Chapter 1: Cell structure

▼ 1.1. Cell Biology and Microscopy

▼ What is cell Biology and microscopy?

A cell can be thought as a bag in which the chemistry of life is allowed to occur, that has partially permeable membrane. It’s structure can be seen with either light microscope or electron microscope. Microscopes have been around since the 17th century, but improvements in the high quality lenses were made in the 19th century.

▼ 1.2. Common features and differences between animal cells and plant cells

▼ What are the common features?

- Cell surface membrane
- Nucleus
- Nucleolus
- Cytoplasm
- Mitochondria
- Golgi apparatus

▼ What are the differences?

- Centriole
- Cell walls and plasmodesmata
- Vacuoles
- Chloroplasts

▼ 1.3. Microscopy and Measurements

▼ Define resolution.

Resolution is the ability to distinguish between two objects very close together; the higher the resolution of an image, the greater detail that can be seen.

▼ Define magnification.

Magnification is the number of times greater that an image is than the actual objects.

$$\text{magnification} = \frac{\text{observed size of the image}}{\text{actual size}}$$

or

$$M = \frac{I}{A}$$

▼ The electromagnetic spectrum

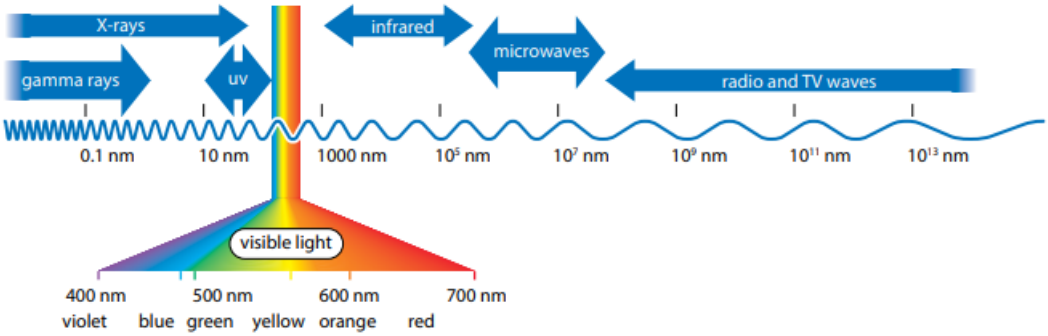


Figure 1.11 Diagram of the electromagnetic spectrum (the waves are not drawn to scale). The numbers indicate the wavelengths of the different types of electromagnetic radiation. Visible light is a form of electromagnetic radiation. The arrow labelled uv is ultraviolet light.

▼ TEM and SEM

▼ SEM (3nm to 20nm)

Scanning electron microscope (SEM), the electron beam is used to scan the surfaces of structures,
and only the reflected beam is observed.

▼ TEM (0.5μm in practice)

The beam of electrons passes through the specimen before being viewed. Only those electrons that are transmitted (pass through the specimen) are seen. This allows us to see thin sections of specimens, and thus to see inside cells.

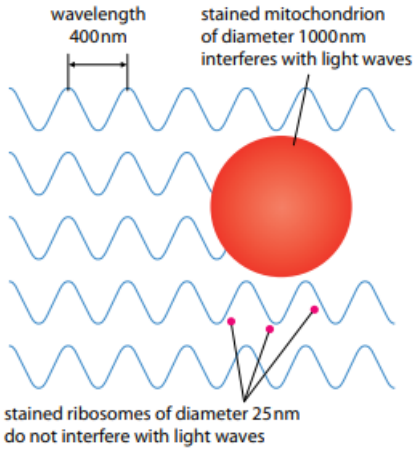


Figure 1.12 A mitochondrion and some ribosomes in the path of light waves of 400 nm length.

Fraction of a metre	Unit	Symbol
one thousandth = 0.001 = 1/1000 = 10^{-3}	millimetre	mm
one millionth = 0.000 001 = 1/1000 000 = 10^{-6}	micrometre	µm
one thousand millionth = 0.000 000 001 = 1/1000 000 000 = 10^{-9}	nanometre	nm

