

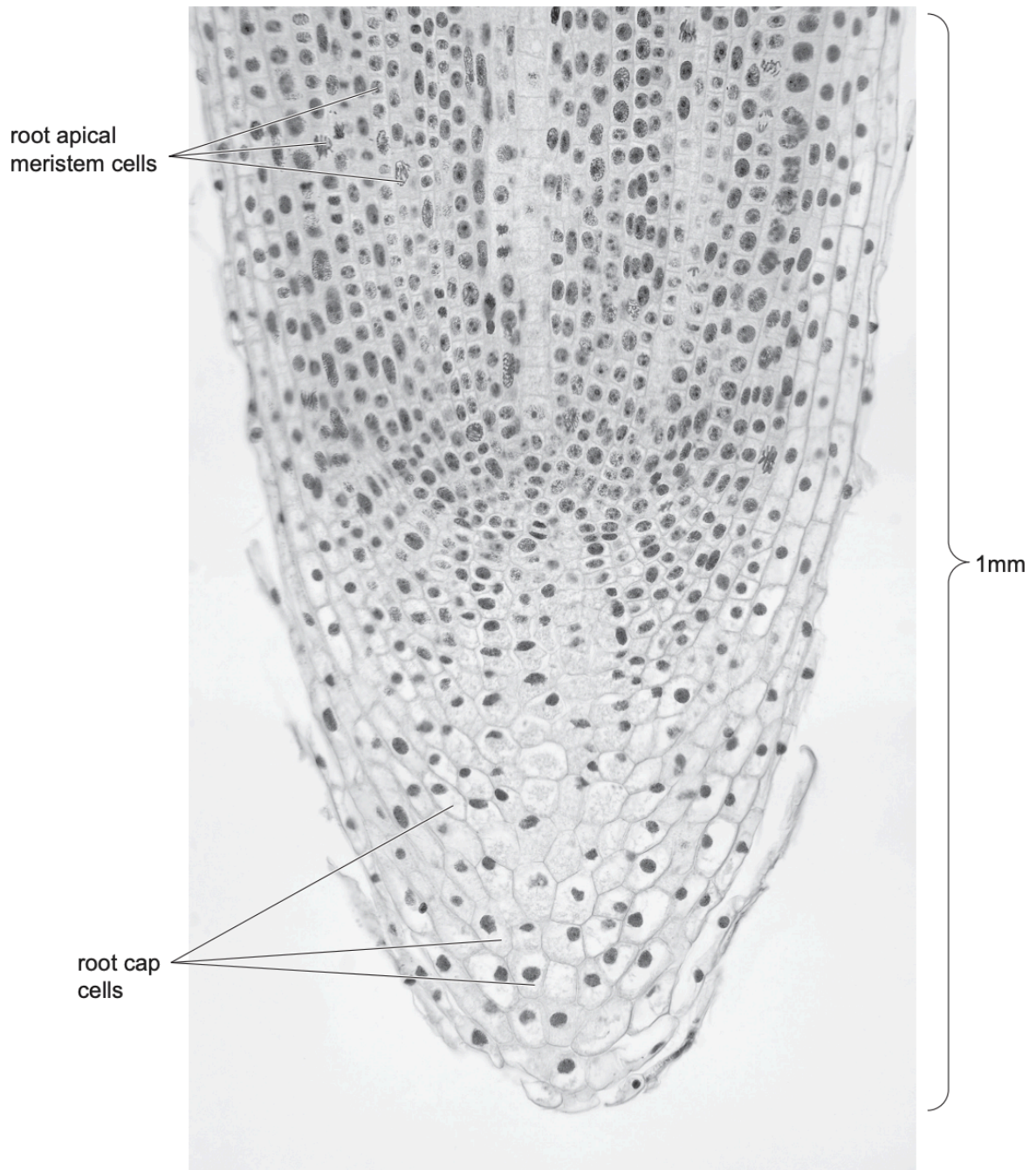
# 1. Cell structure

1.

2 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.

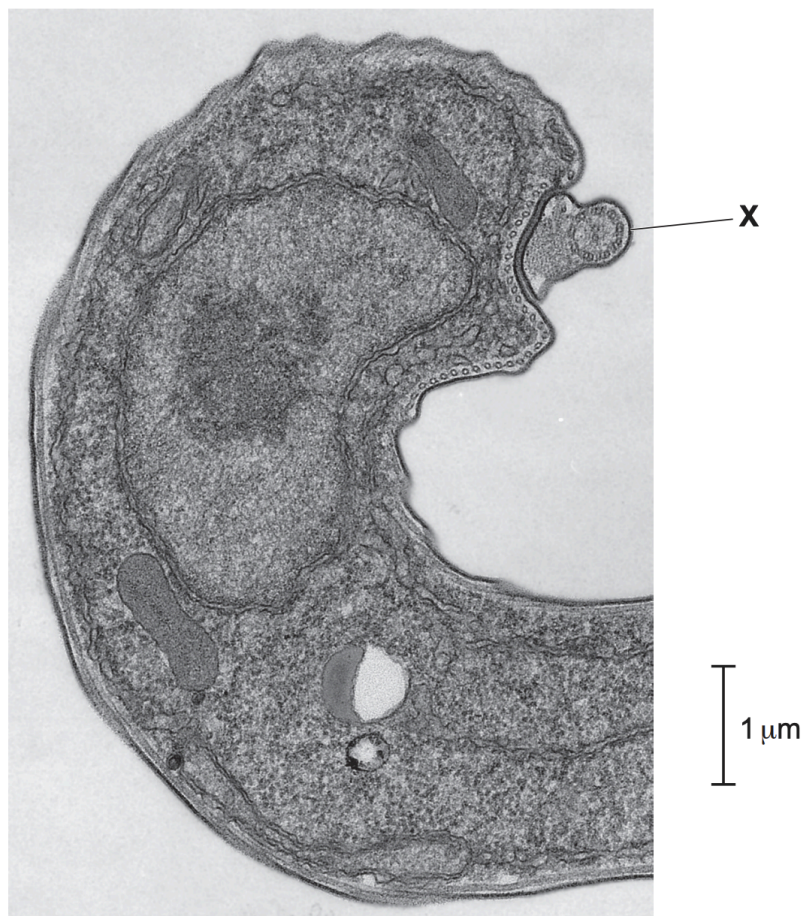


Describe three differences, visible in Fig. 2.1, between root apical meristem cells and root cap cells.

