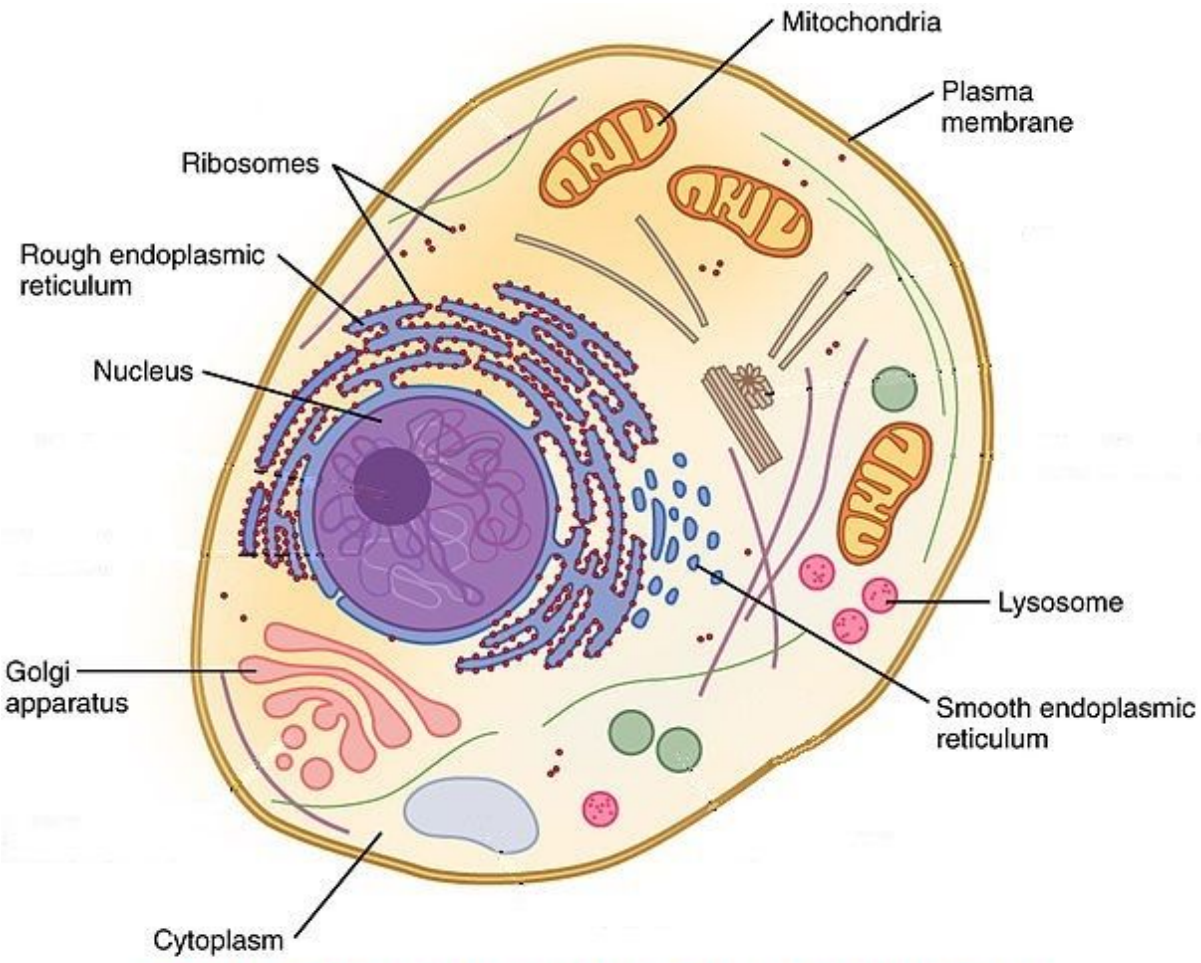
3.4 Eukaryotic cell (pg 67)