▼ 1.4. Ultrastructure of Animal cells

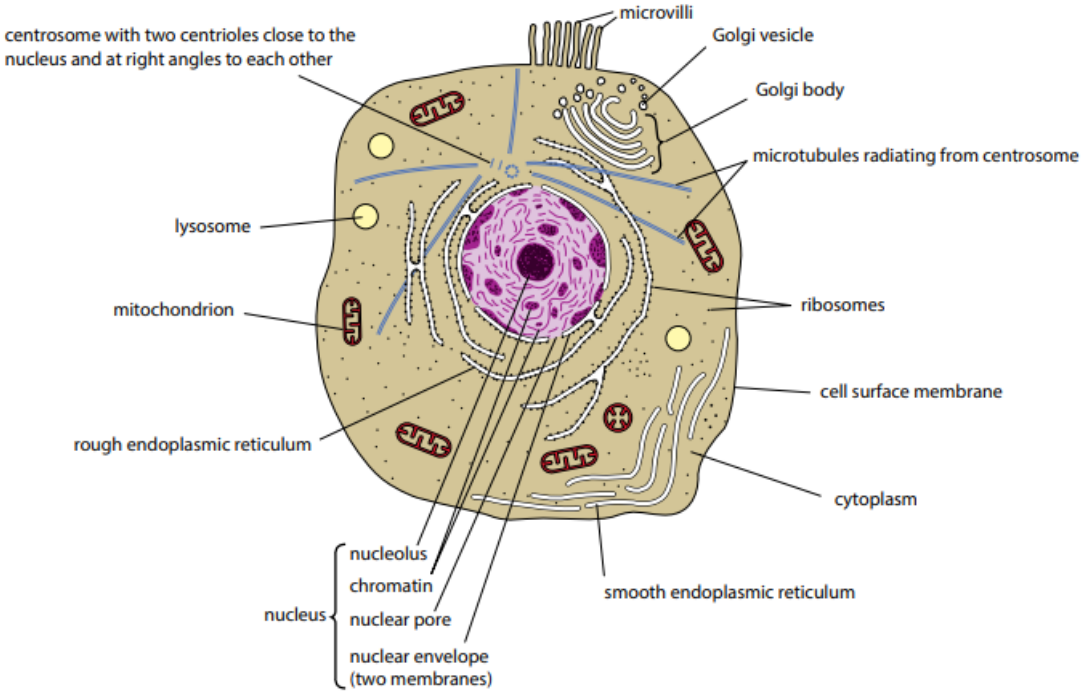


Figure 1.17 Ultrastructure of a typical animal cell as seen with an electron microscope. In reality, the ER is more extensive than shown, and free ribosomes may be more extensive. Glycogen granules are sometimes present in the cytoplasm.

▼ Nucleus

▼ Define nucleus.

Nucleus is a relatively large organelle found in eukaryotic cells, but absent from prokaryotic cells; the nucleus contains the cell's DNA and therefore controls the activities of the cell

It has nuclear envelope and the outer membrane is continuous with the RER.

It also has pores for exchange between the nucleus and the cytoplasm.

▼ What are present within the nucleus?

Inside the nucleus there are chromosomes made up of loosely coiled chromatin. Chromosomes contain DNA, which is organized into functional units called gens. Also within the nucleus, the nucleolus makes ribosomes, using the information in its own DNA.

▼ Define nucleolus

Nucleolus a small structure, one or more of which is found inside the nucleus; the nucleolus is usually visible as a densely stained body; its function is to manufacture ribosomes using the information in its own DNA

▼ Endoplasmic reticulum

Endoplasmic reticulum (ER) is a network of flattened sacs running through the cytoplasm of eukaryotic cells, and molecules, particularly proteins, can be transported through the cell inside the sacs separate from the rest of the cytoplasm; ER is continuous with the outer membranes of the nuclear envelope

▼ Rough endoplasmic reticulum

They are covered by ribosomes(25nm). (ribosomes= protein + RNA).

Proteins made by the rough ER enter the sacs and move through them, and proteins are often altered in the way. Small sacs called vesicles can break off the ER and these can join together to form the **Golgi body**.

▼ Smooth endoplasmic reticulum

No ribosomes.

Makes lipids and steroids, such as cholesterol and the reproductive hormones.

▼ Golgi body (Golgi apparatus or Golgi complex)

▼ Define Golgi body.

Golgi body is a series of fluid filled, flattened and curved sacs with vesicles surrounding the edges.

▼ What is the function of Golgi body.

The Golgi apparatus processes and packages proteins and lipids.

It also produces lysosomes.

In plants, enzymes in the Golgi body convert sugars into cell wall components.

Modifies proteins and lipids (from the primary structure to the next structures)

▼ Lysosomes

▼ Define lysosome and its function.

