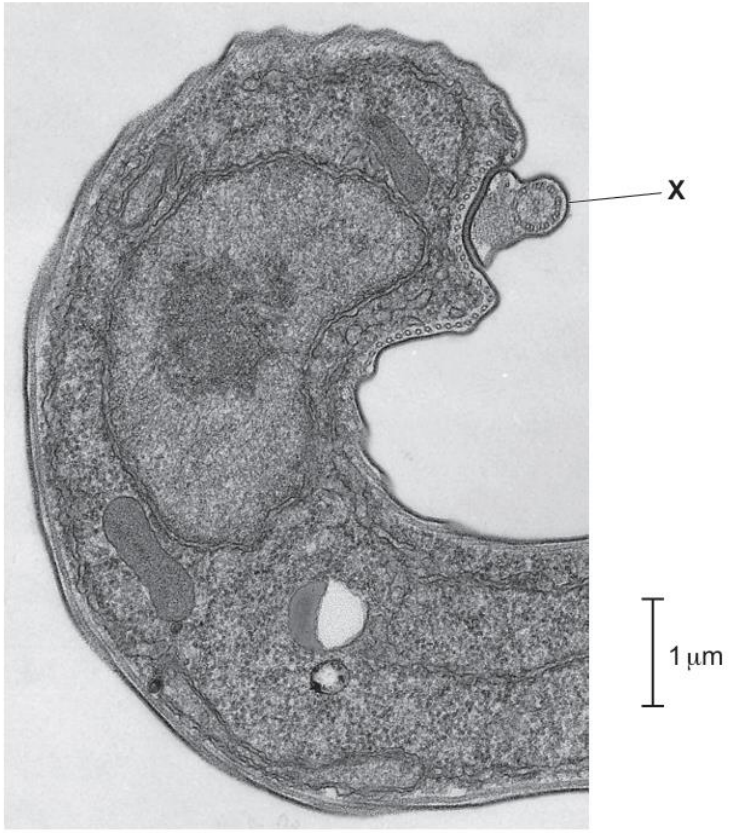


Fig. 4.1

(i) Draw an arrow on Fig. 4.1 to indicate the location in the cell where ribosomal RNA (rRNA) and proteins are assembled to make ribosomal subunits. [1]

(ii) With reference to Fig. 4.1, explain how the structure labelled **X** provides evidence that *T. brucei* is motile (able to move).

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..... [2]

(iii) With reference to Fig. 4.1, explain whether *T. brucei* is a eukaryote or prokaryote.

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..... [3]

8 Fig. 1.1 is a transmission electron micrograph of a cell from the stem of sago pondweed, *Stuckenia pectinata*.

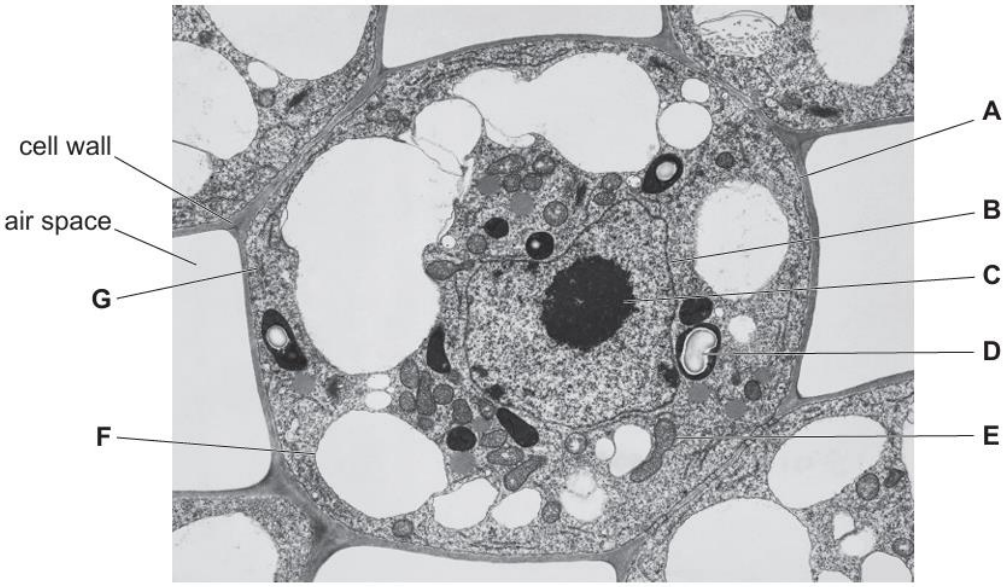


Fig. 1.1

(a) (i) State the evidence from Fig. 1.1 that shows that the cell is from the stem of *S. pectinata* and **not** from the mesophyll of a leaf.

.....

..... [1]

(ii) Complete each row in Table 1.1 to identify a cell structure shown in Fig. 1.1 that carries out the function listed.

Table 1.1

function	name of cell structure	letter on Fig. 1.1
gas exchange		
production of subunits of ribosomes		
active transport of ions		
aerobic respiration		

[4]

(b) Plant vacuoles develop when vesicles fuse together. The vacuoles increase in size as more vesicles fuse.

Fig. 1.2 shows the movement of vesicles within a plant cell during the development of a vacuole.

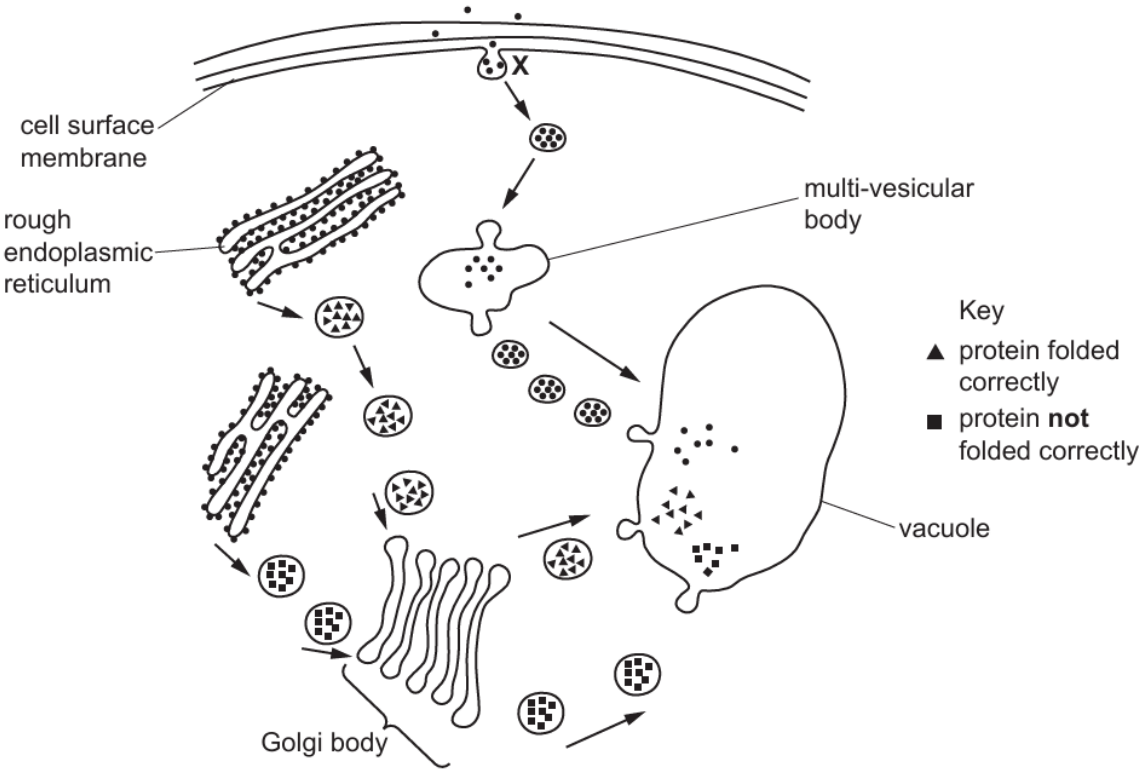


Fig. 1.2

(i) Name the process that is occurring at **X**.

..... [1]

(ii) Some of the vesicles formed by the Golgi body pass to the vacuole. These vesicles contain proteins that have been folded correctly and some that have **not** folded into their correct shapes. The proteins that have **not** folded correctly pass to the vacuole where they are broken down.