includes animals, plants, fungi, yeast, algae



10-500 µm

The nucleus

DNA - stores genetic information

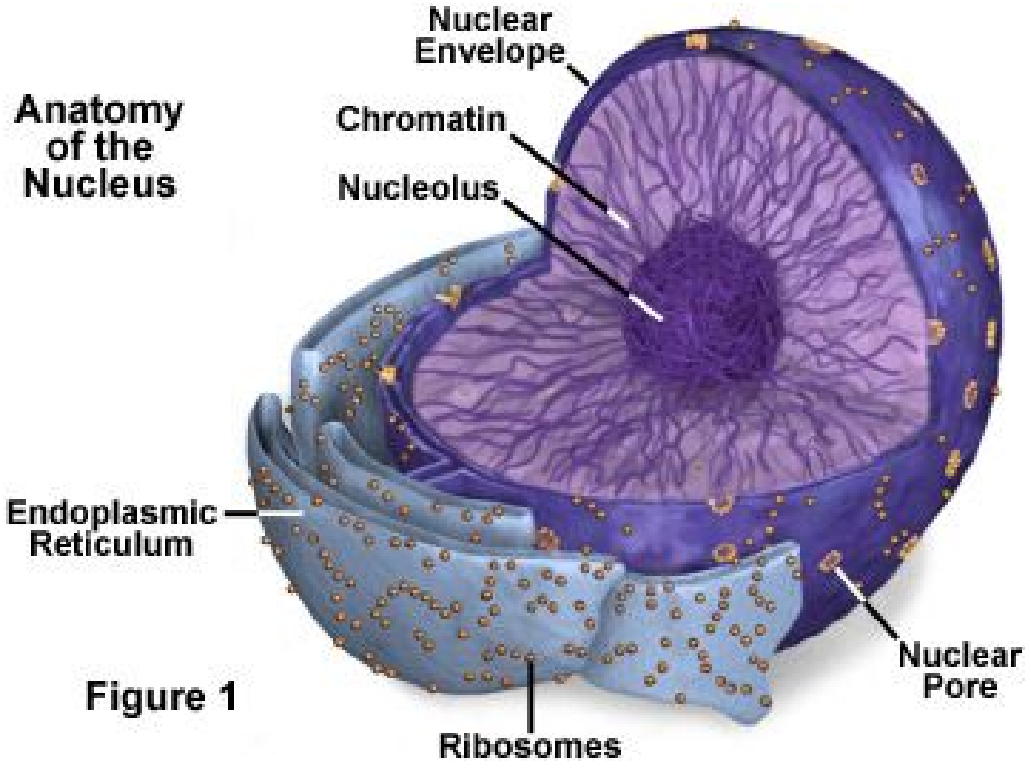


Figure 1

DNA is the ‘recipe book’ or ‘blueprint’ of the cell - no cell can reproduce or survive independently without DNA

DNA is divided into sections called ‘genes’

Each ‘gene’ codes for a polypeptide chain = protein

i.e. each gene holds the recipe (code) for one layer of a cake (protein)

Ingredients = mainly amino acids (no shape, no function)

Each layer = polypeptide (has some shape, no function)

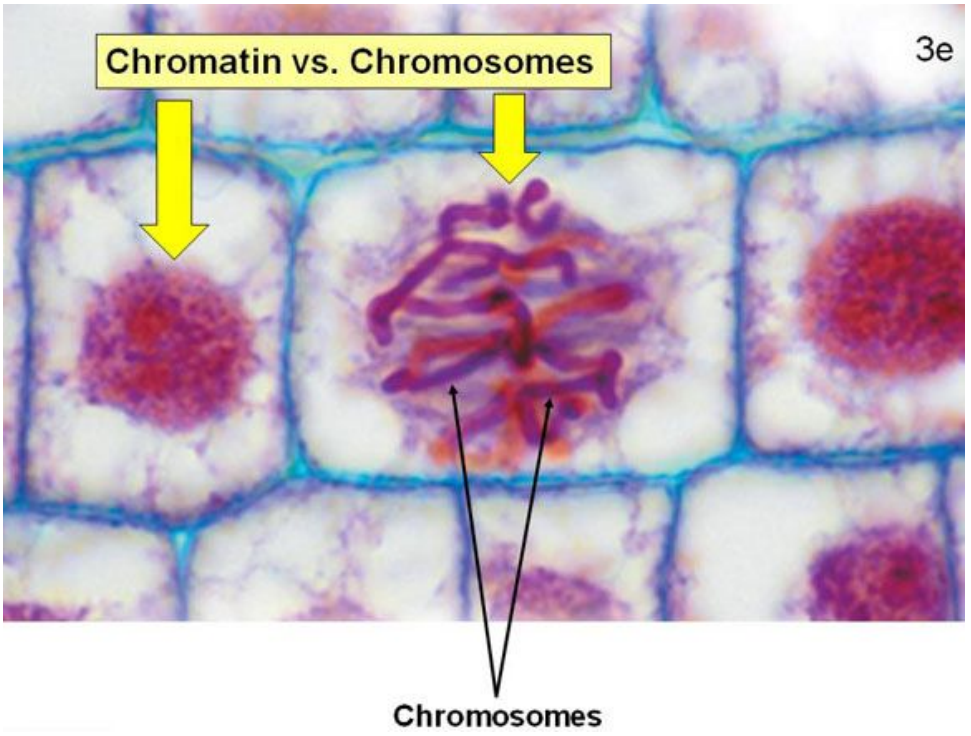
One cake = one protein (has shape & function)

