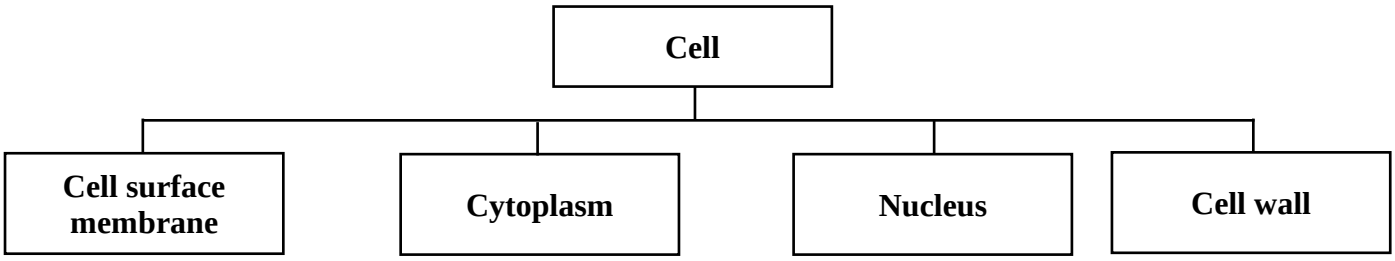
Chapter 2 – Cells

2.1 Main Components of Cell



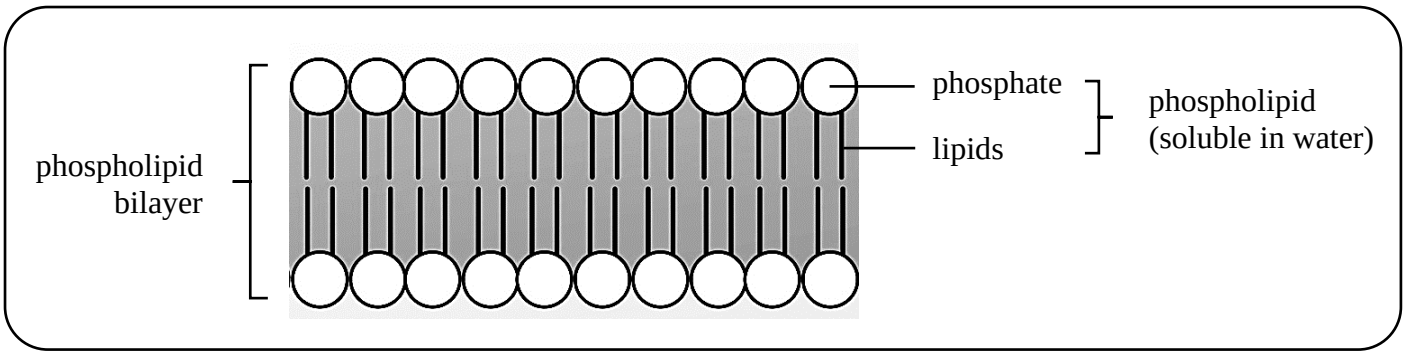
- **Rough endoplasmic reticulum**
- **Smooth endoplasmic reticulum**
- **Mitochondria**
- **Golgi apparatus**
- **Ribosome**
- **Centriole**
- **Vacuole**

<u>What a cell consists of</u>

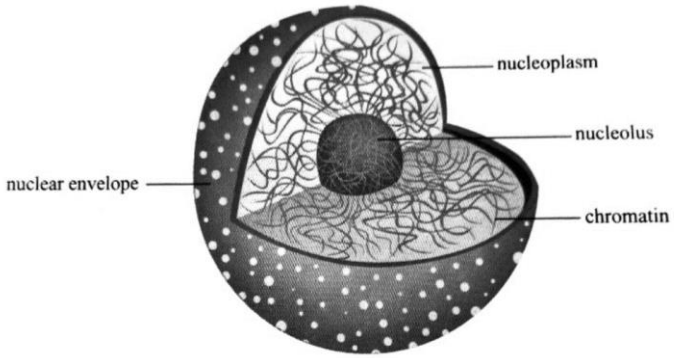
Protoplasm

- Living material which each living cell consists
- Made up of:
  1. **Cell surface membrane**
  2. **Cytoplasm**
  3. **Nucleus**
  4. **Cell wall** (plant)