Root apical meristem cells	Root cap cells
some cells in mitosis/ different stages of cell cycle; some cells in prophase/ metaphase/ telophase; chromosomes visible in some cells	no cells in mitosis/ all cells in interphase; no chromosomes visible/ only chromatin visible
generally smaller size/ less cytoplasm	generally larger size/ more cytoplasm
larger nucleus in proportion to size of cell/ quantity of cytoplasm	smaller nucleus in proportion to size of cell/ quantity of cytoplasm
nucleolus more visible/ prominent	nucleolus not visible/ not prominent
generally all cuboidal/ same shape	variety of shapes – irregular / circular
arrangement of cells: rows/ tightly packed/ compact/ uniform/ regular	arrangement of cells: loosely packed/ irregular/ more intercellular spaces

2. Trypanosoma brucei is a unicellular organism.

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



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

- X is a flagellum
- circular cross section/ looks cylindrical, which suggests tubular structure, hence flagellum
- presence of microtubules
- presence of 9 + 2 microtubule arrangement / pattern in cross section
- location of X on outer part of cell, so can move

With reference to Fig. 4.1, explain whether *T. brucei* is a eukaryote or prokaryote. eukaryote because presence of:

- nucleus / nuclear envelope / nuclear membranes
- mitochondrion
- nucleolus
- chromatin
- endoplasmic reticulum
- X has 9+2 pattern of microtubules
- X is covered by cell surface membrane

not prokaryote because:

- absence of cell wall
- (size) greater than 5 µm – larger than typical prokaryote / bacterial cell

3. Describe the roles of the rough endoplasmic reticulum and the Golgi body in synthesising glycoproteins.

rough endoplasmic reticulum

- translation of mRNA // polypeptide/protein synthesis at ribosomes
- polypeptide/protein folding in lumen
- formation of transport vesicles / vesicles for transport to Golgi body

Golgi body

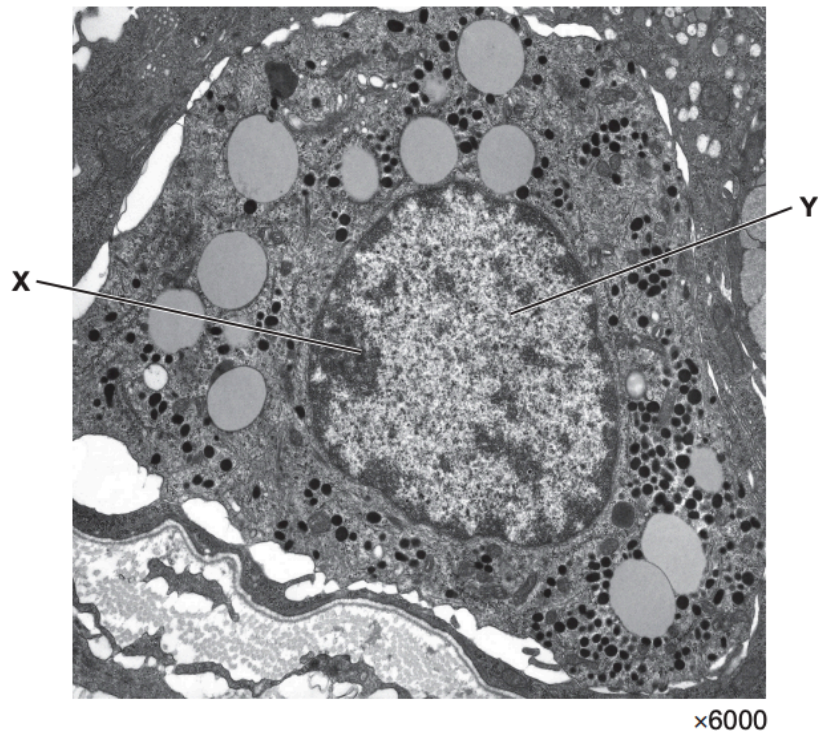
- packaging into Golgi / secretory vesicles // formation of Golgi / secretory vesicle containing glycoprotein // packaging into vesicles for transport to cell surface membrane

rough endoplasmic reticulum or Golgi body

- modification by glycosylation of protein: e.g attachment of sugars / oligosaccharide / polysaccharide / carbohydrate
- checking for misfolded / incorrectly synthesised proteins
- additional detail of post-translational modification: eg. formation of quaternary structure / addition of non-protein groups

4.

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.



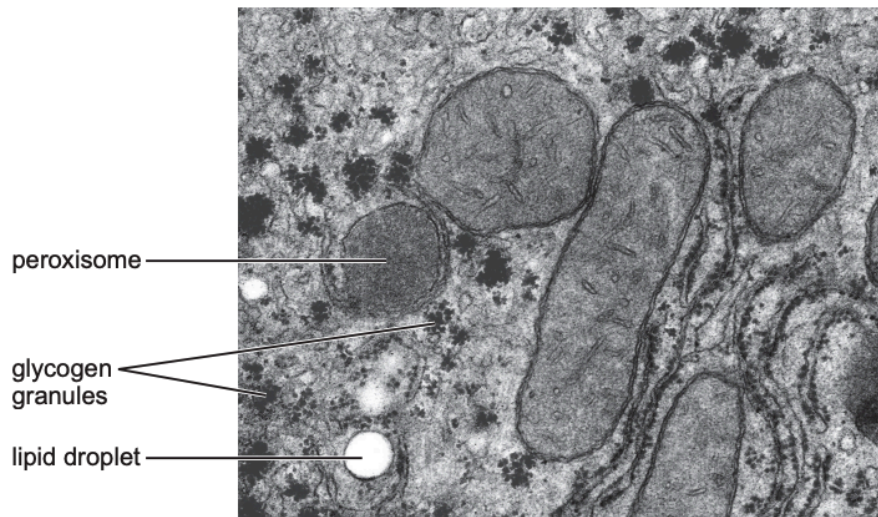
Outline the role of structure X and structure Y, as shown in Fig. 2.1, in the production of extracellular proteins.

- Structure X: (nucleolus) = synthesis of ribosomal subunits / ribosomes
- Structure Y: (chromatin) = contains genes, coding for the polypeptides

5.

- (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.

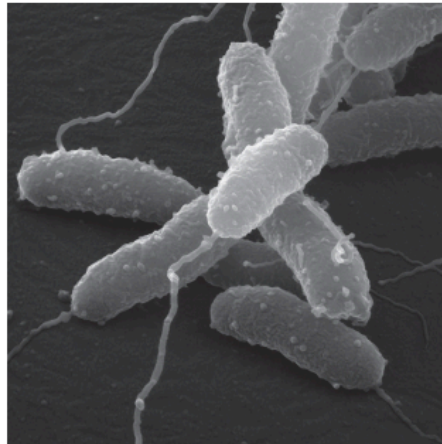


- a. Describe the evidence visible in Fig. 3.2, apart from the presence of a peroxisome, that indicates some of the functions of a hepatocyte.
- Smooth endoplasmic reticulum
    - for lipid/ triglyceride / cholesterol synthesis
    - tubular appearance / no ribosomes
  - Rough endoplasmic reticulum
    - for protein synthesis
    - flattened sac appearance
  - Ribosomes
    - for protein synthesis
  - Mitochondria
    - many mitochondria
    - for (aerobic) respiration
    - produce ATP / provide energy
    - double membrane / presence of cristae
  - presence of glycogen granules as energy / glucose store
  - presence of lipid droplets as energy store
- b. State differences visible in Fig. 3.2, between a peroxisome and a mitochondrion.
- Mitochondrion is larger
  - mitochondrion bound by / has double membrane / two membranes

- peroxisome no cristae / mitochondrion has cristae
  - peroxisome spherical shape and mitochondria different shapes
- c. Suggest why a mitochondrion can synthesise enzymes, but a peroxisome cannot synthesise enzymes.
- Mitochondria has DNA / genes which code for enzymes
  - Mitochondria has 70S ribosomes = site of enzyme synthesis
  - has the enzymes for transcription / translation to synthesise enzymes
  - can produce ATP (for enzyme synthesis)
- d. 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.
- peroxisome membrane bound, so rest of cell protected from hydrogen peroxide
  - peroxisome acts as a compartment / specific area / contained for more efficient breakdown of hydrogen peroxide / control of reactions ;
  - high concentration of enzyme in one location so more enzyme-substrate complexes can form
  - provides optimum conditions for reactions

6.