DNA can exist in two forms:

Loosely coiled form (during the resting/growth phase) = chromatin

Tightly condensed form (during cell division) = chromosome

The structure of DNA is stabilised by proteins called as histones



Role of DNA

- To store genetic information
- To pass the genetic information, without corruption, to a daughter cell
- To control protein production in the cell
- To provide the information need to synthesise ribosomes and ribosomal RNA

Other structures in the nucleus

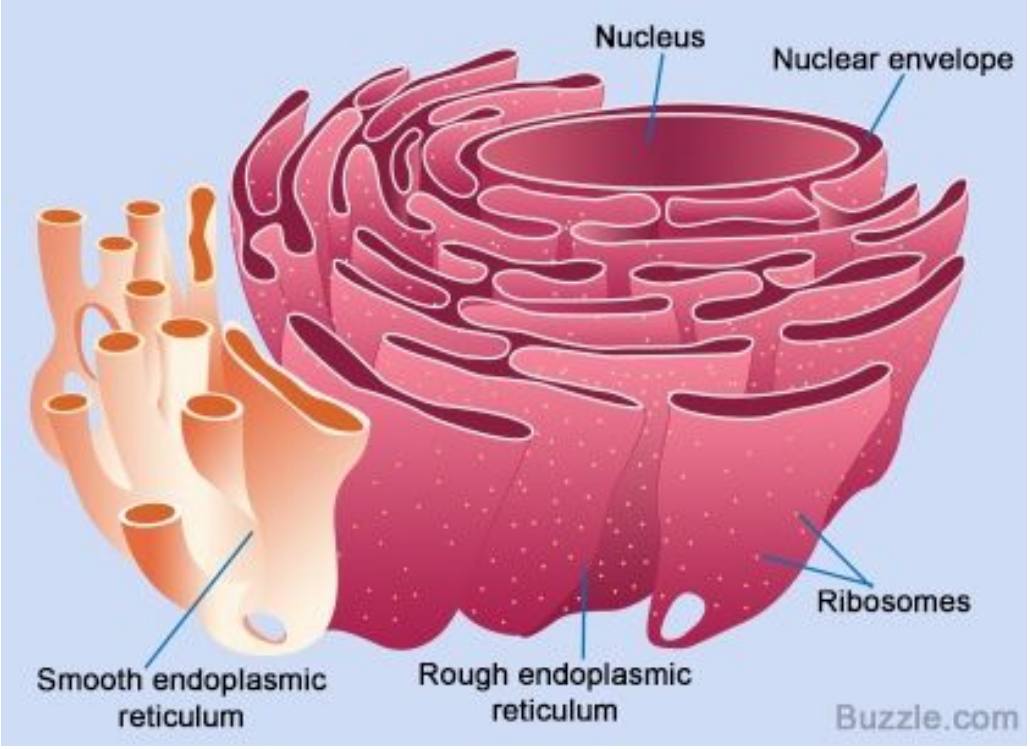
Nuclear envelope: double-membrane that encloses the DNA
: has nuclear pores, that allow for exchange of molecules between the nucleus and the cytoplasm
: joins on to another organelle, called the ER