Lysosome a spherical organelle found in eukaryotic cells; a lysosome contains digestive (hydrolytic) enzymes and has a variety of destructive functions, such as removal of old cell organelles

▼ Mitochondria

▼ Define mitochondrion

Mitochondrion (plural: mitochondria) the organelle in eukaryotes in which aerobic respiration takes place.

▼ More about mitochondria structure and function

Mitochondria has double membranes, usually sausage shaped 1micrometer in diameter. The inner membranes is folded to form cristae which projects into the matrix. Matrix is a solution

containing all the enzymes needed for respiration inside the cristae.

The outer membrane has porins, proteins that form aqeuous channels. The space between the membranes is called the intermembrane space.

Its functions are to carry out aerobic respiration, synthesize lipids, breakdown large molecules and transfer the energy release to ATP, convert ATP to ADP.

▼ Cell surface membrane

Cell surface membrane is the thin layer outside the cell that is semi permeable.

It has trilaminar appearance.

▼ Microvilli

Microvilli are finger-like projections of the cell membrane which increases the cell's surface area.

They line organs like mall intestine to maximize nutrient absorption.

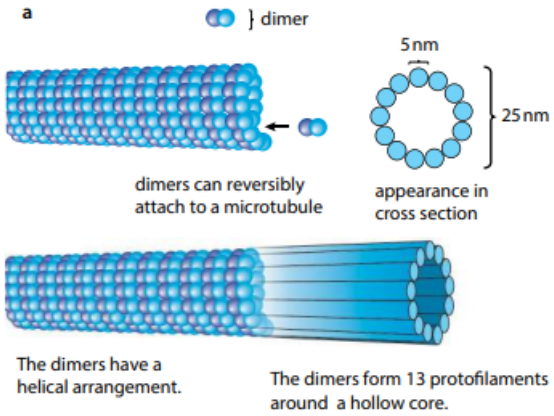
▼ Microtubules and microtubule organizing centers. (MTOCs)

Microtubules are a tiny tubes made up of a protein called tubulin and found in most eukaryotic cells.

Microtubules have a large variety of functions, including cell support, and determining cell shape.

The spindle on which chromosomes separate during nuclear division is made up of microtubules.

Centrioles(singular: centriole, parallel to each other: centromeres) are short hollow cylinders.



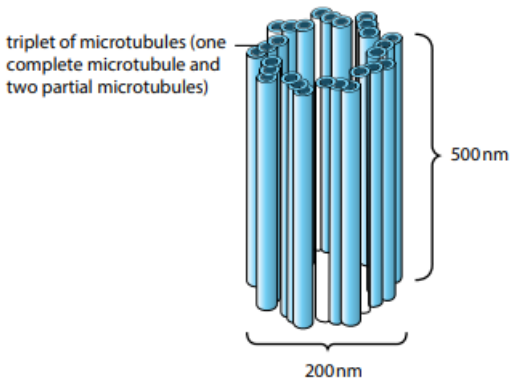


Figure 1.25 The structure of a centriole. It consists of nine groups of microtubules arranged in triplets.

▼ Centrioles

Centrioles are hollow cylinders containing a ring of microtubules arranged at right angles to each other. Centrioles are involved in cell division.

▼ 1.5. Ultrastructure of Plant cells

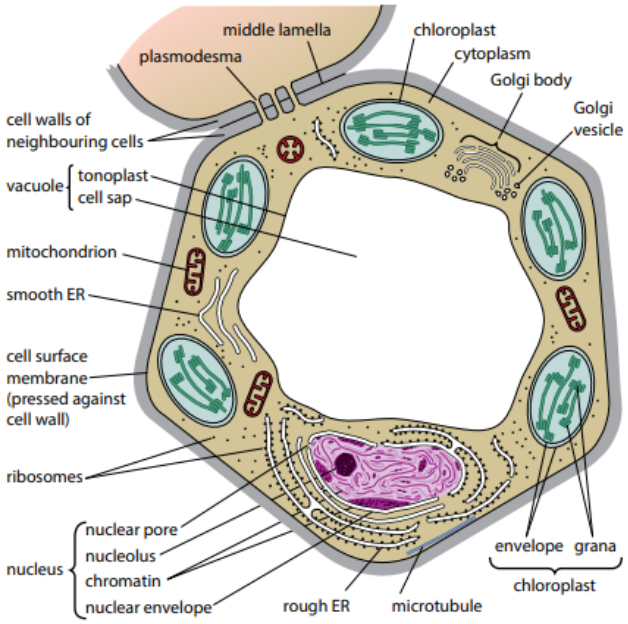


Figure 1.28 Ultrastructure of a typical plant cell as seen with the electron microscope. In reality, the ER is more extensive than shown. Free ribosomes may also be more extensive.

