UNIT 1 - CELL STRUCTURE

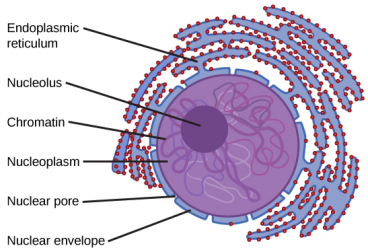
Organisms can either be cellular or acellular.
- Cellular organisms are 'alive' and carry out all 8 essential life processes. They include all living things (both eukaryotes and prokaryotes).
- Acellular organisms are not exactly alive because they only carry out a few of the life processes. The only acellular organisms are viruses.

Cell - the basic unit of life for all living organisms; it is surrounded by a cell surface membrane and contains genetic material, as well as cytoplasm containing organelles.

Organelle - a functionally and structurally distinct part of a cell e.g. a ribosome

❓Question: What are the advantages of having organelles?
- Subunits → function independently
- Allow for efficient functioning via *compartmentalisation* which allows for *division of labour*
- Multiple functions can then be performed simultaneously

1) The Nucleus (avg. size: 6μm)

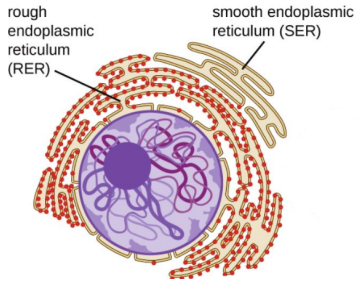


A relatively large organelle found in eukaryotic cells, but absent from prokaryotic cells.
- Contains all of the cell's genetic material
- Controls the activities of the cell
- Surrounded by a double membrane called the nuclear envelope, which is perforated with holes called nuclear pores, the outer part of which is sometimes continuous with the rough endoplasmic reticulum
- The nucleus also contains chromatin, and a structure known as the nucleolus

❓Question: What can enter and exit the nucleus through the nuclear pores?
- mRNA and ribosomes can EXIT the nucleus
- Hormones, proteins, and nucleotides can ENTER the nucleus

2) The Nucleolus (0.5μm – 5μm)

A small structure, one or more of which is found inside the nucleus.
- Usually visible through a light microscope as it is deeply staining.
- Manufactures ribosomes using information from its own DNA. Contains rRNA (ribosomal RNA) for this purpose.



3) The Endoplasmic Reticulum

A network of flattened sacs running through the cytoplasm of eukaryotic cells.
Molecules, particularly proteins, can be transported through the cells inside these sacs. There are two types of endoplasmic reticulum: the rough endoplasmic reticulum (RER) and the smooth endoplasmic reticulum (SER).

Rough endoplasmic reticulum (RER):
- Covered in ribosomes
- Function: production, transportation, and modification of PROTEIN

Smooth endoplasmic reticulum (SER):
- Lacks ribosomes
- Function: production, transportation, and modification of LIPIDS, and storage of calcium ions.

To transport the products made, they release secretory vesicles that transport the protein around and/or out of the cell.

4) Ribosomes (avg. size: 20μm – 30μm, both subunits)

Tiny organelles found in abundance in ALL cells, prokaryotic and eukaryotic, and composed of a small and large subunit.
- Prokaryotic organisms are smaller (20 nm in diameter – 70S) and eukaryotic ribosomes are larger (25 nm – 80S)
- 80S ribosomes – two 40S subunits
- 70S ribosomes – 30S and 50S subunits
- Function: site of translation (protein synthesis)

★ **'S' stands for 'svedberg' and is a measure of how fast molecules move in a centrifuge.**

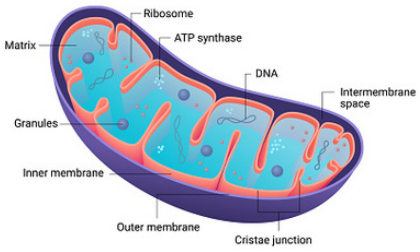
5) Golgi Apparatus (avg. size: 0.5μm – 2μm)

An organelle found in eukaryotic cells consisting of a stack of flattened sacs constantly forming and reforming.
- More than one Golgi apparatus may be present in a cell.
- Golgi vesicles carry their contents to other parts of the cell, often to the surface (exocytosis). They are used to make lysosomes.
- Functions: chemically modifies the contents e.g. sugars may be added to proteins to make glycoproteins.

6) Lysosomes (avg. size: 0.1µm – 1.2µm)

Spherical organelles found in eukaryotic cells containing hydrolytic enzymes (lysozymes). Functions include:

- Digestion of material taken in from endocytosis e.g. digestion of engulfed bacteria in a phagocyte
- Exocytosis of hydrolytic enzymes for extracellular digestion
- Digestion of used/worn out organelles within the cell
- Autophagy: self-digestion where the whole cell is destroyed too clear space and remove unwanted cells (programmed cell suicide for example)



7) Mitochondria (avg. size: 1µm)

Organelles in eukaryotic organisms where aerobic respiration occurs.