Nucleoplasm: cytoplasm of the nucleus

Nucleolus: the part of DNA which is responsible for synthesis ribosomal RNA

Endoplasmic Reticulum

‘Oven’ that ‘bakes’ amino acids into polypeptides



Rough ER

- is continuous with the outer membrane of the nuclear envelope

- Has a granular appearance under the microscope, due to the presence of molecules called ribosomes

- also contains molecules called transfer RNA (tRNA) and amino acids

- the network of tubules of the ER is called cisternae

- RER is the site of polypeptide synthesis - has a large surface area

- Provides a pathway for transport of substances from the nucleus to the Golgi body

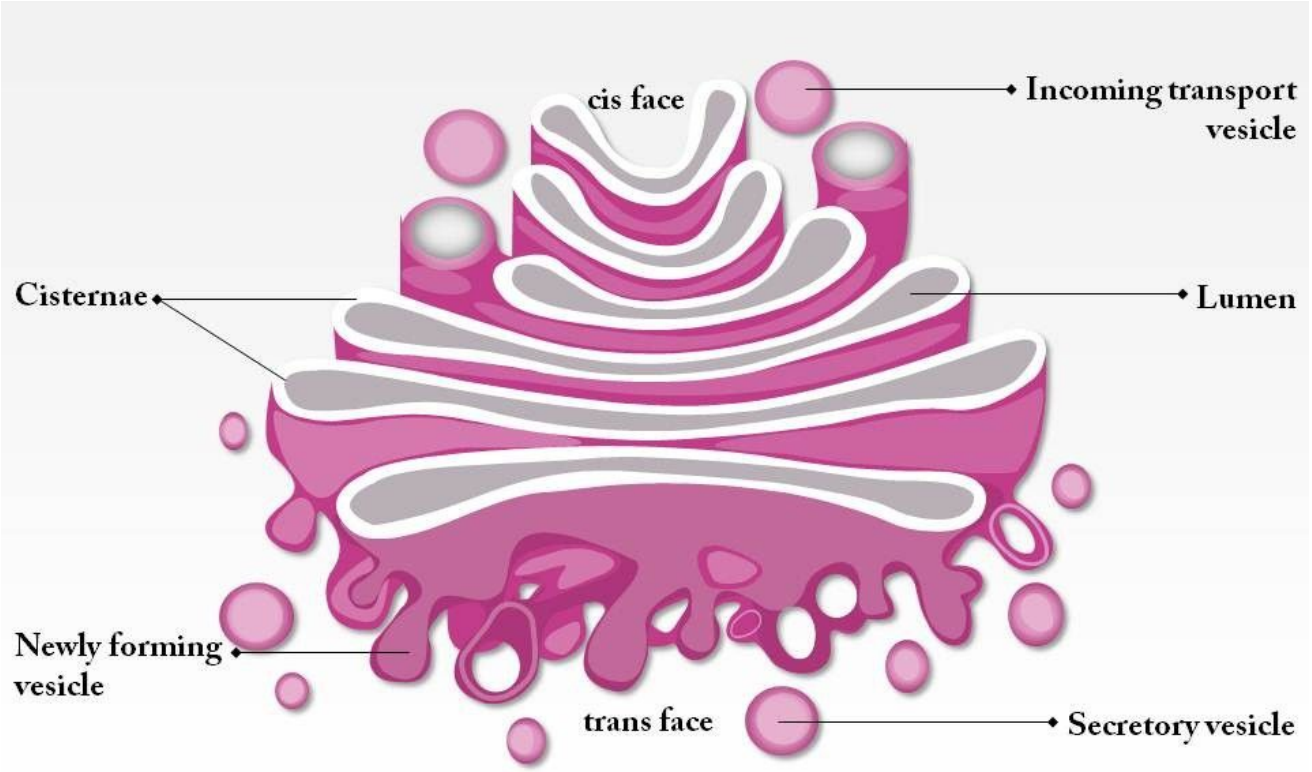
Smooth ER

- no ribosomes

- synthesis, storage and transport of carbohydrates and lipids

Golgi apparatus

"Post office" of the cell



Golgi apparatus

- has a cis face (incoming) and trans face (outgoing)