▼ Chloroplasts

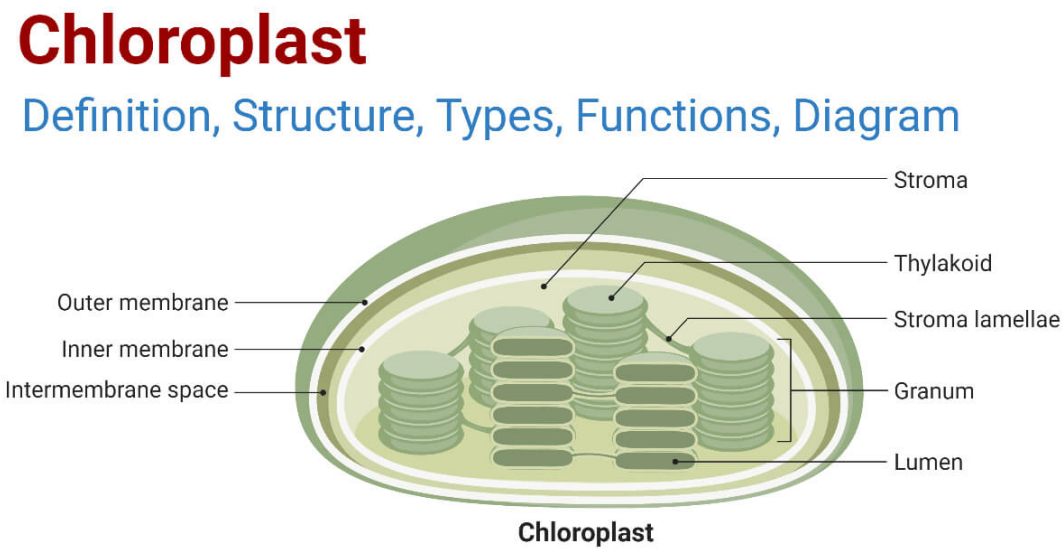
▼ The structure of chloroplasts.

Chloroplasts have elongated shape 3 to 10 micrometer.

Has double membranes.

Contains thylakoid membranes which are stacked up to form grana and are linked together by lamellae.

Suspended in semi-fluid stroma.



▼ The functions of chloroplasts

It is the site of photosynthesis so carries out photosynthesis.

▼ Plasmodesmata

Plasmodesmata are small channels that pass through the cell wall of adjoining plant cells to communication between cells.

▼ 1.6. Two fundamentally different types of cells

Prokaryotes	Eukaryotes
average diameter of cell is 0.5–5 µm	cells commonly up to 40 µm diameter and commonly 1000–10 000 times the volume of prokaryotic cells
DNA is circular and lies free in the cytoplasm	DNA is not circular and is contained in a nucleus – the nucleus is surrounded by an envelope of two membranes
DNA is naked	DNA is associated with protein, forming structures called chromosomes
slightly smaller (70S) ribosomes (about 20 nm diameter) than those of eukaryotes	slightly larger (80S) ribosomes (about 25 nm diameter) than those of prokaryotes
no ER present	ER present, to which ribosomes may be attached
very few cell organelles – no separate membrane-bound compartments unless formed by infolding of the cell surface membrane	many types of cell organelle present (extensive compartmentalisation and division of labour): ■ some organelles are bounded by a single membrane, e.g. lysosomes, Golgi body, vacuoles ■ some are bounded by two membranes (an envelope), e.g. nucleus, mitochondrion, chloroplast ■ some have no membrane, e.g. ribosomes, centrioles, microtubules
cell wall present – wall contains murein, a peptidoglycan (a polysaccharide combined with amino acids)	cell wall sometimes present, e.g. in plants and fungi – contains cellulose or lignin in plants, and chitin (a nitrogen-containing polysaccharide similar to cellulose) in fungi

Table 1.2 A comparison of prokaryotic and eukaryotic cells.

▼ Eukaryotes

Eukaryote has nuclei, has linear DNA inside it and does not have cell walls/peptidoglycan cell walls.

Fungi has chitin cell wall.

Has many membrane bound organelles.

Has larger ribosomes(80S).