Explain how proteins that have **not** folded correctly are broken down in the vacuole.

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..... [3]

(c) Small vacuoles in *S. pectinata* may have roles similar to lysosomes in animal cells.

Describe the role of lysosomes in animal cells in defence against pathogens.

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.....

.....

..... [2]

9 The liver receives blood from the hepatic artery and from the hepatic portal vein. The hepatic portal vein transports blood from the digestive system.

Hepatocytes are the main cell type of the liver. They have a wide range of functions, including:

- the synthesis of triglycerides and plasma proteins
- detoxifying waste
- energy storage.

(c) Fig. 3.2 is a transmission electron micrograph of part of a hepatocyte showing some cell structures.

The peroxisome shown in Fig. 3.2 is a spherical organelle bound by a single membrane. It carries out a variety of enzyme-catalysed metabolic reactions, including detoxification. Some of these reactions require oxygen.

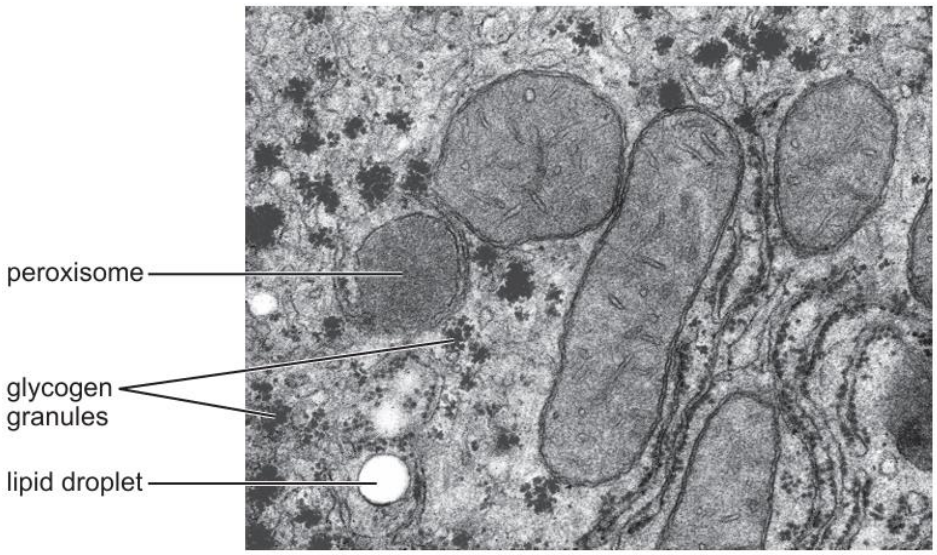


Fig. 3.2

(i) Describe the evidence **visible** in Fig. 3.2, apart from the presence of a peroxisome, that indicates some of the functions of a hepatocyte.

Add labels to Fig. 3.2 to identify the location of any cell structures, if not already labelled, that are part of your evidence.

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.....

..... [3]

(ii) The mitochondria in Fig. 3.2 are larger than the peroxisome.

State **one other** difference, **visible** in Fig. 3.2, between a peroxisome and a mitochondrion.

.....

.....

.....

..... [1]

(iii) Some of the enzymes used within mitochondria can be synthesised by the organelle. Peroxisomes cannot synthesise any of the enzymes that they contain.

Suggest why a mitochondrion can synthesise enzymes, but a peroxisome cannot synthesise enzymes.

.....

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.....

..... [2]

(iv) One of the enzymes present in peroxisomes is catalase. This enzyme catalyses the breakdown of hydrogen peroxide to harmless products.

Suggest why it is useful to the cell for this reaction to take place within peroxisomes.

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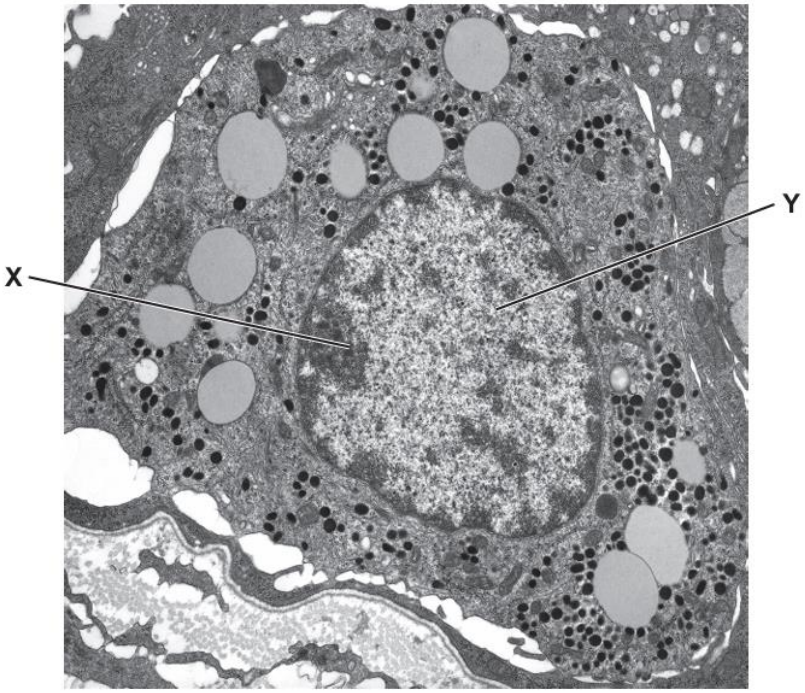
.....

.....

.....

..... [2]

10 Fig. 2.1 is a transmission electron micrograph showing a section of a specialised epithelial cell found in the lining of the stomach. This cell produces extracellular proteins that are released into the bloodstream.



×6000

Fig. 2.1

(a) Outline the role of structure **X** and structure **Y**, as shown in Fig. 2.1, in the production of extracellular proteins.

structure **X** .....

.....

.....

structure **Y** .....

.....

.....

[2]

11 B-lymphocytes are activated to form plasma cells during immune responses.

Fig. 2.1 is a drawing of a plasma cell made from a transmission electron micrograph.

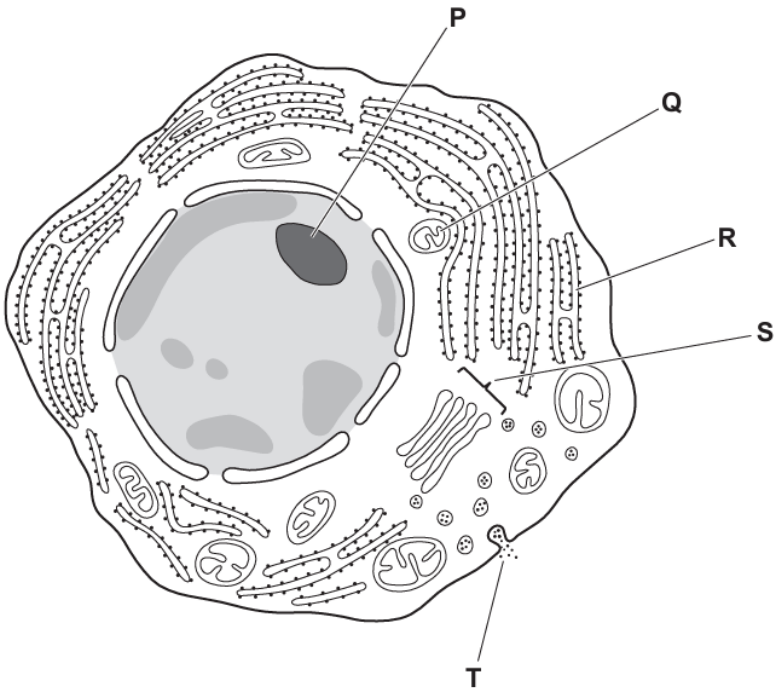


Fig. 2.1

(a) (i) State the name of the process that is occurring at **T**.

..... [1]

(ii) Complete Table 2.1 to show the names and functions of the cell structures labelled **P**, **Q**, **R** and **S** in the plasma cell shown in Fig. 2.1.

Table 2.1

cell structure in Fig. 2.1	name of cell structure	function of cell structure in plasma cell
P		
Q		
R		
S		

[4]

12 Human cytomegalovirus (HCMV) is a common virus affecting humans. In people with a fully functioning immune system, infection by HCMV usually causes no, or only mild, symptoms.