- the flattened sacs are called as cisternae

- Polypeptide chains from the ER are passed on to the Golgi

- In the Golgi, the polypeptides are folded into 3-D structures called proteins

- Polypeptides may also be modified with carbohydrates and lipids

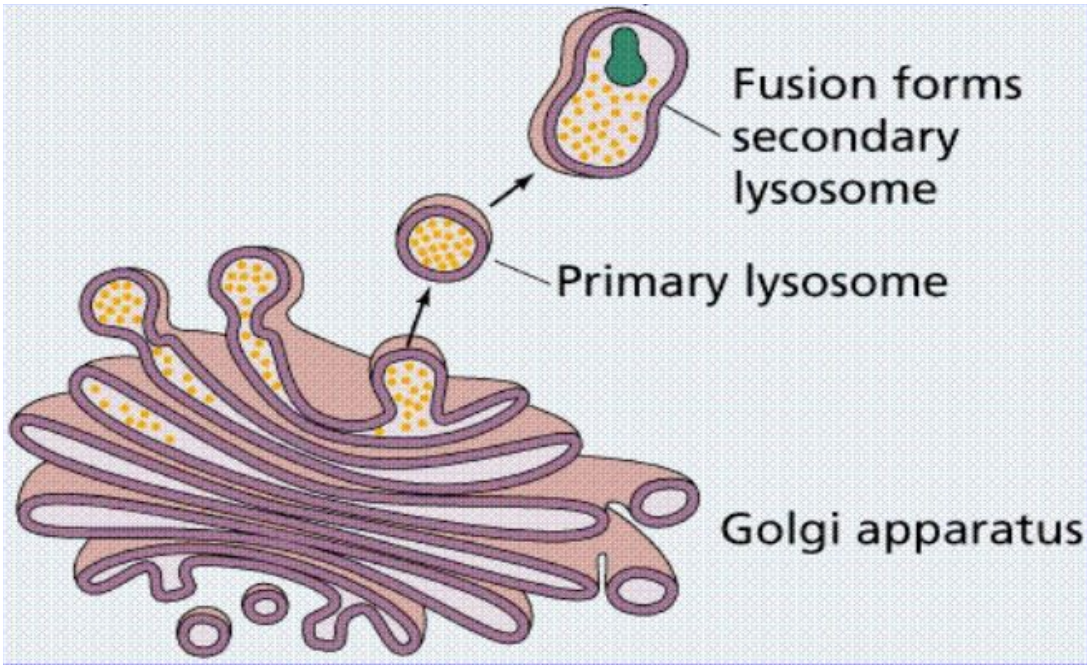
- Once fully assembled, the protein is packaged into membrane-bound circular structures, called vesicles

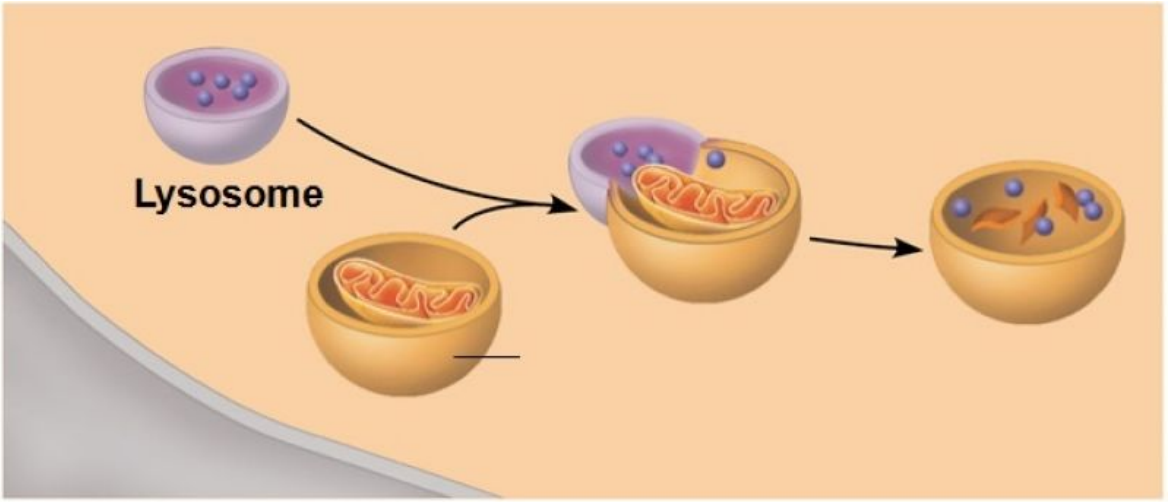
- Vesicles are transported, by motor proteins (‘the postman’), to their correct destination in the cell

- some vesicles only contain enzymes. These vesicles are called lysosomes.