Part	Function	Structure
1. Cell surface membrane (plasma membrane)	Controls substances entering or leaving cell	• Made up of: 1. Lipids (fats) 2. Proteins • **Partially permeable** membrane → only allow some substances to pass through (smaller than pores)
2. Cytoplasm	• Most cellular activities occur • Contains **organelles**	• Major part of cell • Mostly water → materials diffuse easily
3. Nucleus	• Control cellular activities (cell growth, repair worn-out parts) • Cell division • Involved in protein production	Chromatin threads • Long thread-like structure • Made up of 1) Protein 2) DNA (deoxyribonucleic acid) • DNA: store hereditary information (instructions for cellular activities) • Cell division: condense, highly coiled → chromosomes
4. Cell wall	• Protects cell from injury • Gives fixed shape	• Only in plant cells • Made of cellulose • **Fully permeable** membrane → substances move freely across



Nucleus



DNA is made up of:

1. chromatin threads

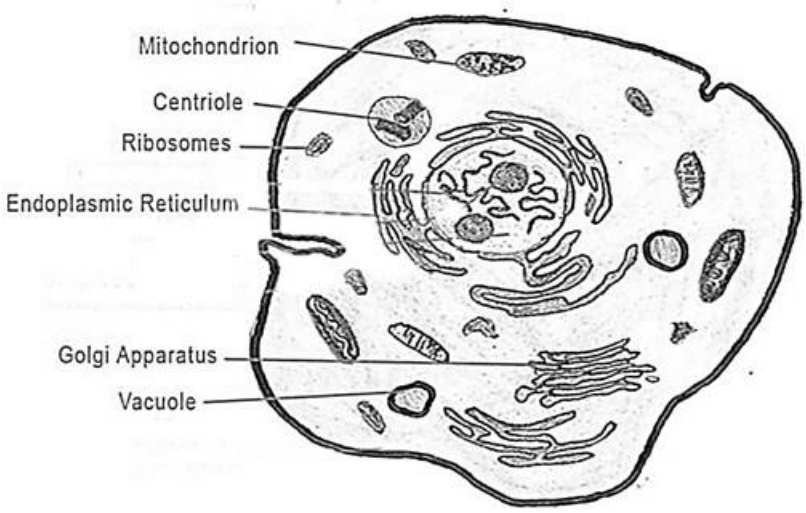
2. chromosomes

Parts	Function
1. **Nuclear envelope** (double membrane)	Separate content of nucleus from rest of cytoplasm
2. **Nucleoplasm**	Liquid found in nucleus
3. **Chromatin**	• Store hereditary information • Carries instructions for cell to carry out activities • Cell dividing: condense → chromosomes
4. **Nucleolus**	Manufacture proteins

Cytoplasm

Contains organelle (specialised functions)