Fig. 5.1 shows an electron micrograph of the pathogen that causes cholera.

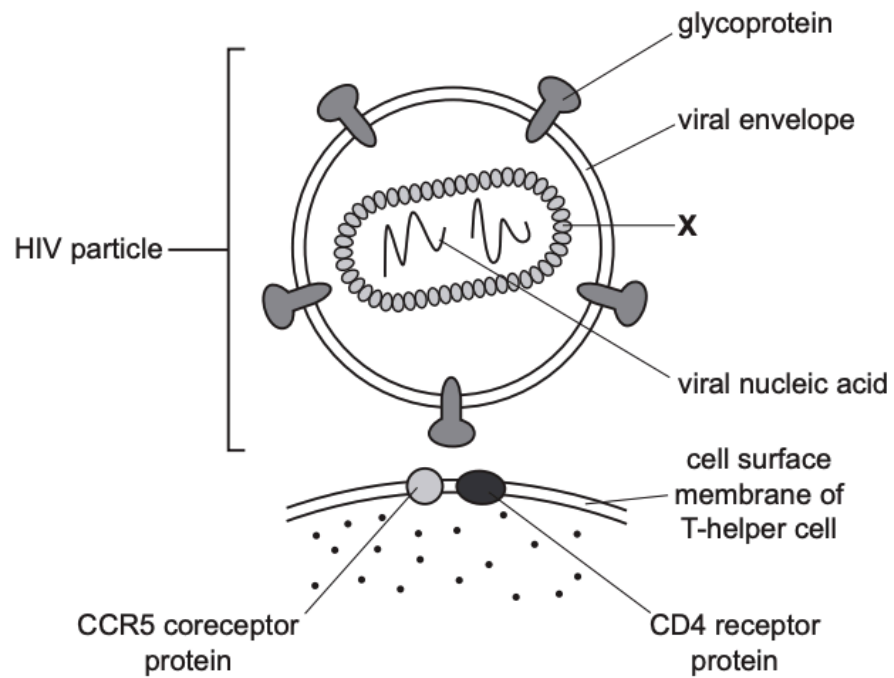


**Fig. 5.1**

(i) Name the type of electron microscope used to produce the image shown in Fig. 5.1.

- Scanning electron microscope

7.



Identify structure X

- Protein coat/ capsid

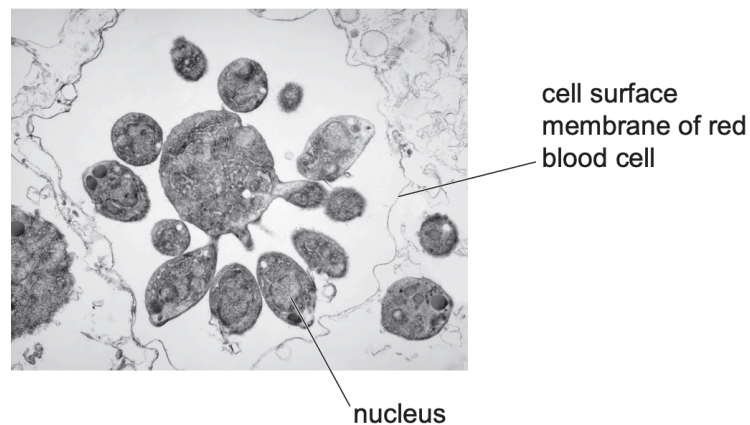
8. Define magnification

- the number of times larger an image is than actual

9.

The malarial pathogen, *Plasmodium falciparum*, enters red blood cells after a person becomes infected. After some time, each cell of *P. falciparum* divides to form daughter cells.

Fig. 1.1 shows a cell of *P. falciparum* that is forming many daughter cells.



With reference to Fig. 1.1, suggest how the presence of *P. falciparum* affects a red blood cell

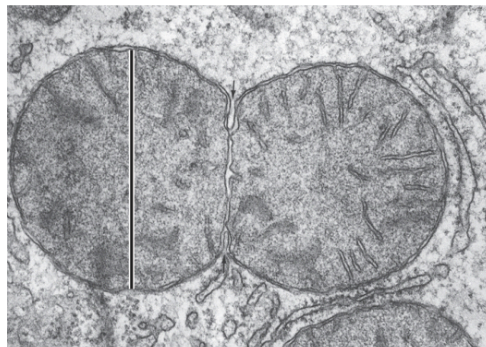
- irregular shape of cell (surface) membrane / cell loses its biconcave shape  
OR cell swells / cell is larger / cell expands

Any 2 from:

- cell membrane bursts / cell bursts / cell dies / cell lysis / haemolysis OR short(er) life span
- daughter cells fill the cell
- cell loses haemoglobin / haemoglobin used up by pathogen – pathogen uses amino acids from haemoglobin
- less / no oxygen transported OR reduced / decreased uptake of oxygen
- release of toxins by pathogen

10.

Fig. 4.2 is a transmission electron micrograph of a mitochondrion that is dividing.



magnification  $\times 50\,000$

State two features of mitochondria that are visible in Fig. 4.2.

- mitochondrial envelope / two membranes / double membrane / inner membrane and outer membrane
- inner membrane is folded / cristae
- (70S) ribosomes
- mitochondrial matrix

11. Name one substance that may be added to the network formed by the cellulose microfibrils in the formation of a cell wall.

- Hemicellulose / pectin / lignin

Thickness of cell surface membrane = 7nm

12. Function of golgi body

- Modification of proteins
- Packaging of proteins into golgi vesicles

13. Describe the internal appearance of cilia

- 9+2 pattern / arrangement / structure
- composed of microtubules
- AVP: dynein 'arms'
- outer 9 are pairs of microtubules / doublets and central two are single