Lysosomes

The recycling centre of the cell





Lysosomes

- Lysosome contains hydrolytic enzymes = enzymes that can break down larger molecules using water, through the process of hydrolysis

- Mis-folded proteins, lipids and carbohydrates, and worn out organelles, are sent to the lysosomes, to be broken down

- These molecules are first enclosed in a vesicle called a phagosome

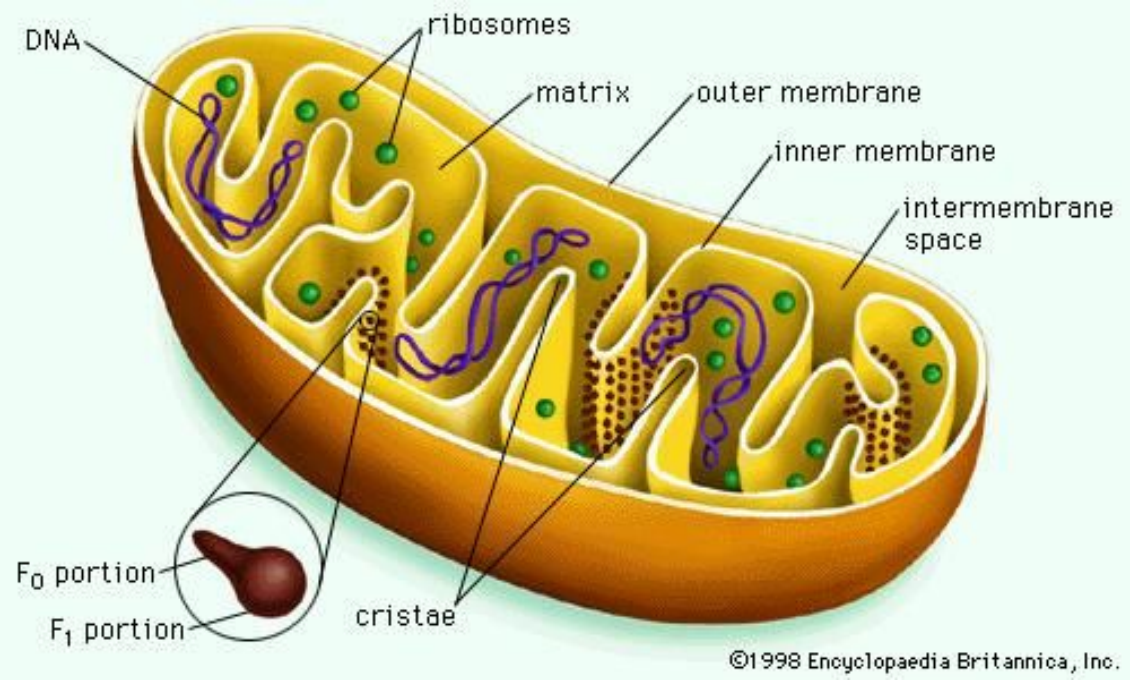
- Phagosome and lysosome merge, hydrolytic enzymes released, organelles or molecules (or bacterial cells) broken down

- Soluble products - amino acids, sugars etc are re-absorbed and recycled

- Insoluble debris is egested

Mitochondria

Power house of the cell - Glucose → ATP (energy)



Mitochondria

- Double membrane structure
- Site of respiration (glucose to ATP)
- inner membrane highly folded
- Folds are called cristae

Cristae contain:

- electron carriers as part of the electron transport chain (ETC)
- the enzyme ATP synthase