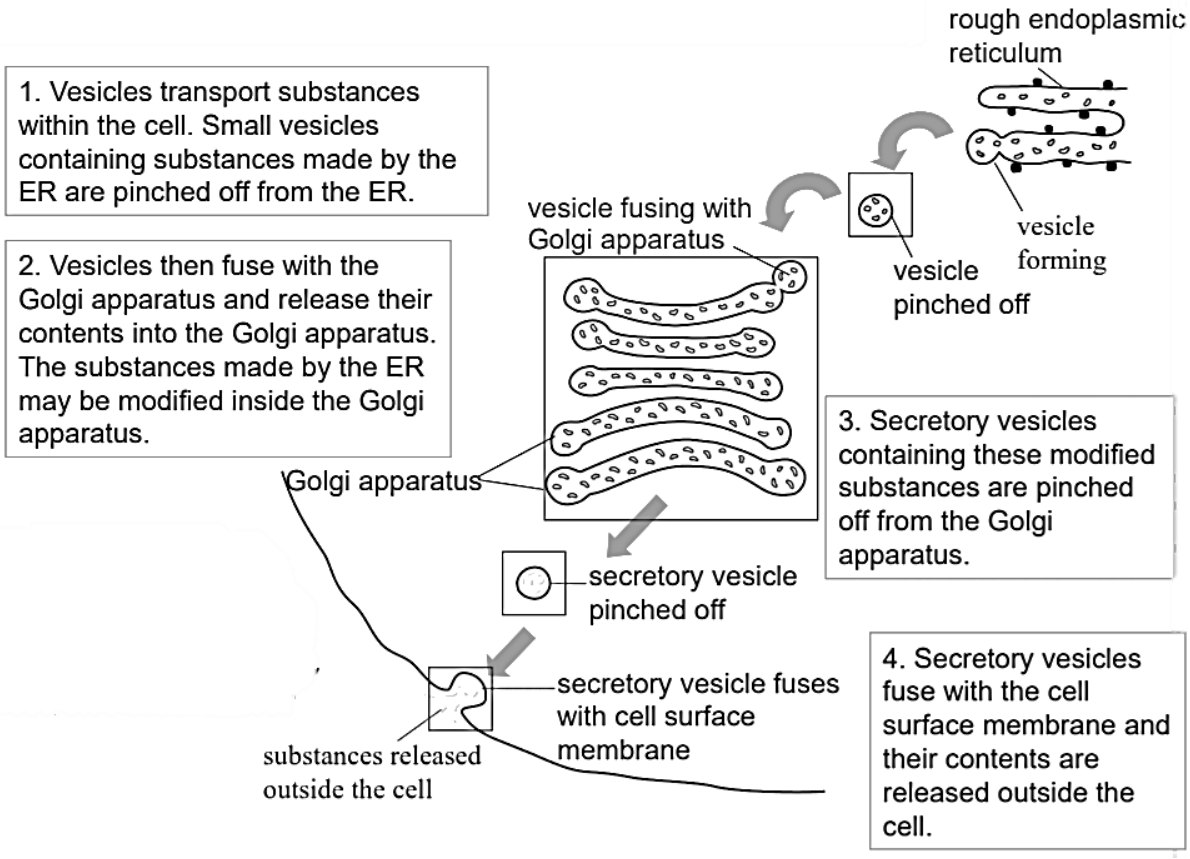
1. **Ribosomes**
2. **Rough endoplasmic reticulum** (RER)
3. **Smooth endoplasmic reticulum** (SER)
4. **Golgi apparatus**
5. **Mitochondria**
6. **Vacuole**
7. **Chloroplast** (plant)
8. **Centriole** (animal)