Fig. 2.1**A** is a diagram of a section through HCMV. In Fig. 2.1**B**, only the outer part of HCMV is sectioned.

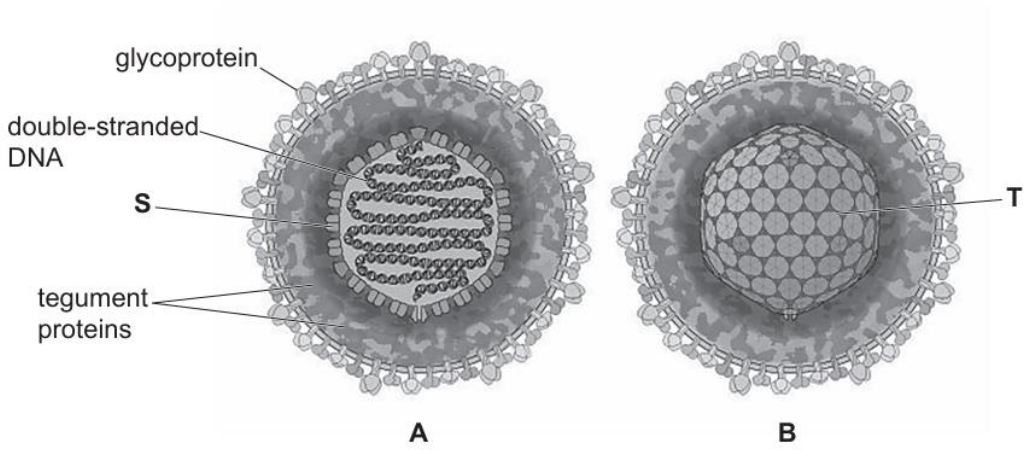


Fig. 2.1

The viral DNA shown in Fig. 2.1 contains genes that code for proteins important in viral replication and viral structure, including viral DNA polymerase and proteins known as tegument proteins.

Viruses can only replicate in host cells as they need to use processes and contents of the host cell. Complete viral particles that are released from the host cell are known as virions.

(a) Structure **S** in Fig. 2.1**A** is a subunit of structure **T** in Fig. 2.1**B**.

Name the chemical compound used to make structure **S and** name structure **T**.

S .....

T .....
[2]

(d) The virus in Fig. 2.1 is drawn as a spherical shape. Structure **T** is always the same shape. However, electron micrographs show that HCMV virions are not all the same shape.

Suggest how HCMV virions can be of different shapes.

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.....

.....

.....

..... [2]

(e) With reference to Fig. 2.1**A**, state **one** similarity **and one** difference between the genetic material of HCMV and the genetic material of a typical bacterial cell.

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..... [2]

13 **(a)** Fig. 1.1 is a transmission electron micrograph showing a section of a human liver cell.

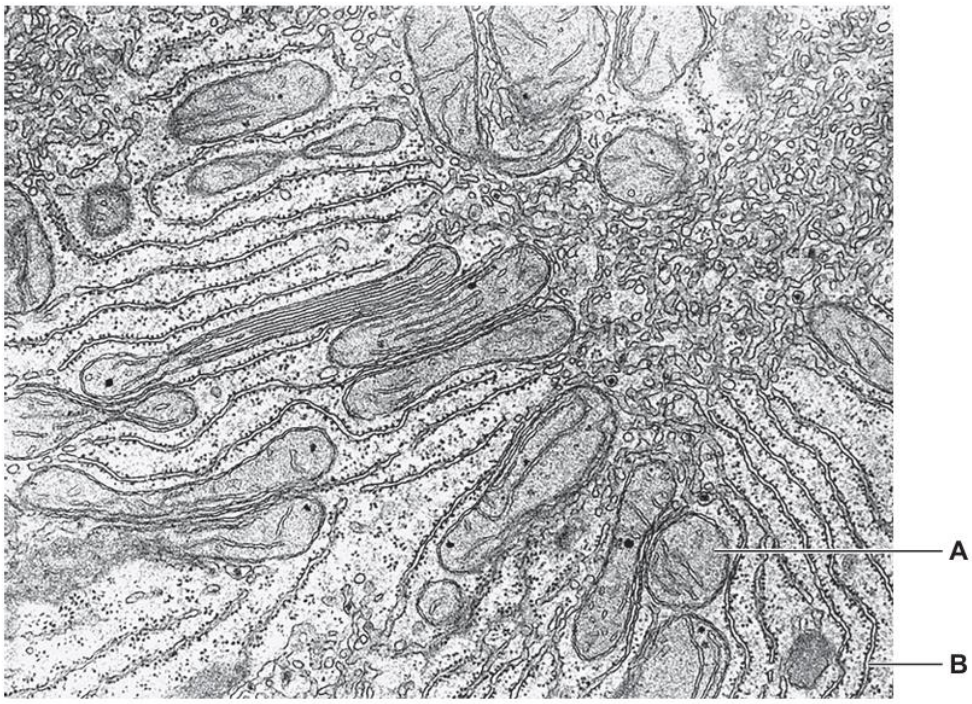


Fig. 1.1

(i) Name organelles **A** and **B** shown in Fig. 1.1.

A .....

B .....
[2]

(ii) In liver cells, enzymes are attached to the membrane of smooth endoplasmic reticulum.

With reference to the functions of smooth endoplasmic reticulum, suggest the advantages of having enzymes attached to the membrane rather than free in the lumen.

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.....

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.....

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..... [3]

14 **(a)** Scientists have produced structures known as virosomes, which are used in certain vaccines. Virosomes do **not** cause disease.

Fig. 4.1 is a diagram of a section through a virosome used in some vaccinations to protect against the virus which causes influenza.

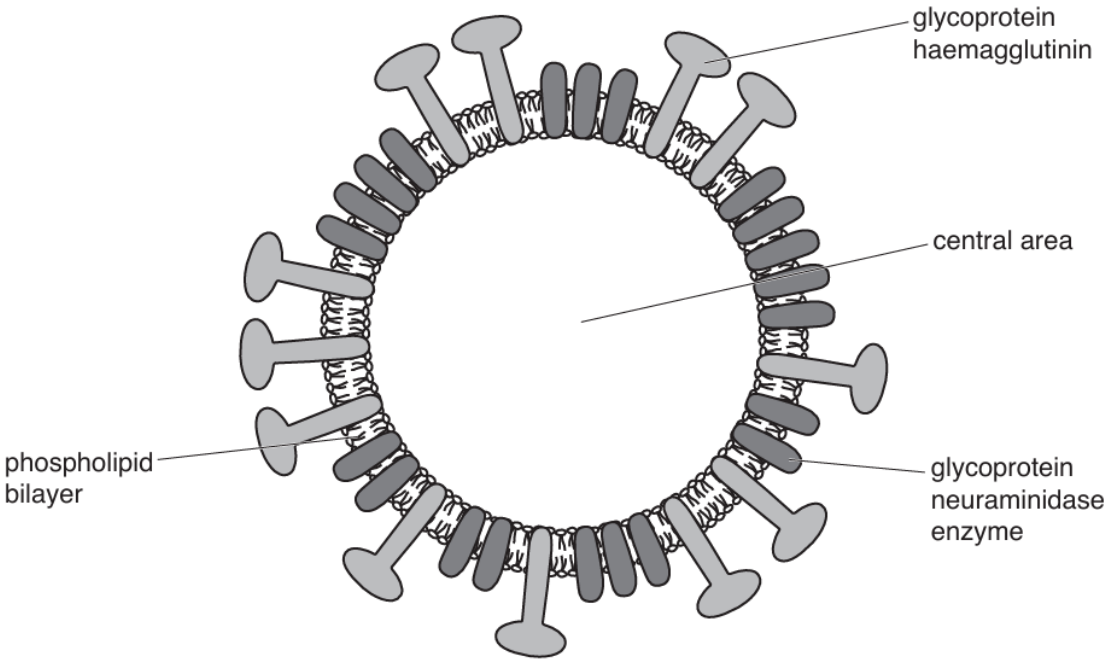


Fig. 4.1

(i) State the differences between the structure of a virosome and a virus.

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.....

.....

..... [2]

15 **(c)** Scientists have studied the process of cell death that occurs during the development of the cells that become mature xylem vessel elements.