▼ Prokaryotes (1-5µm)

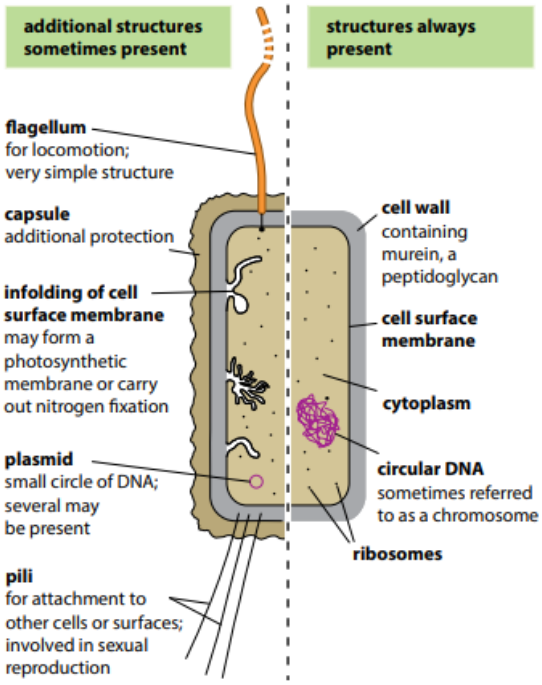


Figure 1.30 Diagram of a generalised bacterium showing the typical features of a prokaryotic cell.

Prokaryote lack nuclei, has circular DNA that floats freely in the cytoplasm.

Does not contain membrane bound organelles.

Has smaller ribosomes (70s).

▼ Cell wall

Rigid, outer covering made up of peptidoglycan.

▼ Capsule

Protective slimy layer which helps the cell to retain moisture and adhere to surfaces.

▼ Plasmid

Circular piece of DNA.

▼ Fragelum

A tail like structures which rotates to move the cell.

▼ Pili

Hair like structures which attach to other bacterial cells.

▼ Ribosomes

Synthesizes proteins.

▼ Viruses

Viruses are non living structures which consist of nucleic acid (DNA or RNA) enclosed in a protective protein coat called capsid, sometimes covered with a phospholipid layer called the envelope.

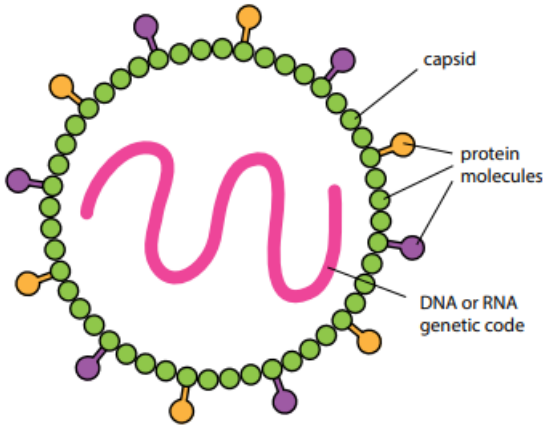


Figure 1.31 The structure of a simple virus.

Feature	Light microscope	Electron microscope
source of radiation	visible light	electrons
wavelength of radiation used	400 nm – 700 nm	about 0.005 nm
maximum resolution	200 nm	0.5 nm in practice
lenses	glass	Electromagnets
specimen	Living or non-living or dead	non-living or dead
stains	coloured dyes	Heavy metals
image	coloured	black and white

Organelles each *lacking* a boundary *membranes*: ribosomes, centrioles, cytoskeletal structures.

Organelles bounded by a *single* membranes: Golgi apparatus, lysosomes, SER.

Organelles bounded by *two* membranes: nucleus, mitochondria, chloroplast.

Aug 22, Monday (extra-class notes)

Maximum magnification of the **light microscope** is 1500.

The **disadvantage of TEM** is its size and its unavailability to see living things as it requires the observing things to be in a vacuum condition.

Golgi body- closed

RER and SER flattened vesicles - open

Secretion - шүүрэл

Lysosomes fuse with the incoming vesicles

Cilia and flagella - hair-like projections from cell surface that aid in cell movement.

3 main domains: archaea (bacteria that live in extreme conditions), eukaryotic, bacteria.

The structure of prokaryotes

Extremely small: 1-1.5

Occur in three different shapes Coccus spirochete bacillus

Glycocalyx is the layer of polysaccharides on the outside of the cell wall. Includes the carbohydrate antennae branches.

If you have any questions reach out to**: 23C Chinguun.M, IG: @chinguun__0511, FB: Chinguun Tsetsgee.**
Or post questions on the discord server for help!