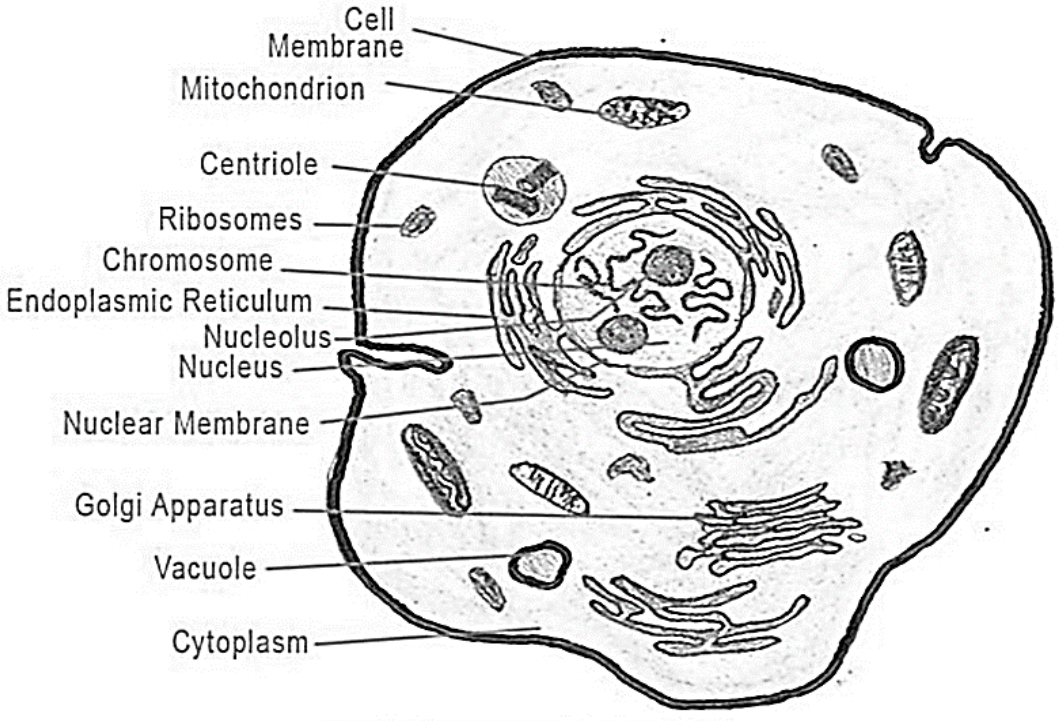
<table>
<tr><th>Part</th><th>Function</th><th>Structure</th></tr>
<tr><td>1. Ribosomes</td><td>Manufacture & synthesise proteins<table><tr><td>Location</td><td>Proteins</td></tr><tr><td>1) Attach to ER</td><td>Transported out</td></tr><tr><td>2) Lie freely in cytoplasm</td><td>Used within cytoplasm</td></tr></table></td><td>Small spherical structure</td></tr>
<tr><td>2. Rough endoplasmic reticulum</td><td>Transport proteins → Golgi</td><td>• √ ribosomes attached to membrane (rough surface)
• Outer surface connected to nuclear envelope</td></tr>
<tr><td>3. Smooth endoplasmic reticulum</td><td>1) Synthesise fats & steroids
2) Detoxification: convert harmful substances → harmless
3) Transport materials other than proteins (e.g. sugar)</td><td>• × ribosomes attached to membrane (smooth surface)
• More <u>tubular</u> than RER, connected to RER</td></tr>
<tr><td>4. Golgi apparatus</td><td>1) Sort and chemically modify substances made by ER
2) Store and package substances in vesicles → secrete out</td><td>Vesicles: fuse with one side, pinched off from opposite side</td></tr>
<tr><td>5. Mitochondria
  </td><td>Aerobic respiration
• Food substances oxidised
• Release energy for cellular activities</td><td>• Double membrane
▪ Outer: cover organelle
▪ Inner: create intricate inner folds
• Interior: highly folded membrane
→ greater surface area for chemical reactions to occur</td></tr>
<tr><td>6. Vacuole</td><td>Store substances within cell<table><tr><td>Animal</td><td>1) Water
2) Food substances</td></tr><tr><td>Plant</td><td>Cell sap: contains
(a) dissolved sugars
(b) mineral salts
(c) amino acids
(d) waste</td></tr></table></td><td>Fluid-filled, enclosed by membrane<table><tr><td>Animal</td><td>Many small vacuoles</td></tr><tr><td>Plant</td><td>A single large vacuole, surrounded by tonoplast</td></tr></table></td></tr>
<tr><td>7. Chloroplast</td><td>Photosynthesis (chlorophyll)
→ make food</td><td>Contain chlorophyll (green pigment)
• embedded in disk-like structures, arranged in stacks
• absorb light energy → photosynthesis</td></tr>
<tr><td>8. Centriole</td><td>Important for cell division</td><td>• Small hollow tubes
• Found in pairs near nucleus</td></tr>
</table>

Manufacture and transport of proteins

1. Rough endoplasmic reticulum **synthesises proteins**
2. Small vesicles containing proteins **pinched off** from RER
3. Vesicle **fuse** with Golgi apparatus, **release contents** into Golgi apparatus
4. Golgi apparatus carries out **chemical modifications** to proteins (sorts[1] and chemically modifies[2] substances made by ER & stores[3] and packages[4] substances in vesicles to be secreted out)
5. Secretory vesicles containing modified proteins, **pinched off** from Golgi apparatus
6. Vesicles move to cell surface membrane and **fuse** with CSM, **release contents** outside cell