During this development, the tonoplast ruptures (bursts) and releases hydrolytic enzymes contained in the vacuole into the cytoplasm.

(i) Name an organelle found in animal cells that has a similar function to the vacuole in the developing xylem vessel elements.

..... [1]

16 In mammals, some cell signalling molecules are steroid (lipid) hormones. These hormones are transported in the bloodstream to reach capillary networks.

At a capillary network, hormones pass out of the blood into tissue fluid.

(d) The hormone-receptor complex shown in Fig. 3.2 enters the nucleus and binds to DNA. This switches on a gene coding for a polypeptide that is synthesised in the cytoplasm.

(i) Name the structure through which the hormone-receptor complex enters the nucleus.

..... [1]

17 Fig. 5.1 is a transmission electron micrograph showing parts of two plant cells. The function of the middle lamella is cell-to-cell adhesion. The middle lamella is composed of a polysaccharide known as pectin.

Pectin interacts with the polysaccharides cellulose and hemicellulose in the cell walls of the plant cells so that the cell walls are held close together, as shown in Fig. 5.1.

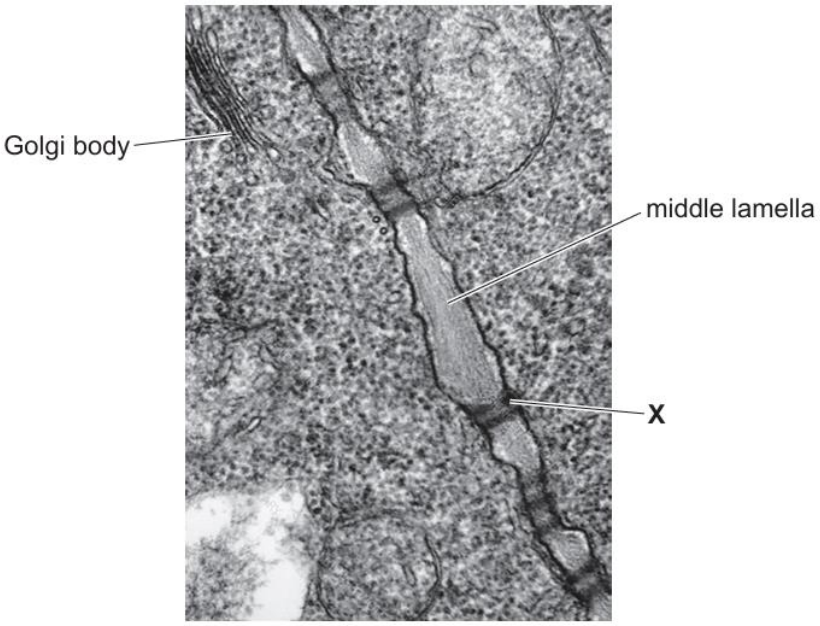


Fig. 5.1

(a) Cell structure **X** in Fig. 5.1 is a cytoplasmic channel with strands of cytoplasm passing through the cell walls of the two cells.

Name cell structure **X and** state **one** function of this cell structure.

name .....

function .....

..... [2]

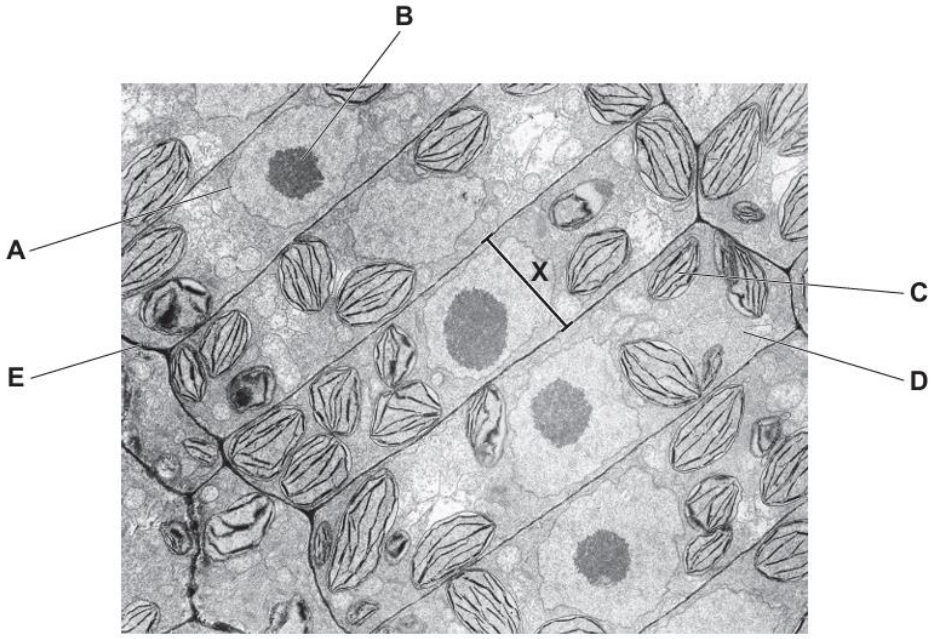
(b) Researchers have discovered that pectin is synthesised within the Golgi body. Golgi vesicles containing pectin are moved to the cell surface membrane for release.

(i) Suggest why researchers would **not** have investigated ribosomes as being the possible location for the synthesis of pectin.

.....

..... [1]

18 Fig. 1.1 is a transmission electron micrograph of cells from duckweed, *Spirodela oligorrhiza*.



magnification ×4275

Fig. 1.1

(b) (i) Table 1.1 lists some biological molecules found in plant cells.

Complete Table 1.1 by choosing **one** letter from Fig. 1.1 that indicates a cell structure where each biological molecule is found.

Table 1.1

biological molecule	letter from Fig. 1.1
DNA	
cellulose	
phospholipid	
histone proteins	

[4]

(ii) State the name of a cell structure, **visible in Fig. 1.1**, where ATP is synthesised.

..... [1]

19 Lysosomes are cell structures that contain enzymes known as acid hydrolases.

Fig. 6.1 shows some processes that occur in animal cells.

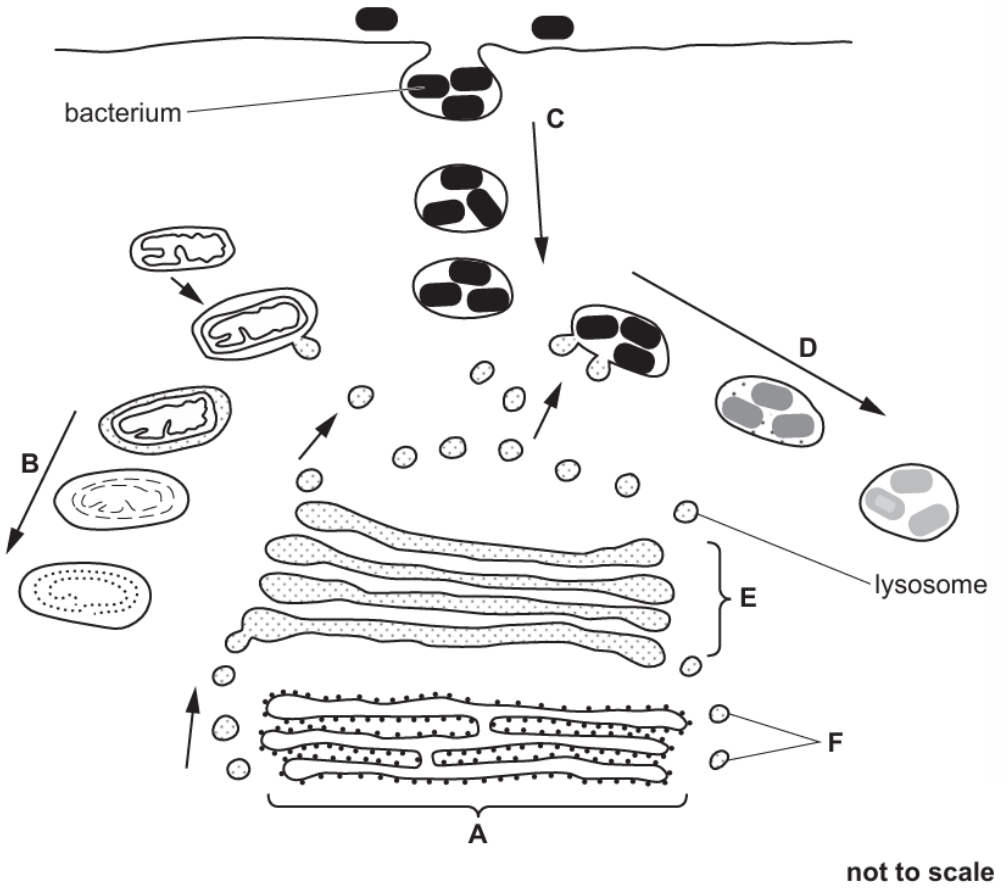


Fig. 6.1

(a) Name the cell structures labelled **A** and **E**.