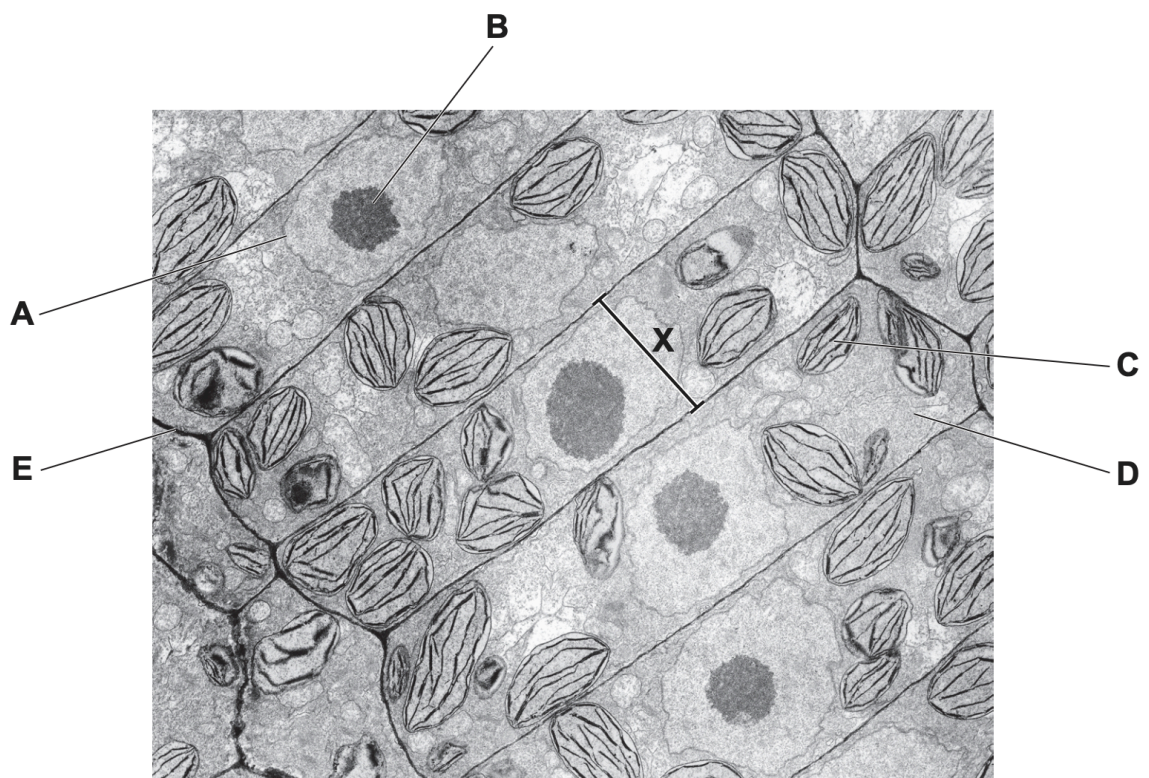
14. Name the type of microscope slide that is used to calibrate eyepiece graticule.

- Stage micrometer

NOTE:

Function of a pair of centrioles: to organise the microtubules of the cell cytoskeleton

1.



magnification  $\times 4275$

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**

<b>biological molecule</b>	<b>letter from Fig. 1.1</b>
DNA	
cellulose	
phospholipid	
histone proteins	

[4]

**DNA – A / B / C ;**  
**cellulose – E ;**  
**phospholipid – A / C ;**  
**histone proteins – A / B ;**

NOTE:

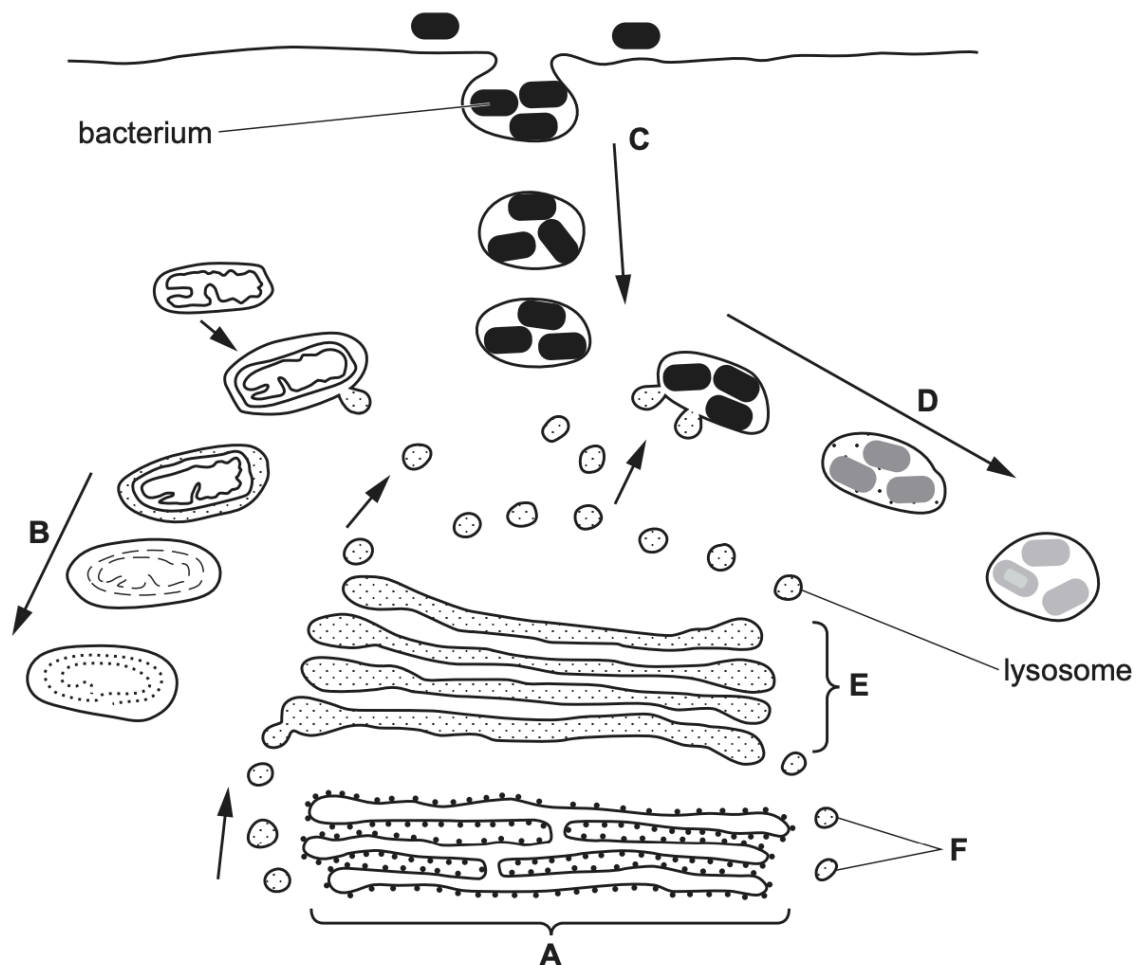
- DNA in a plant cell is found in nucleus, in chloroplasts and in mitochondria.
  - Nucleus, chloroplasts and mitochondria are membrane-bound organelles, and also have phospholipid bilayers. When asked to label a part containing phospholipid bilayer in a plant cell, label the nuclear membrane / chromosome membrane if visible, since the cell membrane in a plant cell is usually not visible (only the cell wall is)
2. Describe evidence from the above figure that shows that the image is a transmission electron micrograph.
- (section at) high resolution
  - any named structure visible that can only be seen in a TEM / not be seen in a photomicrograph
    - e.g. internal structure of chloroplasts / thylakoid(s) / grana
    - e.g. internal structure of mitochondria / cristae
  - higher magnification (magnification > 1000) than with light microscope
  - (very) thin
  - 2D / no surface contours / no surface features / not 3D
3. Name a cell structure that produces mRNA  
Nucleus.