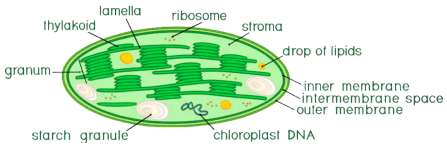
- Functions: carry out aerobic respiration and produce ATP
- The mitochondrial matrix is also a site for important processes such as the Krebbs cycle
- Depending on the metabolic activity of the cell, different amounts of mitochondria will be present e.g. muscle and secretory cells would have lots of mitochondria because they are very active and require lots of ATP

ATP - the universal energy currency required to power any active process in the body

$$ADP + Pi \rightleftarrows ATP + H_2O$$

ATP = adenosine triphosphate, ADP = adenosine diphosphate

8) Chloroplasts (avg. size: 2µm – 4µm)



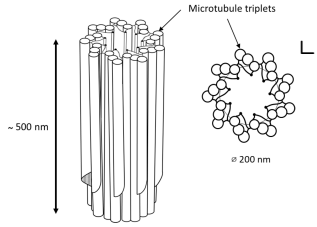
Organelles where photosynthesis occurs. They are not found in animal cells.

- Function: produce sugars for the plant through photosynthesis
- Lipid droplets preserve and maintain the chloroplast membrane, and sugars are stored as starch granules
- Like mitochondria, the number of chloroplasts varies with the activity of the cell, e.g. mesophyll cells will have more chloroplasts than root hair cells because they are exposed to more sunlight.

9) Plasmodesmata (avg. size: 50µm – 60µm)

- Pore-like structures found in plant cell walls which line up to form tube-like pores connecting cells
- They contain cytoplasm and are lined with the cell surface membrane.
- Viruses can pass through plasmodesmata and spread throughout the plant because they do not need to pass the cell surface membrane

10) Centrioles (250 nm in diameter, 500 nm in length)



Centrioles are small, cylindrical structures made from 9 triplets of microtubules.

- Found just outside the nucleus in animal cells and act as the main microtubule organising centres (MTOCs) during cell division

Plant cells DO NOT HAVE CENTRIOLES.

11) Microtubules and the Cytoplasm

The cytoplasm is the contents of the cell that suspends all other organelles.

- Site of many metabolic processes
- Can be 'sol' (runny) or 'gel' (jelly-like), and is composed of 90% water
- Contains the cytoskeleton, a network of microtubules

Microtubules are tubes of the protein tubulin and are found in most eukaryotic cells.

- Functions are vast and include cell support, as well as forming the spindle that forms during mitosis
- Tubulin forms dimers of α-tubulin and β-tubulin. 1 dimer is 5 nm in diameter
- Dimers can form 13 protofilaments around a hollow core, thus forming a microtubule 25 nm in diameter.

12) Cilia and Flagella

Cilia are whip-like structures projecting from the surface of many animal cells, as well as prokaryotic cells such as bacteria.