A .....

E .....

[2]

(b) State the function of the structures labelled **F**.

.....

..... [1]

(d) With reference to the processes occurring at **B** and at **D** in Fig. 6.1, outline the role of acid hydrolases in lysosomes.

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..... [3]

20 There are two types of cell, prokaryotic and eukaryotic. Bacterial cells are prokaryotic and plant cells are eukaryotic.

(a) There are differences in the structural features that are common to bacterial cells and plant cells. For example, the cell surface membrane in a plant cell contains cholesterol, but in a bacterial cell the membrane contains molecules known as hopanoids. Cholesterol and hopanoids have the same function.

Some of the main structural features common to both types of cell are shown in Table 1.1.

Complete Table 1.1 by giving **one** difference between a bacterial cell and a plant cell for each structural feature listed.

The difference between the cell surface membranes of the two types of cell has been completed for you.

Table 1.1

feature common to bacterial and plant cells	bacterial cell	plant cell
cell surface membrane	contains hopanoids	contains cholesterol
ribosome		
DNA		
cell wall		

[3]

(c) Fig. 1.1 is a photomicrograph showing chloroplasts in plant leaf cells.

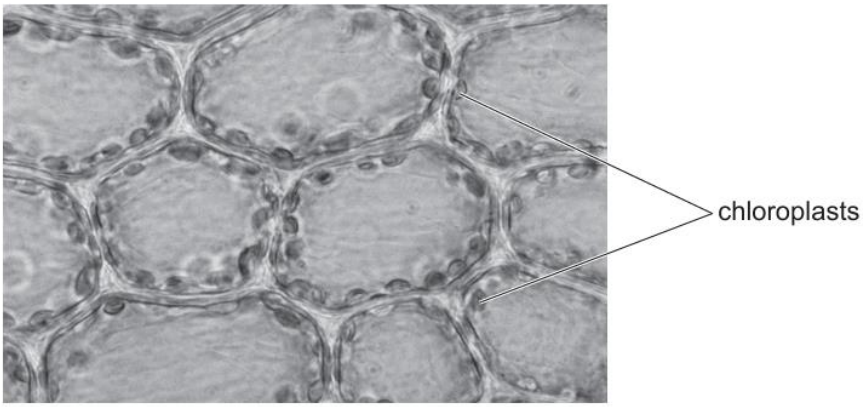


Fig. 1.1

Explain why the chloroplasts are seen only around the periphery (edge) of each plant cell.

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.....

..... [1]

21 **(a)** Fig. 1.1 is a transmission electron micrograph of cells from the leaf of a plant.

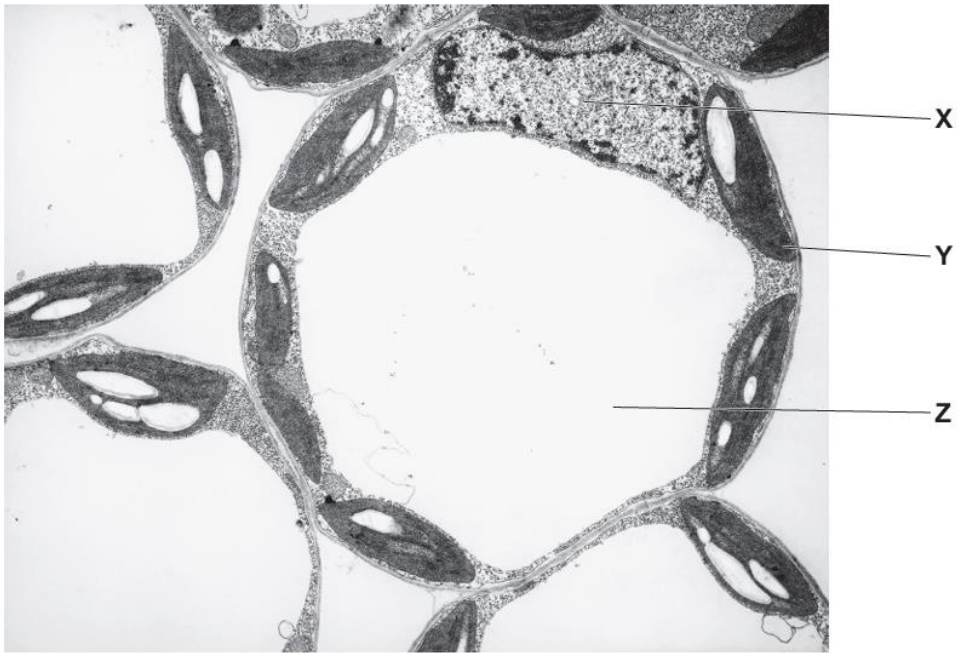


Fig. 1.1

(i) Name the cell structures **X**, **Y**, and **Z**.

X .....

Y .....

Z .....

[3]

(ii) State **two** ways in which the structure of an animal cell differs from plant cells such as those shown in Fig. 1.1.

1 .....

.....

2 .....

.....

[2]

22 Picornaviruses are small viruses that are 30 nm in diameter. Picornaviruses are able to enter the cells of mammals and birds and can replicate within these cells.

Fig. 1.1 shows the entry of a picornavirus into its host cell.

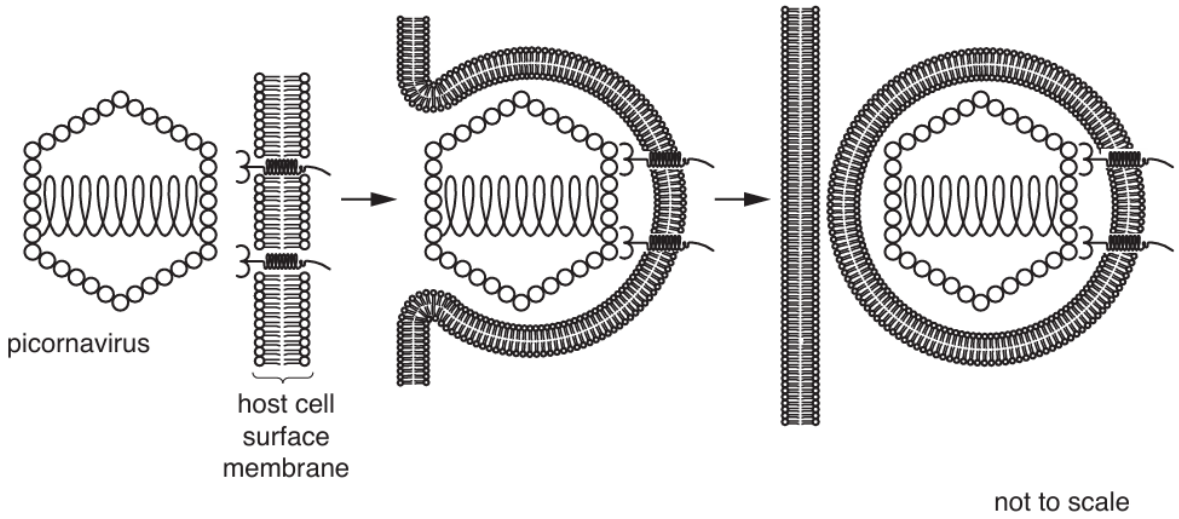


Fig. 1.1

(a) State the key features of a virus, such as picornavirus.

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.....

..... [2]

23 Collagen is a major component of the cartilage found in some of the structures of the human gas exchange system. Cells that synthesise and secrete the components of cartilage are known as chondrocytes.

(a) Fig. 4.1 is a transmission electron micrograph of a chondrocyte.