Animal cell diagram



Differences between plant and animal cells

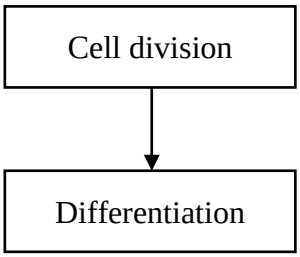
Structure	Plant cell	Animal cell
Cell wall*	Present	Absent
Chloroplast*	Present	Absent
Vacuole*	One / a few Large, central Permanent	Small Many Temporary
Centrioles	Present	Absent

2.2 Specialised Cells, Tissues and Organs

Cells

Different types of cells

Organism	Example of cells
Human	1) Liver cells 2) Nerve cells 3) Skin cells
Plants	1) Xylem cells 2) Phloem cells 3) Root hair cells

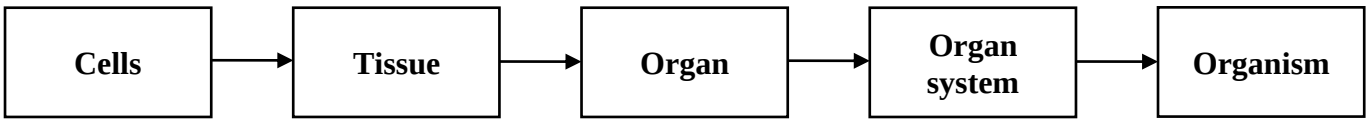


Cell division: produce new cells

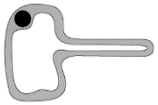
Differentiation: cell specialised for specific function

(a) develop special structures

(b) lose certain structures



Specialised cells

Cell	Function	Adaptations to function	
1. **Red blood cell** 	Transport oxygen: lungs → all parts of body	1) Contain **haemoglobin**	Haemoglobin binds with oxygen reversibly in lungs • **form oxyhaemoglobin** • **transportation of oxygen** → oxygen-deficient cells
		2) **Lacks nucleus** (anucleated)	Increases cell's ability to **pack more haemoglobin** into cell → **more oxygen transported** per unit time
		3) **Circular biconcave** shape	Increases **surface area to volume ratio** → oxygen diffuse into and out of whole cell at **faster rate**
2. **Xylem vessel** 	Transport 1) water 2) mineral salts	1) Absence of **cross walls** & **protoplasm**	Water and mineral salts **move faster** and easily through the **hollow lumen**
		2) **Lignin**	**Strengthens walls**, prevent **collapse** of vessel
		3) Xylem vessels **bundled**	Provide **mechanical support** to plant
3. **Phloem vessel**	Conducts manufactured food (sucrose & amino acids): green parts → other parts	1) Companion cells have many mitochondria	Provides energy needed by the companion cells to load sugars from mesophyll cells into the sieve tubes by active transport
		2) Pores in sieve plates	Manufactured food substances flow rapidly through sieve tubes
4. **Root hair cell** 	Absorb from soil 1) water 2) mineral salts	1) Long narrow outgrowths	Increase **surface area** → absorb water & mineral salts **faster**
		2) Thin cell walls	Facilitate uptake of water and dissolved mineral salts
		3) Partially permeable membrane	
		4) Absence of cuticle layer	
		5) Concentrated cytoplasm and cell sap	
5. **Palisade cells**	Carry out photosynthesis	Numerous chloroplasts	Contain green pigment chlorophyll → photosynthesis
6. **White blood cell**	Engulf harmful bacteria	Can change shape & move about	Through walls of blood vessels into surrounding tissues
7. **Nerve cell**	Conduct electrical impulses ↔ brain	Very long	• Connect distant parts of body → spinal cord + brain • Their chemical reactions → impulses travel along the fibre

Organisation of cell

Organisms	
Unicellular	**Multicellular**
Entire body made up of only 1 cell	Made up of more than 1 cell
Bacterial cell 	Algae cell 