NOTE: mRNA is NOT produced in the nucleolus!! Only rRNA are synthesised in the nucleolus.

4. State the functions of lysosomes

- Separate hydrolytic enzymes/ hydrolases from the rest of the cell
- Transport from RER/ ribosomes to Golgi apparatus
- transport from Golgi to, cell surface membrane

5.

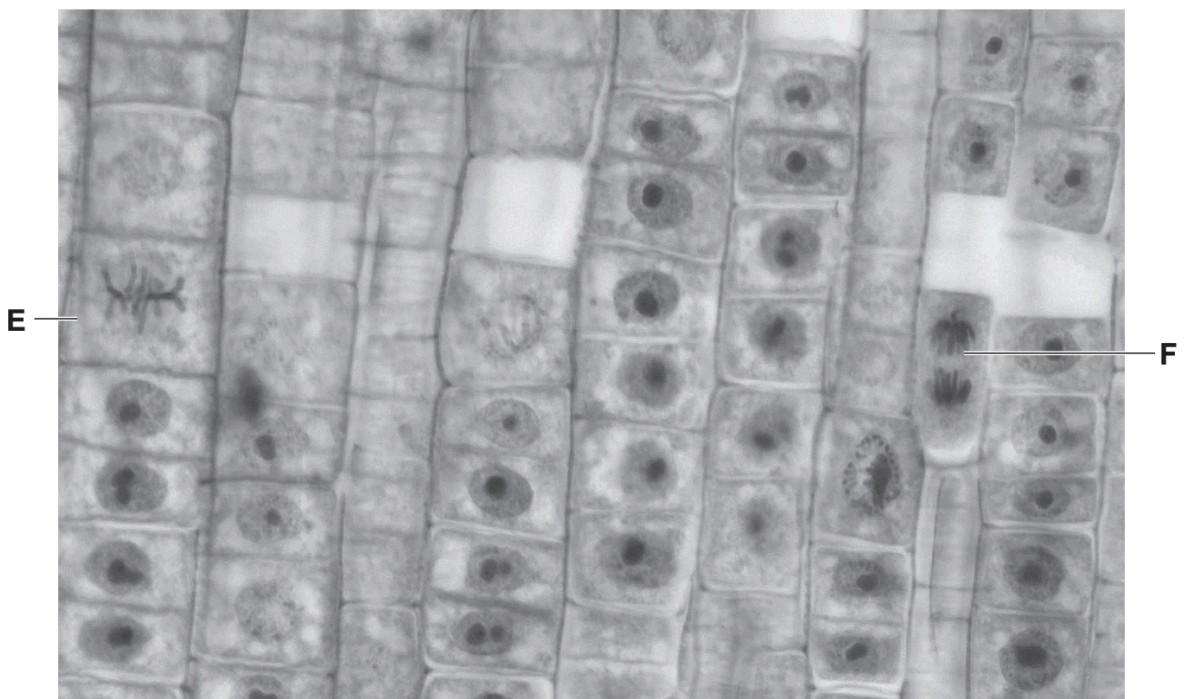


Name the process by which bacteria are taken into the cell at C  
phagocytosis/ endocytosis

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

- break down / digest / destroy bacteria / pathogen(s) ;
- break down / digest / destroy worn out / defective organelles ; autophagy
- catalyse / speed up, hydrolysis ;
- any two named substrates: polysaccharides / proteins / (phospho)lipids / (named) nucleic acids

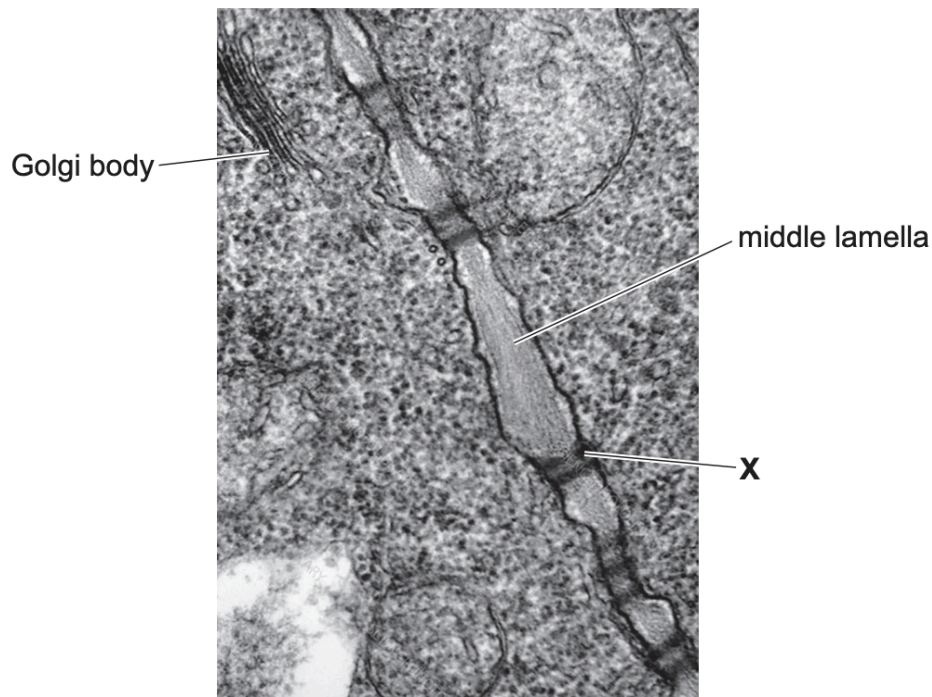
- idea that recycle / reuse, biological molecules within cell ;
  - (macrophage / phagocyte) cut up to present antigen ;
6. Carrier proteins in the membranes of lysosomes maintain a lower pH than the surrounding cytoplasm by moving hydrogen ions. Suggest how the carrier proteins maintain the lower pH within the lysosomes.
- moves / pump(s), hydrogen ions / protons, into the lysosome against concentration gradient
  - active transport / uses ATP / energy from respiration / ref to conformational change of carrier.
- 7.



State, with a reason, whether figure shows a region of animal or plant tissue.  
(these cells are undergoing mitosis)

- cell walls present;
- uniform / regular, shape of cells ;
- no, cleavage furrow / pinching in of cytoplasm (in cells at cytokinesis) ;
- cell plate present (in late telophase / cytokinesis, stages) ;

8.



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, which interacts with the polysaccharides cellulose and hemicellulose in the cell walls so that they are held close together.

Cell structure X is a cytoplasmic channel with strands of cytoplasm passing through the cell walls of the 2 cells. Name cell structure X.

Ans: Plasmodesma.

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.

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

- (only) polypeptides / proteins, synthesised at ribosomes ;
- carbohydrates / polysaccharides, not synthesised at ribosomes ;
- enzymes, for synthesis / required, not located at ribosomes ;

Name the mechanism that is used to transport pectin out of the cell.

Ans: Exocytosis.