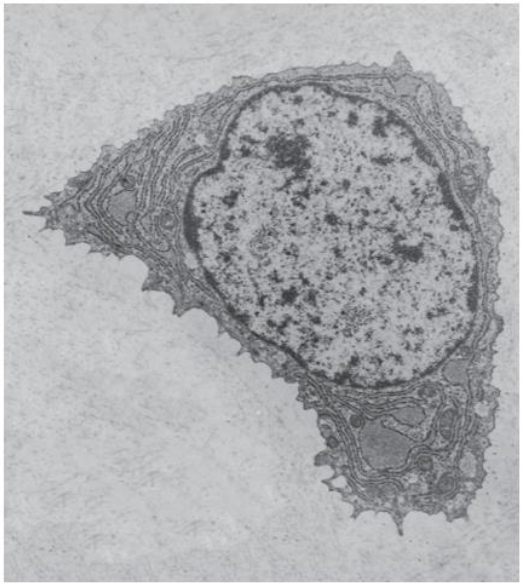


Fig. 4.1

With reference to Fig. 4.1, explain **two** features of the chondrocyte that show how the cell is adapted to its function.

.....

.....

.....

.....

..... [2]

24 **(a)** Fig. 1.1 is a diagram of a human chromosome at a stage in mitosis.

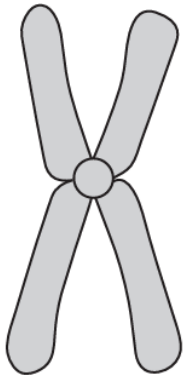


Fig. 1.1

(iii) Suggest the role of ATP in the process of mitosis.

.....

.....

.....

.....

..... [2]

(b) Prokaryotes divide by a process known as binary fission.

Fig. 1.2 shows some of the stages in binary fission.

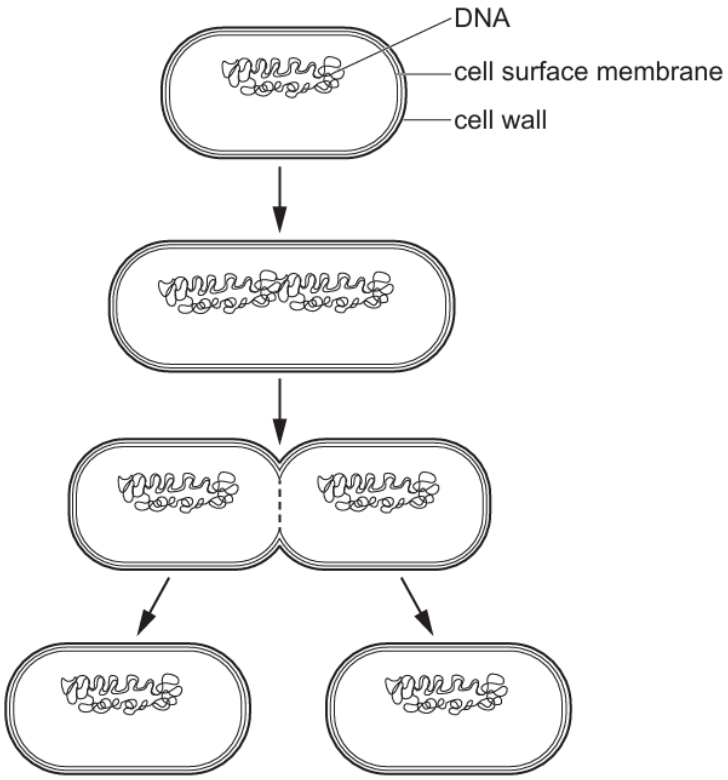


Fig. 1.2

With reference to Fig. 1.2, identify **two** events that occur during binary fission that do **not** occur during mitosis in human cells.

.....

.....

.....

.....

..... [2]

25 **(a)** Fig. 4.1 is a scanning electron micrograph of a section of a plant cell wall.

In living plant tissue cytoplasmic strands form part of structure **W**.

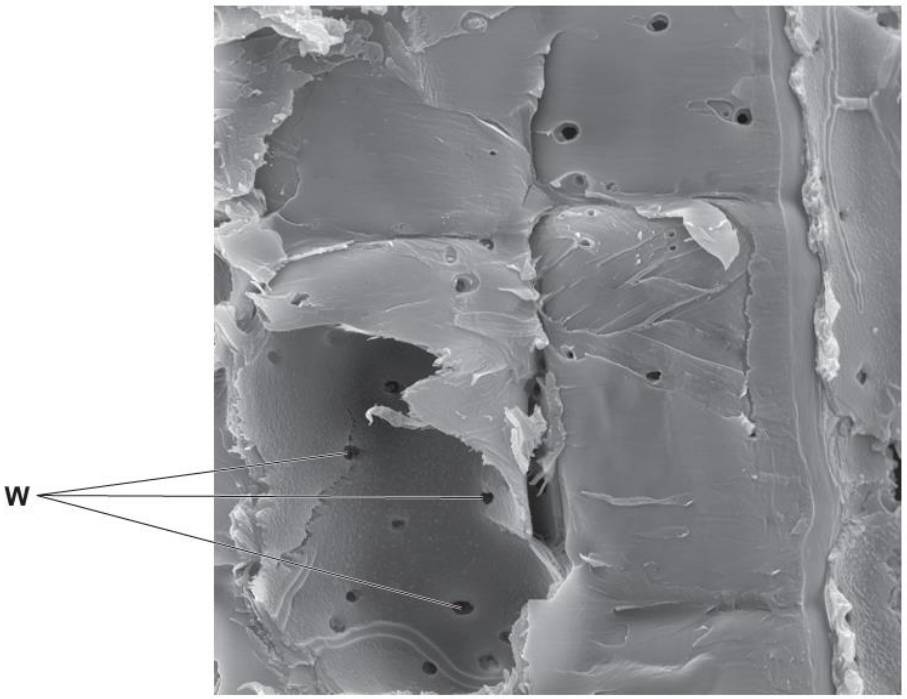


Fig. 4.1

(i) Identify the structures labelled **W** in Fig. 4.1.

..... [1]

(ii) Describe the function of structure **W**.

.....

.....

.....

.....

..... [2]

(b) Viruses can infect plant cells.

(i) Outline the key structural features of a virus.

.....

.....

.....

..... [2]

26 Fig. 1.1 shows the structure of the amino acid glycine.

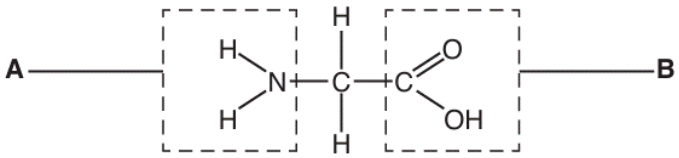
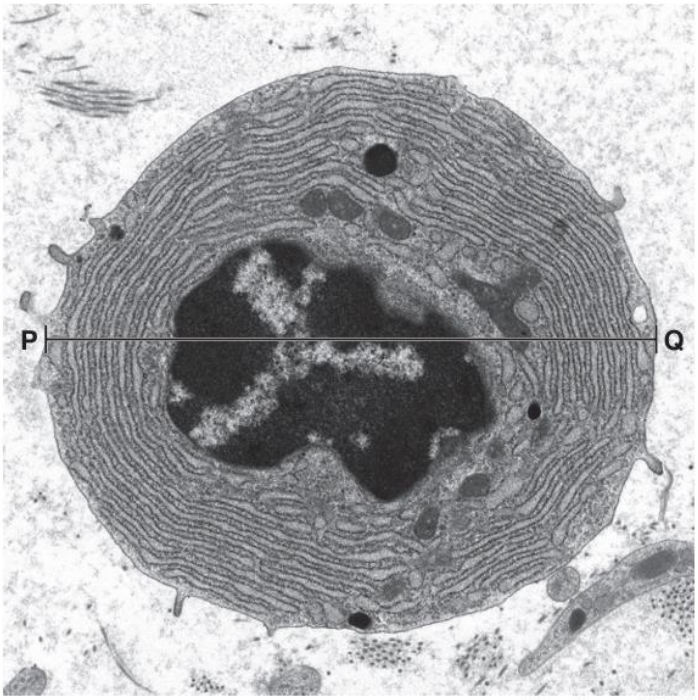


Fig. 1.1

(b) Plasma cells synthesise and secrete antibodies.

Fig. 1.3 is a transmission electron micrograph showing a plasma cell.



magnification ×6000

Fig. 1.3

(i) Use a label line and the label **T** on Fig. 1.3 to identify where the genes coding for the polypeptide chains of the antibodies are located. [1]

(ii) Calculate the actual diameter of the plasma cell shown by the line **P**–**Q**.