Tissue

Type	Type of cells	Example	Organism	Description
1. **Simple tissue**	1	1) Muscular tissue	human	
		2) Epithelial tissue	human	Skin tissue
		3) Epidermis tissue	plant	Cover surface of leaves, stems and roots
		4) Mesophyll tissue	plant	Carry out photosynthesis in leaves
2. **Complex tissue**	> 1	1) Blood	human	Consists of (a) Red blood cell (b) White blood cell (c) Platelets (d) Plasma
		2) Connective tissue		(a) Supporting tissues of the body (b) Contain large amounts of intercellular material & specialized cells (c) Bind tissues and organs together
		3) Xylem tissue	plant	Vessels + dead cells
		4) Phloem tissue	plant	Sieve tubes + companion cells

Organ

Example	Tissues	Work together	Function
Stomach	1) Gland tissue	Food digestion	Secrete enzymes → digest food
	2) Muscular tissue		• Contract → churn food • Mixes food with digestive enzymes
	3) Nervous tissue		• Detects presence of food in stomach • Causes gland tissue → secrete digestive enzymes
Leaf	1) Mesophyll tissue	Plant nutrition & transport	Carry out photosynthesis
	2) Xylem tissue		Transport water + mineral salts → leaf (photosynthesis)
	3) Phloem tissue		Transport products of photosynthesis (food substances) away from leaf

Organ system

Organism	Examples
Human	1) Digestive system 2) Circulatory system 3) Respiratory system 4) Transport system
Plants	1) Root system 2) Shoot system

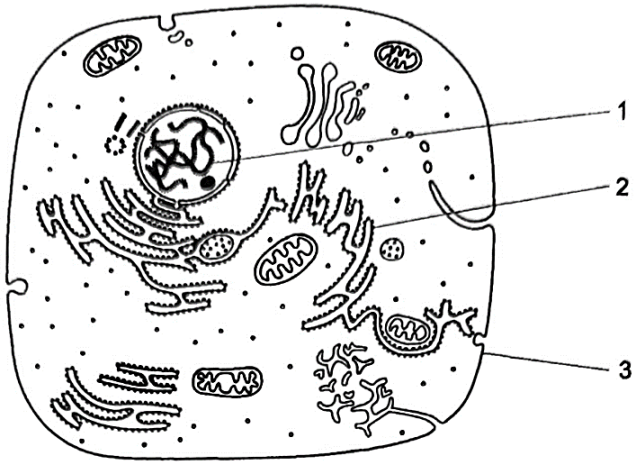
Typical questions

Multiple choice questions

1. An animal cell is unable to undergo cell division. Which of the following structures are most likely damaged or missing from the cell?
   A Cell wall and chloroplasts
   B Mitochondria and Golgi apparatus
   C Nucleoli and vacuoles
   D Chromatin threads and centrioles

2. When viewed through an electron microscope, which structure is surrounded by a double membrane? (N2011/P1/Q1)
   A endoplasmic reticulum
   B Golgi apparatus
   C mitochondrion
   D ribosome

3. The diagram shows the structure of a typical animal cell as seen using an electron microscope.

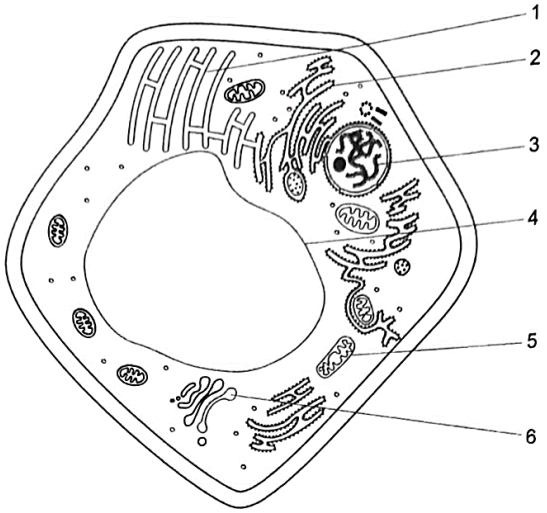


   Which cell components are needed to synthesise and build proteins within the cell? (N2012/P1/Q1)
   A 1 only
   B 1 and 2 only
   C 2 and 3 only
   D 1, 2 and 3

4. Which mature structure contains a nucleus? (N2014/P1/Q2)
   A red blood cell
   B root hair cell
   C sieve tube element
   D xylem vessel

5. How does the cell wall help to maintain the turgor of a plant cell? (N2016/P1/Q4)
   A It maintains the concentration gradient.
   B It prevents mineral ions from leaving the cell.
   C It prevents water from leaving the cell.
   D It supports the cell membrane.