9. State the function of plasmodesmata.

- allows symplast pathway / movement ;
- allows transport of water / sucrose / sugars / amino acids / organic substances / ions / mineral salts / lipids / assimilates / hormones / cell signalling molecules between cells
- cell to cell communication / signalling

10. Describe the differences in structure and function between RER and SER.

Structure

- RER has ribosomes; SER does not have ribosomes
- RER occurs as flattened sacs / cisternae; SER is tubular
- RER is continuous with (external) nuclear membrane
- RER has a more regular / layered arrangement; SER has a more irregular / disorganised arrangement

Function

- RER produces / transports proteins / glycoproteins
- SER produces lipids / cholesterol / steroids

11. Describe features, other than the presence of Golgi vesicles, that would help you identify a Golgi body in a transmission electron micrograph.

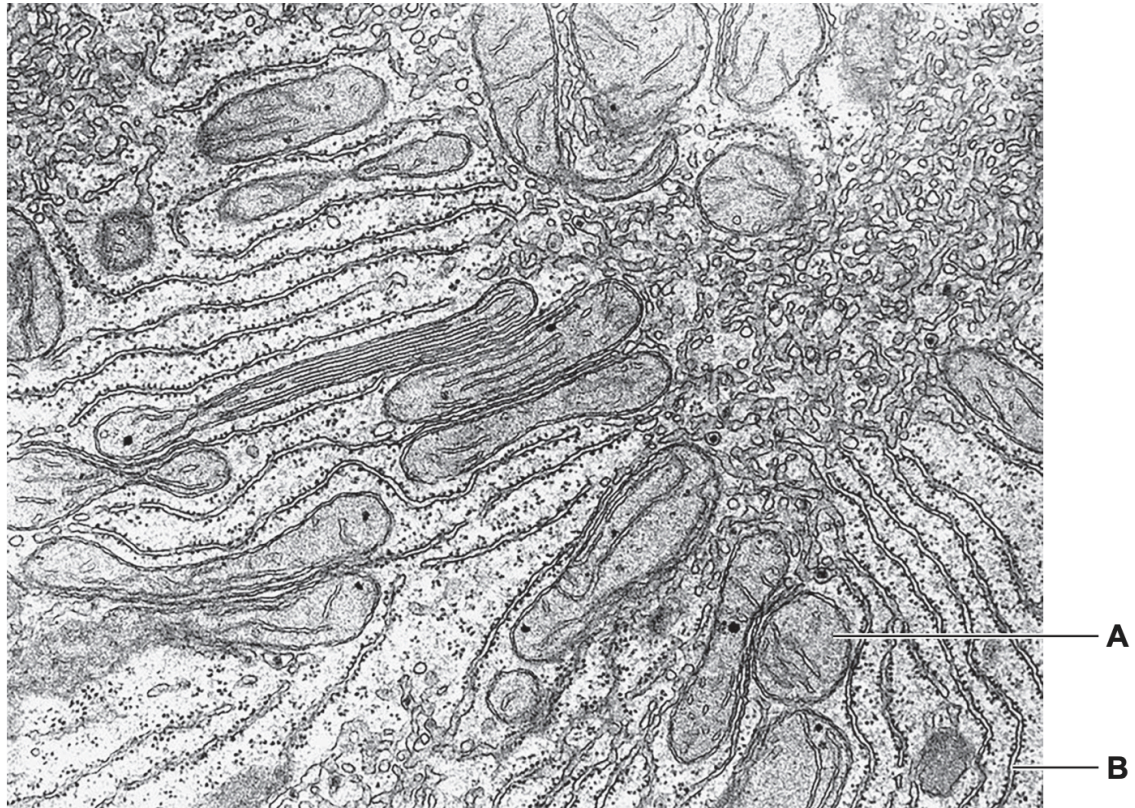
- flattened sacs / cisternae ;
- stack / layered / described ;
- each cisterna in stack is separate / not interconnected ;
- smooth (outer surface) / no ribosomes ;
- close to, nucleus / RER ;
- single membrane ;
- AVP:
  - 2 distinct faces
  - ref. to swollen ends to cisternae

12. State structural features that would confirm that a pathogen is a virus.

- nucleic acid core – either DNA or RNA ;
- protein coat / capsid ; (outer covering made of capsomeres) ;

13.

Fig. 1.1 is a transmission electron micrograph showing a section of a human liver cell.



Label A and B

- A = mitochondrion
- B = rough endoplasmic reticulum

14. 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.

- more efficient synthesis / metabolism of named products:
  - Lipids
  - Phospholipid
  - steroid/ steroid hormone/ oestrogen/ testosterone
  - sterol/ cholesterol
- other function ; e.g. detoxification
- max 2 from:
  - synthesis of products is a pathway / requires more than one enzyme ;
  - further detail: enzymes of same pathway are close together / in clusters
  - products of one reaction are substrates of the next

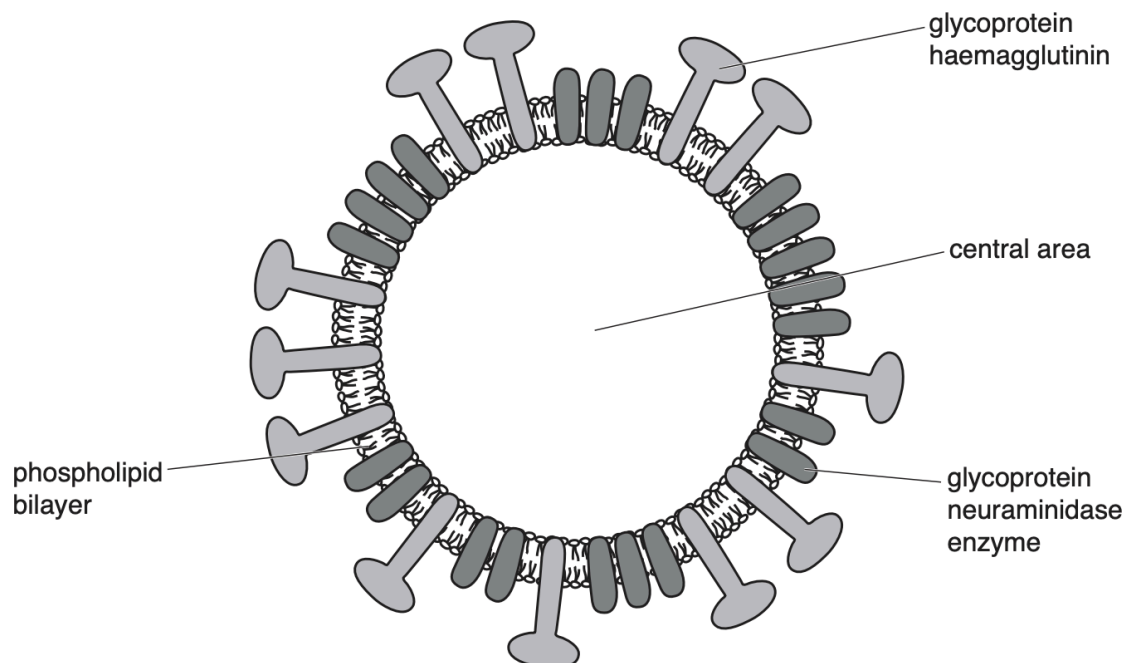
- membrane gives enzymes more stability / greater protection (from degradation)
- AVP:
  - greater efficiency as enzyme held so that active site faces substrates in lumen
  - allows reactions to occur on cytoplasmic side of membrane
  - allows reaction to continue / complete in SER transport vesicles

15. Explain the advantages of using a transmission electron microscope compared with a light microscope.

- higher magnification (without loss of detail)
- higher resolution / ability to see object that are close together as separate objects ;
- ref. to resolution of (up to) 0.5 nm compared to, 200 nm / 0.2  $\mu\text{m}$  (light microscope) ;
- ability to see organelles such as, SER / ribosomes / other named organelle ;
- AVP: very thin sections, qualified, e.g. for greater internal detail

16.