Write down the formula used to make your calculation.

Show your working and give your answer to the nearest micrometre (μm).

formula

actual diameter = ... μm [2]

(iii) The plasma cell in Fig. 1.3 is very metabolically active.

Suggest why there are very few mitochondria visible in the electron micrograph in Fig. 1.3.

.....

.....

..... [1]

27 Fig. 1.1 is a photomicrograph of a transverse section through the stem of creeping buttercup, *Ranunculus repens*.

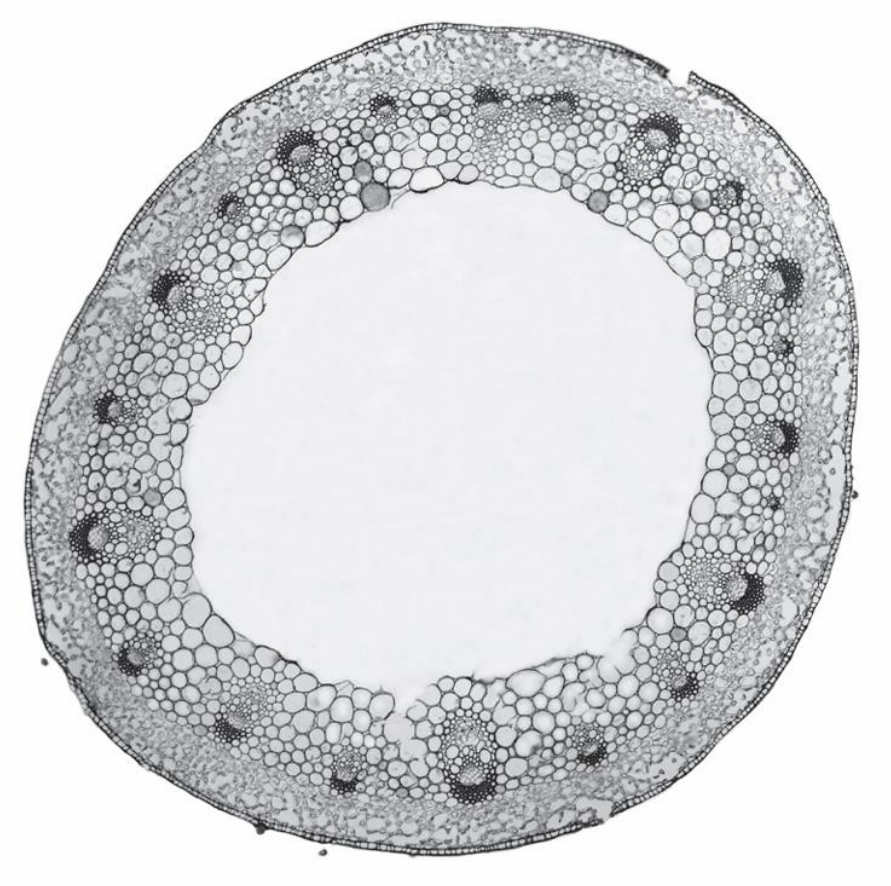


Fig. 1.1

(d) Draw a diagram in the space provided to show the structure of a typical plant cell.

Label your diagram with the name of any structures that are found **only** in plant cells.

Do **not** label any structures that are also found in animal cells.

[5]

28 **(b)** Fig. 1.2 is a transmission electron micrograph of a hybridoma cell.

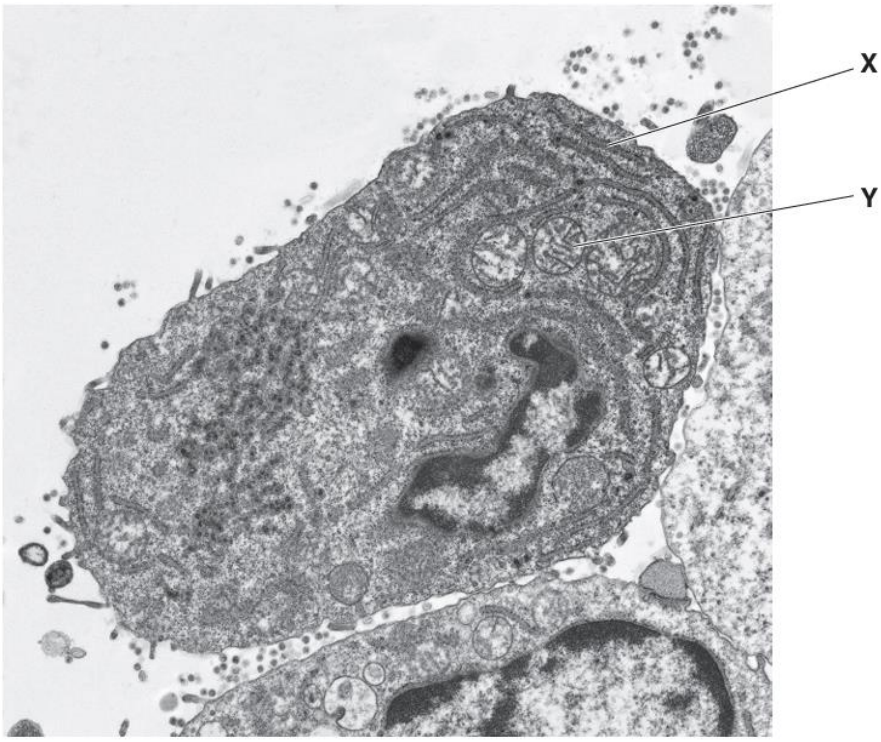


Fig. 1.2

(i) The hybridoma cell in Fig. 1.2 synthesises and secretes molecules of a monoclonal antibody.

State the roles of the structures labelled **X** and **Y** in the production of antibody molecules in the hybridoma cell.

X .....

.....

.....

Y .....

.....

.....

[2]

29 Some tissues of the gas exchange system include cells that are able to produce and secrete mucins. Mucins are stored in vesicles in these cells, ready for secretion. Once outside the cell, mucins adsorb water to form mucus.

(b) Mucins are described as glycosylated proteins. The process of glycosylation involves the addition of sugar components after polypeptides are synthesised.

Suggest **one** location in the cell where glycosylation of mucin could occur.

..... [1]

30 The bacterium *Vibrio cholerae* is the causative organism of the infectious disease cholera.

V. cholerae has structural features typical of all bacterial cells. It also has a flagellum for movement.

(a) Fig. 4.1 is an outline drawing of *V. cholerae*.

Complete Fig. 4.1 by drawing **and** labelling the structures found in *V. cholerae*.

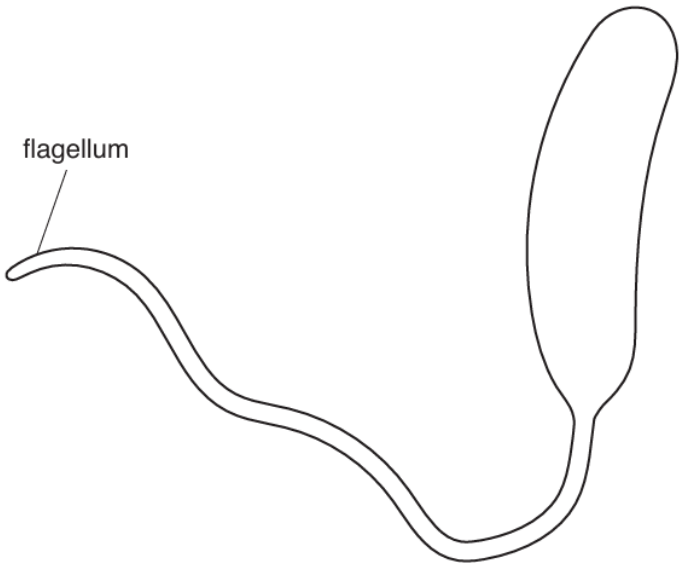


Fig. 4.1

[4]

31 Fig. 1.1 is a drawing of a photomicrograph of a spongy mesophyll cell from a leaf.

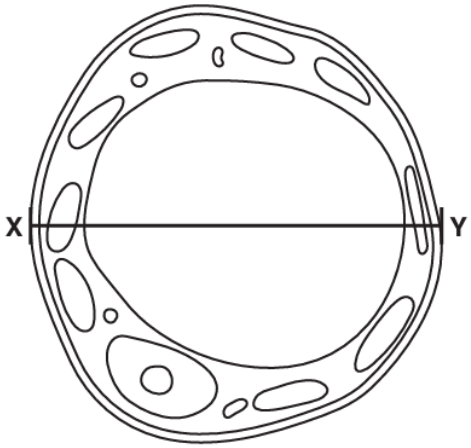


Fig. 1.1

(a) On Fig. 1.1, add a label line and the correct letter for each of the three cell structures listed.