6. The diagram shows the structure of a plant cell as seen using an electron microscope.

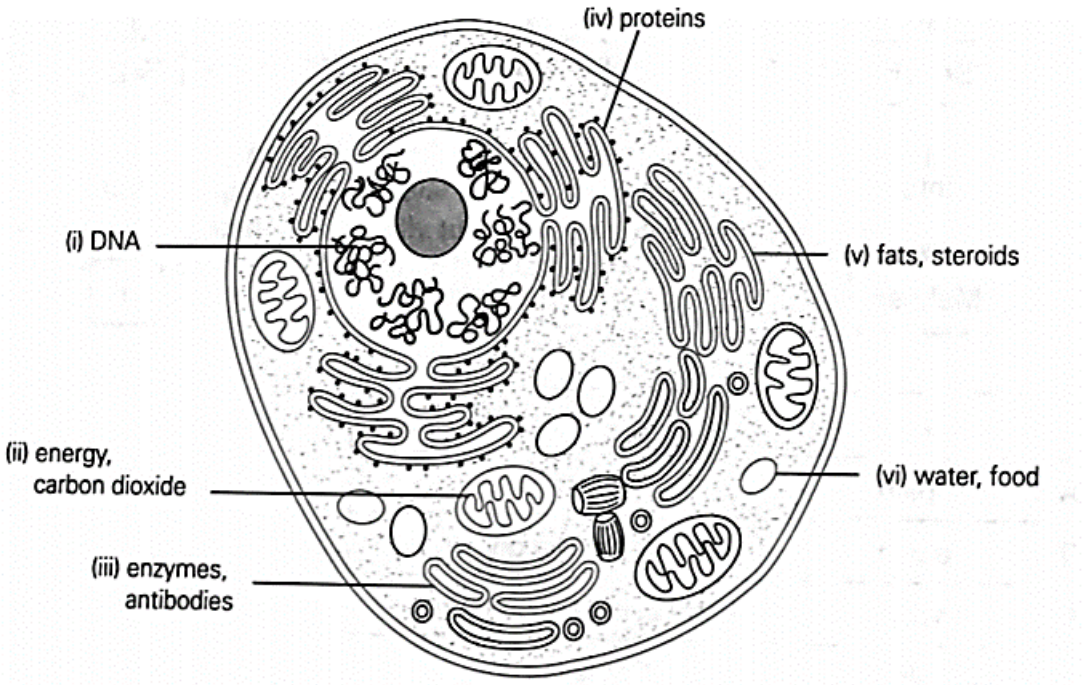


Which structures are involved in the process of enzyme synthesis within the cell? (N2017/P1/Q1)

A 1, 2, 4, 5 and 6
B 1, 3 and 6
C 2, 3, 5 and 6
D 3, 4 and 5

Structured questions

1. Study the diagram of a eukaryotic cell below. Organelles in which various substances in the cell are manufactured, processed or stored have been labelled.



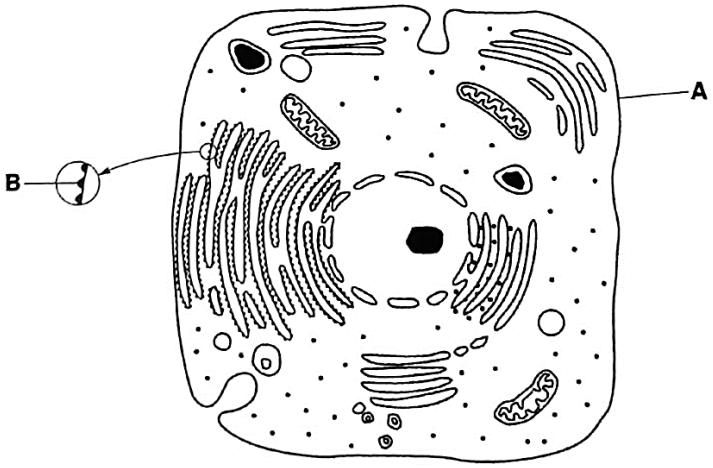
(a) Identify the organelles that contain the substances shown in the diagram. [6]