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



State the differences between the structure of a virosome and a virus.

- Virosome does not have nucleic acid / genetic material / DNA / RNA ;
- Virosome does not have capsid / protein coat ; no capsomeres
- only some viruses have envelopes ;

Explain how the structure of the virosome shown in Fig. 4.1 suggests that the central area of the virosome is aqueous.

- heads / phosphate (groups) of phospholipids are hydrophilic / fatty acid tails of phospholipids are hydrophobic ;
- heads / phosphates, point towards the centre of the virosome so, must be aqueous / water present;

17.

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

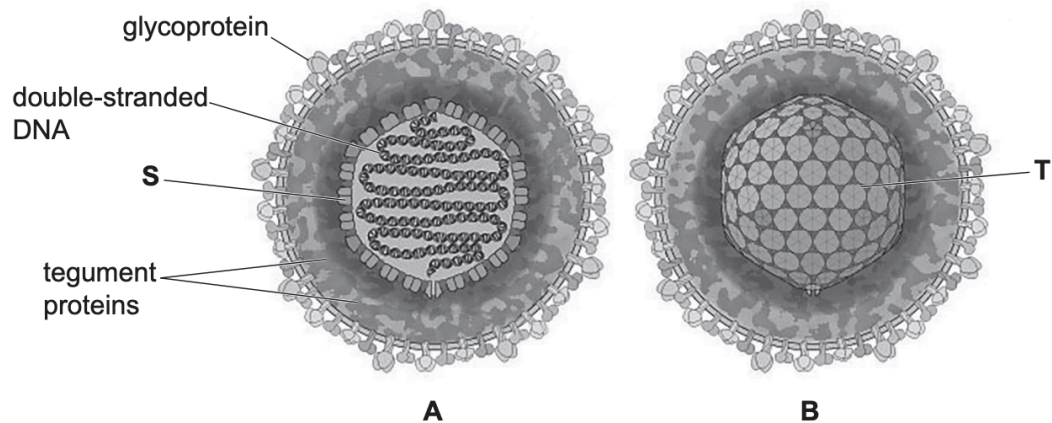


Fig. 2.1

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.

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

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

- S: protein
- T: capsid

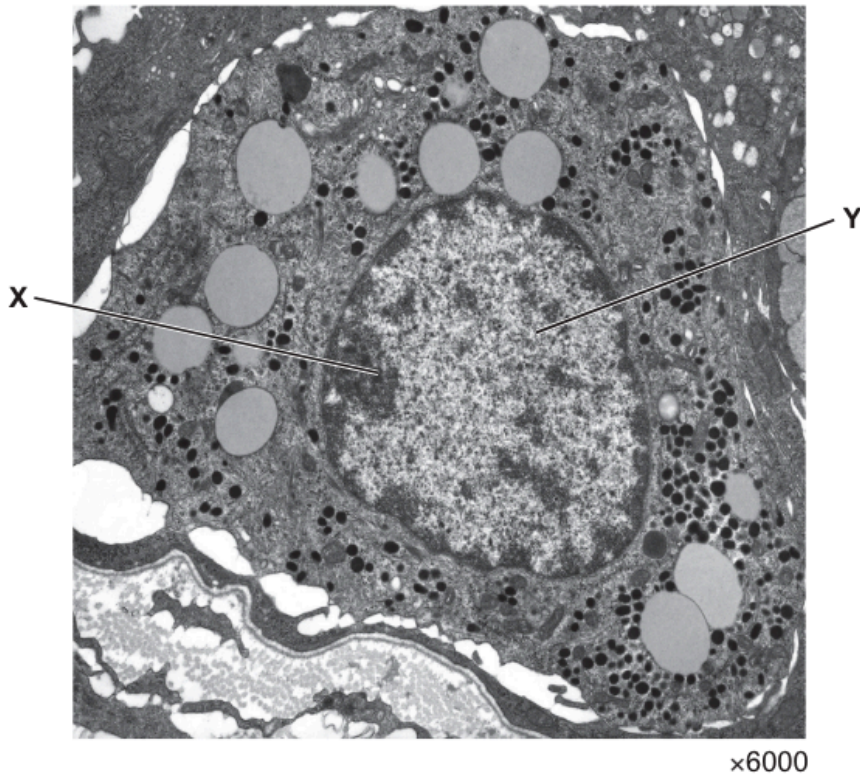
NOTE: for S, it asks for the chemical compound making structure S, not for the name of structure S! Read carefully.

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

- Similarity: both have double stranded DNA
- Difference:

- bacterial DNA, circular / closed loop (v HCMV linear)
- bacteria (can also) have, plasmid DNA / plasmids
- bacterial DNA (also) has genes for, metabolism / AW ora
- bacterial DNA free in cytoplasm but HCMV DNA surrounded by, capsid / protein coat

1.



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.

Outline role of structure X and Y in the production of extracellular proteins.

#### Structure X

- Nucleolus
- synthesis of ribosomal subunits / ribosomes; synthesis of organelles that are the sites of protein synthesis

#### Structure Y

- Chromatin
- contains gene(s), coding for the polypeptide(s); site of transcription / for production of mRNA

2. Features of two different types of cell found in plant tissue, which are adapted for the efficient transport of assimilates.