- nucleolus = **N**
- tonoplast = **T**
- chloroplast = **C**

[3]

(c) The drawing in Fig. 1.1 was made using the high power objective lens of a light microscope. Some of the structures in Fig. 1.1 confirm that the cell is eukaryotic.

An electron micrograph of the same cell would reveal **additional** cell structures that are found in eukaryotes and not in prokaryotes.

List two examples of these additional cell structures.

1 .....

2 .....

[2]

32 Fig. 1.1 is a transmission electron micrograph of a cell from the root of thale cress, *Arabidopsis thaliana*.

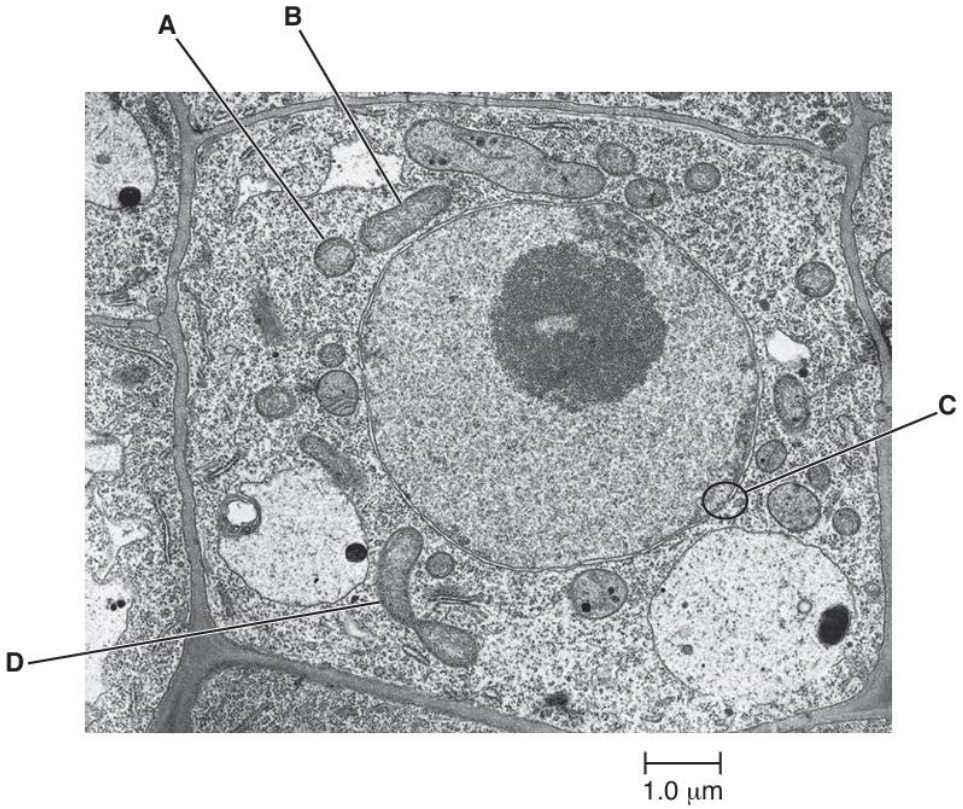


Fig. 1.1

(a) (i) The structures labelled **A** and **B** on Fig. 1.1 are sections of two mitochondria.

Suggest why **A** and **B** are different shapes.

.....

.....

.....[1]

(ii) The structure labelled **D** on Fig. 1.1 is a mitochondrion about to divide.

Explain the importance of the division of mitochondria for the cell shown in Fig. 1.1 **and** for cells in the root tips of thale cress.

.....

.....

.....

.....

.....[2]

(b) Within a cell, substances move between the nucleus and the cytoplasm. The area labelled **C** in Fig. 1.1 shows an area where this communication occurs.

Make a large, labelled drawing of area **C** to show where this communication occurs.

[2]

(c) Outline the functions of the nucleus in non-dividing cells, such as the cell in Fig. 1.1.

.....

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.....

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.....

.....

.....[4]

33 Viruses share common structural features. Some viruses, such as human immunodeficiency virus (HIV), also have an outer envelope as part of their structure.

(a) Outline the key structural features of viruses.

.....

.....

.....

.....

.....

.....

..... [3]

34 As a red blood cell matures, cell organelles are lost from the cell. This provides more space for the haemoglobin molecules that have been synthesised.

(a) The red blood cell has a short lifespan due to the loss of the nucleus and other organelles.

State **one** function performed by each of the organelles listed, before they are lost from the developing red blood cell.

rough endoplasmic reticulum

.....

Golgi body

.....

centrioles

.....

[3]

35 **(a)** Fig. 3.1 is a transmission electron micrograph showing two adjacent cells in a leaf.

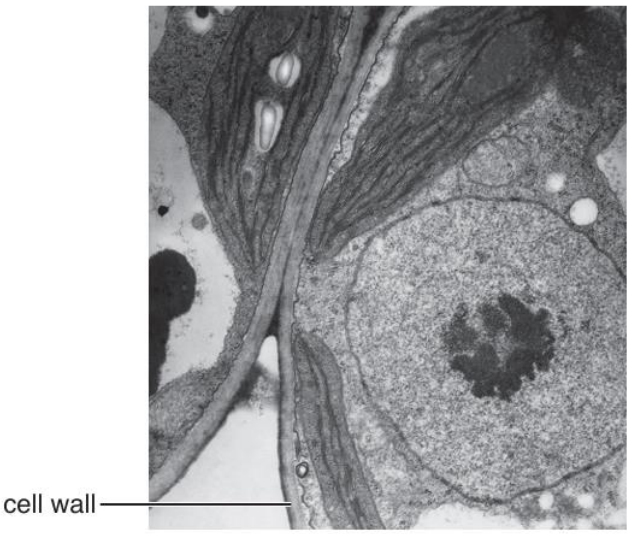


Fig. 3.1

(ii) State **one** feature **visible** in Fig. 3.1, other than the cell wall, that identifies the cells as plant cells.

..... [1]

(iii) Outline the role of ATP in a leaf cell.

.....

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.....

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..... [3]

36 **(a)** Fig. 5.1 shows the structure of a prokaryotic cell.

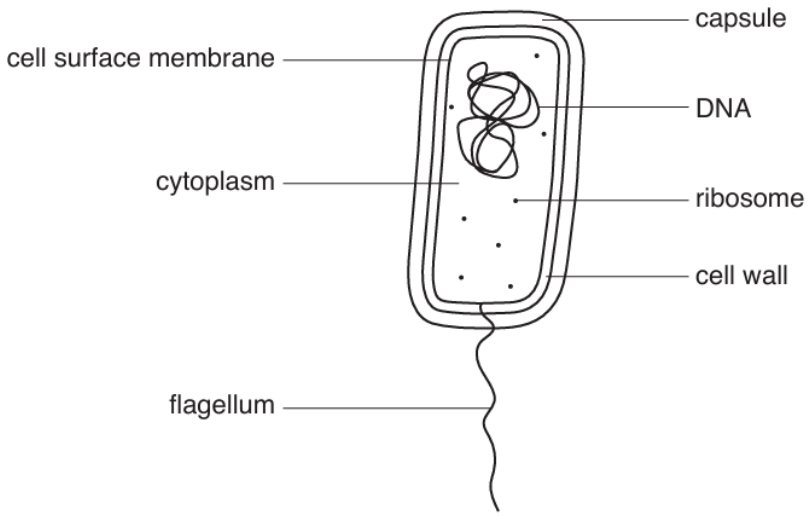


Fig. 5.1

Fig. 5.1 has **not** been fully labelled to confirm that the cell is prokaryotic.

State what **other** information could be added to **two** of the labels to confirm that this cell is prokaryotic and **not** eukaryotic.

.....

.....

..... [2]