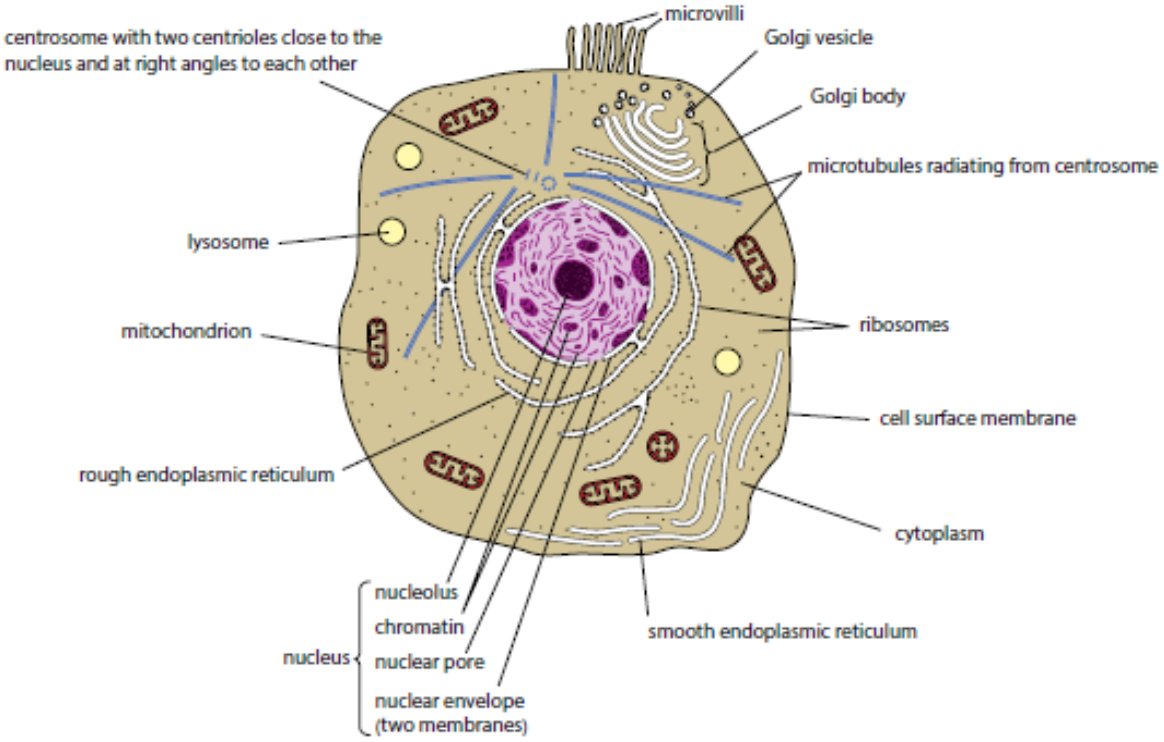
- They 'beat' causing locomotion and move fluid across the top of the cell
- An example of cilia can be found in the ciliated epithelium that lines the trachea and pushes mucus away from the lungs and into the alimentary canal
- Contain a basal body of 9 microtubule triplets (like a centriole) and a cilium made of a 9+2 structure (9 doublets around 2 single microtubules in the centre)
- They are made up of 600 different polypeptides

Flagella have the exact same structure as cilia, but are much longer and are used by cells to move through fluid.

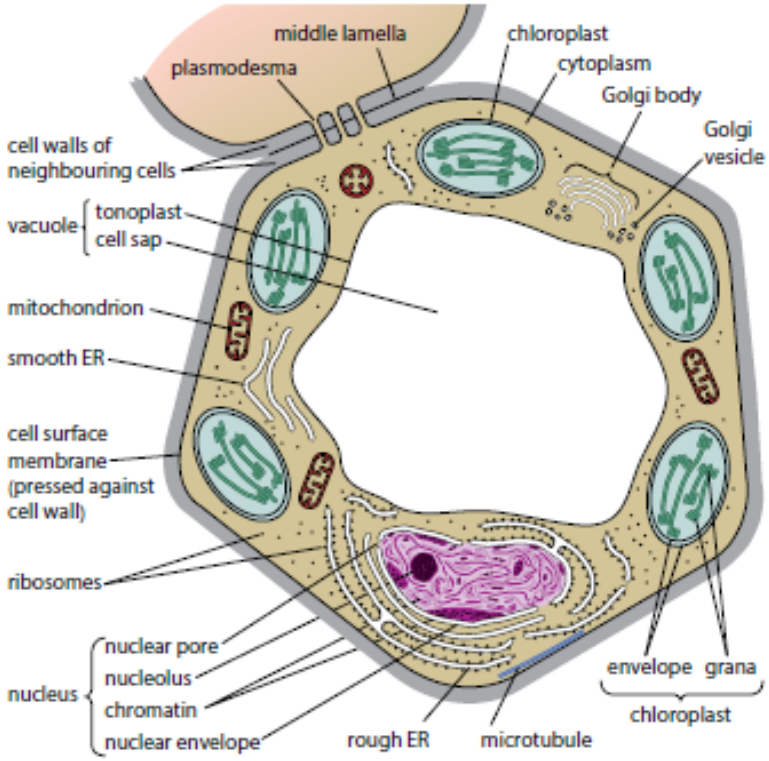
- Flagella can also move and propel the cell through fluid e.g. a sperm has a flagella (tail) which helps is 'swim'

The basal body + the cilium = the cilia (same for flagella), and the entire thing is covered by the cell surface membrane.