(i)	DNA	nucleus
(ii)	Energy and carbon dioxide	mitochondrion
(iii)	Enzymes and antibodies	Golgi apparatus
(iv)	Proteins	rough endoplasmic reticulum
(v)	Fats and steroids	smooth endoplasmic reticulum
(vi)	Water and food	vacuole

(b) State how the organelles identified in (ii), (iii), (iv) and (v) work together in the synthesis and transport of substances within the cell. [5]

Ribosomes on RER manufacture proteins which are then sent to the Golgi apparatus for modification and storage.
The Golgi apparatus packages the modified proteins into vesicles for transport within or secrete out of the cell.
SER synthesises fats and steroids, which are also packed into vesicles by the Golgi apparatus for transport.
Mitochondrion supplies respiration energy for all these processes to occur.

2. (a) The figure below shows a diagram of an animal cell. (N2016/P2/A5)



(i) Identify A on the figure and state its function. [2]

Cell surface membrane.
The cell surface membrane is partially permeable and controls substances moving in and out of the cell.

(ii) Identify B on the figure and state its function. [2]

Ribosome.
Ribosomes are sites of protein synthesis.

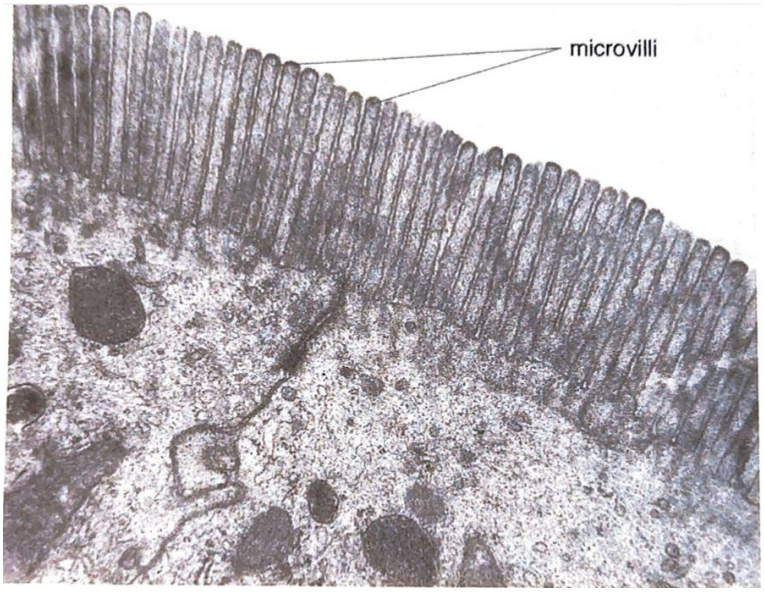
(b) Liver cells have more mitochondria than most cells in the human body. Suggest why liver cells have a large number of mitochondria. [2]

The mitochondrion is the site of aerobic respiration where chemical energy in the form of ATP is released. There are large numbers of mitochondria in the liver cells to release the energy needed to carry out metabolic reactions, for example protein synthesis,

(c) State two structures which are found in plant cells but are not shown in the figure above. [2]

Chloroplast, cell wall

(d) The figure below is a photomicrograph showing part of two epithelial cells from a human small intestine. The cell surface of these cells are folded to form finger-like structures called microvilli.



Suggest the purpose of microvilli in the small intestine. [2]

The microvilli increase surface area to volume ratio to increase the rate of absorption of digested food from the intestinal lumen into the capillaries of the villi.