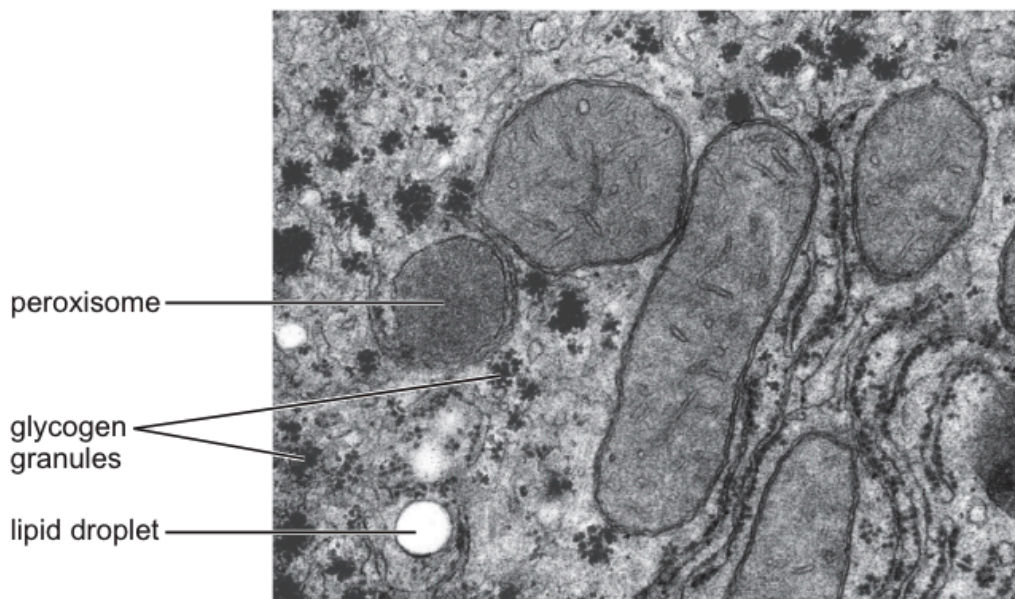
feature of cell	cell type A	cell type B
cytoplasm	✓	✓
nucleus	x	✓
mitochondria	few	many
cellulose in the cell wall	✓	✓
ribosomes	x	✓

**Key**  
 ✓ present  
 x absent

Identify cell type A and explain why the plasmodesmata are important.

- Cell type A: sieve tube element
- connect the cytoplasm of the two cells / ref. to the symplast pathway ;
- idea of allow (rapid) diffusion of, sucrose / named molecules, from one cell to an adjacent cell / AW ;
- idea of efficiency of, loading into / unloading from, sieve tubes ;

3.



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.

- 1 smooth endoplasmic reticulum labelled on Fig. 3.2 and detail
  - for, lipid / triglyceride / cholesterol synthesis
  - tubular appearance / no ribosomes

- 2 rough endoplasmic reticulum labelled on Fig. 3.2 and detail
  - for protein, synthesis / for enzyme synthesis
  - flattened (sac) appearance and ribosomes
- 3 mitochondrion labelled on Fig. 3.2 and detail
  - many mitochondria for (aerobic) respiration / to produce ATP / provide energy, (for hepatocyte reactions)
  - double membrane / presence of cristae
- 4 presence of glycogen granule(s) as, energy / glucose, store ; releases / provides glucose
- 5 presence of lipid droplet(s), as energy store ; provides fatty acids ; provides components for cholesterol synthesis

Visible differences between a peroxisome and a mitochondrion.

- Mitochondria are larger
- mitochondrion, bound by / has, double membrane / two membranes ; peroxisome has (only) one membrane
- peroxisome no cristae / mitochondria has cristae
- peroxisome spherical shape and mitochondria, different shapes

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

- mitochondrion (ora for peroxisomes) has, DNA / genes (coding for enzymes) ; genetic, material / information, qualified with, transcription / ref. to mRNA / coding for enzymes
- (70S) ribosomes (site of enzyme synthesis)
- has the enzymes for, transcription / translation, (to synthesise enzymes) ;
- can produce ATP (for enzyme synthesis)
- AVP: ATP cannot enter peroxisome to provide energy source; peroxisome has enzymes that cause degradation of one / or more, substance(s) involved in protein synthesis

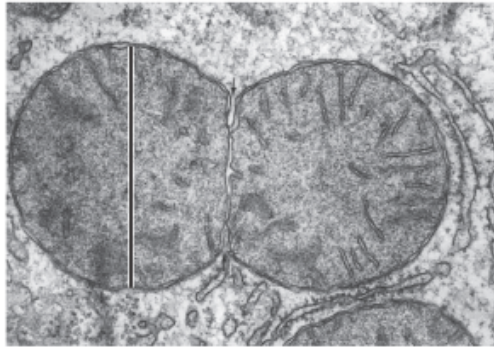
One of the enzymes present in peroxisomes is catalase. This enzyme catalyses the breakdown of hydrogen peroxide to harmless products. Suggest why it is useful to the cell for this reaction to take place within peroxisomes.

- (peroxisome) membrane bound, so rest of cell protected (from hydrogen peroxide) ;
- A hydrogen peroxide can have toxic effects on (rest of) cell / (peroxisome) acts as a compartment / specific area / contained, for, more efficient breakdown of hydrogen peroxide / control of reactions ;
- high concentration of enzyme in one location ; more enzyme-substrate complexes can form
- Provides optimum conditions for (other peroxisome) reactions ;

- production of oxygen as by-product, so useful for, peroxisome reactions requiring oxygen / mitochondrial function / aerobic respiration ;

State the level of protein structure that is not shown  
Primary

4.

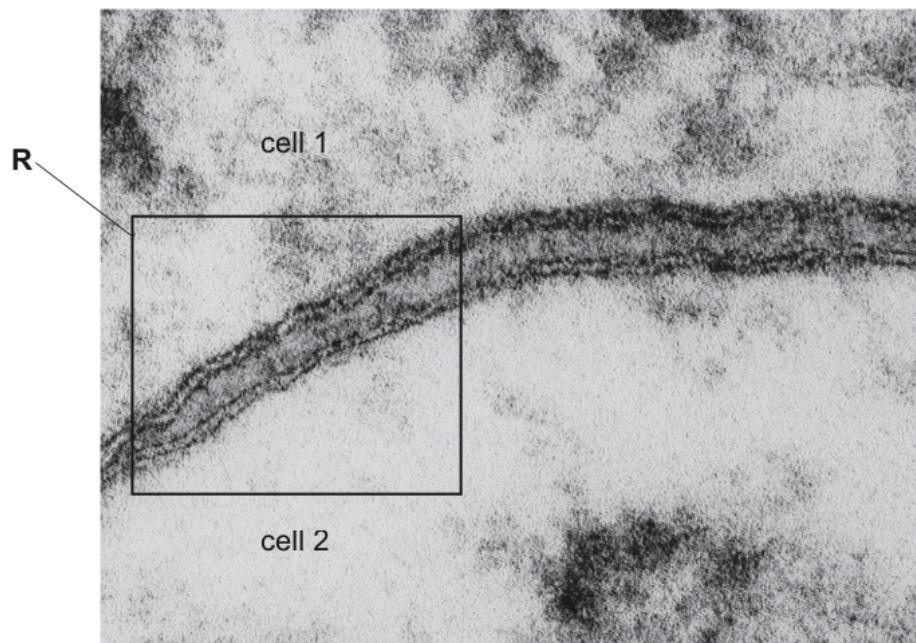


magnification  $\times 50\,000$

Visible features of mitochondria

- Double membrane/ envelope
- Inner membrane/ cristae
- Mitochondrial matrix
- 70S ribosomes

5.



$\times 300\,000$

Draw diagram of region R

- dark line(s) labelled as phosphate heads
- clear area(s) between pairs of dark lines labelled as, fatty acid tails / hydrocarbon chains / hydrophobic core
- clear area between the two cell surface membranes labelled as, interstitial fluid / tissue fluid / extracellular matrix / intercellular space ;