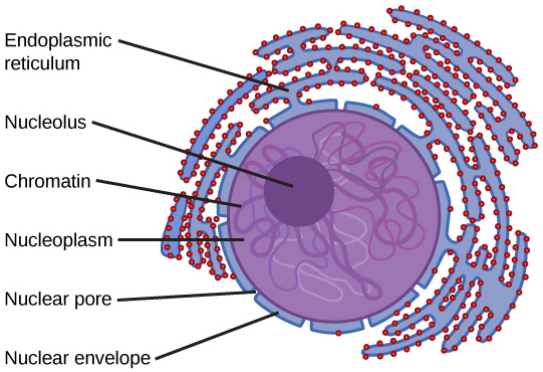
Typical Animal Cell

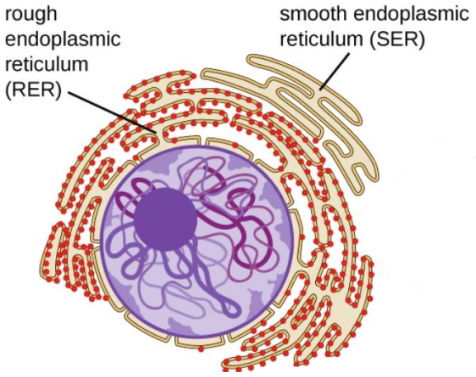


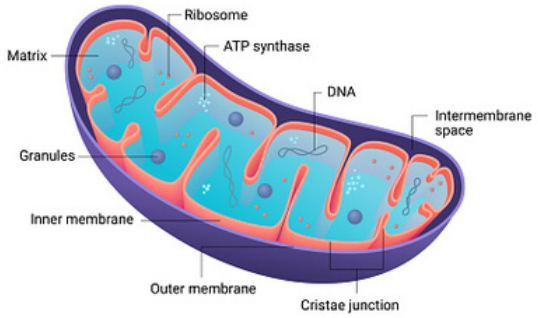
Typical Plant Cell

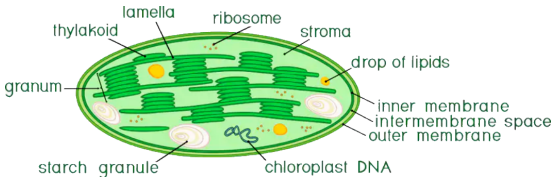


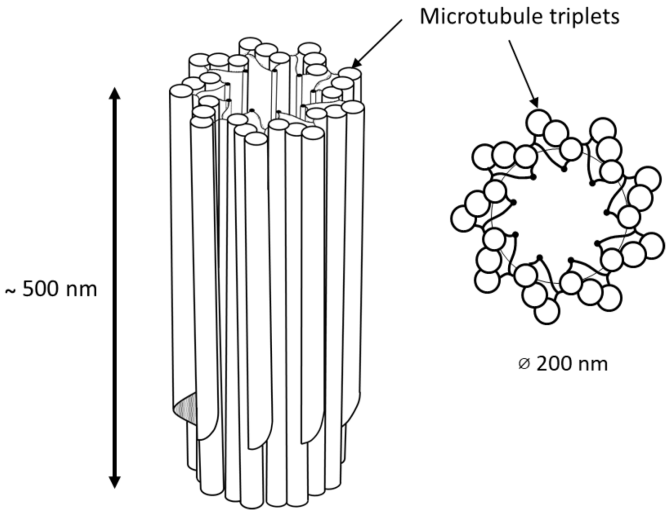
Diagrams

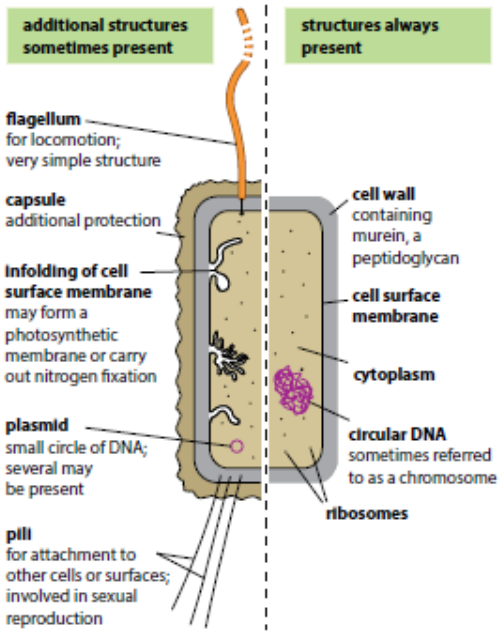












Bacterium ↑

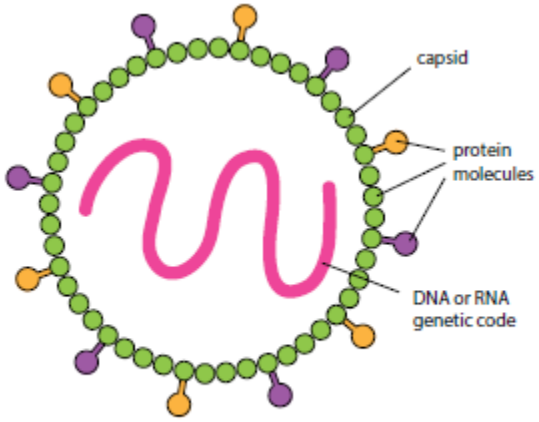


Figure 1.31 The structure of a simple virus.