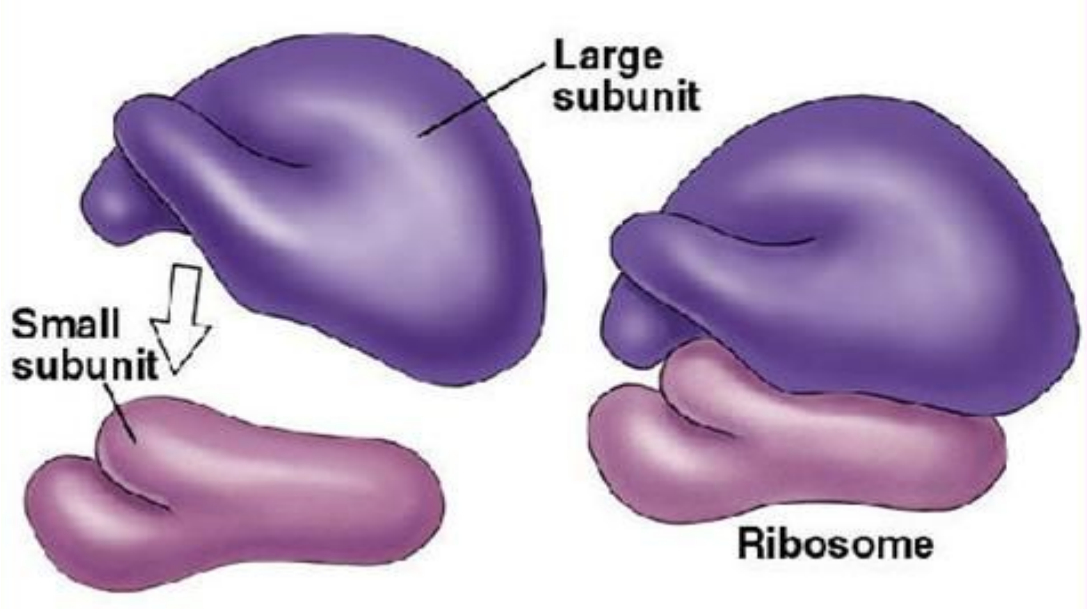
A mitochondria is a cell within a cell:

- it has its own DNA
- it has ribosomes

The DNA and ribosomes of mitochondria are more similar to prokaryotic than eukaryotic cells.

Ribosomes

Site of polypeptide synthesis

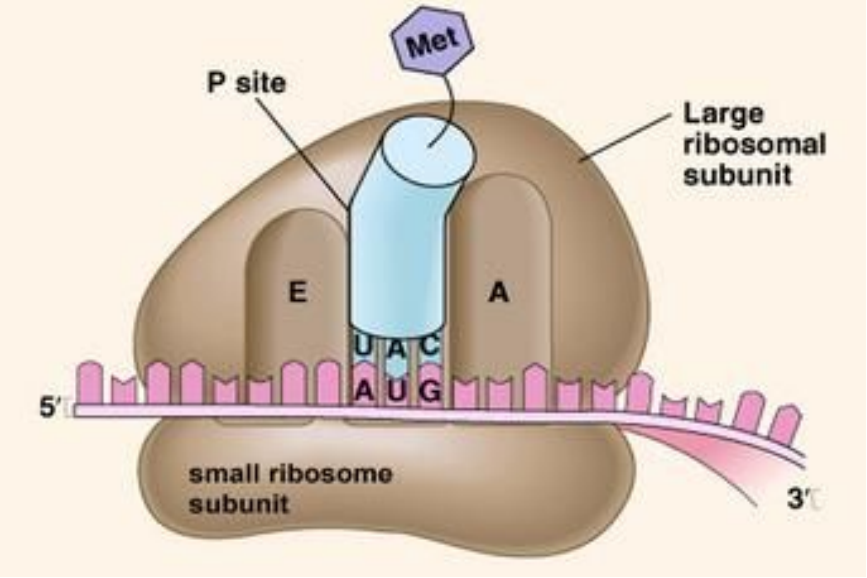


- Mostly found in the RER, some in cytoplasm
- Two subunits, which overlap, leaving a gap in between
- messenger RNA can fit into this gap

- messenger RNA ‘copies’ the information (‘recipe’) from DNA, and brings it to the RER

- Ribosome reads the ‘recipe’ and assembles the ingredients (amino acids) in the correct order, to form a polypeptide chain.

- The large subunit has two binding sites for tRNA within the large subunit
- Ribosome holds the mRNA in place, so the tRNA can read the information (‘recipe’) on the mRNA



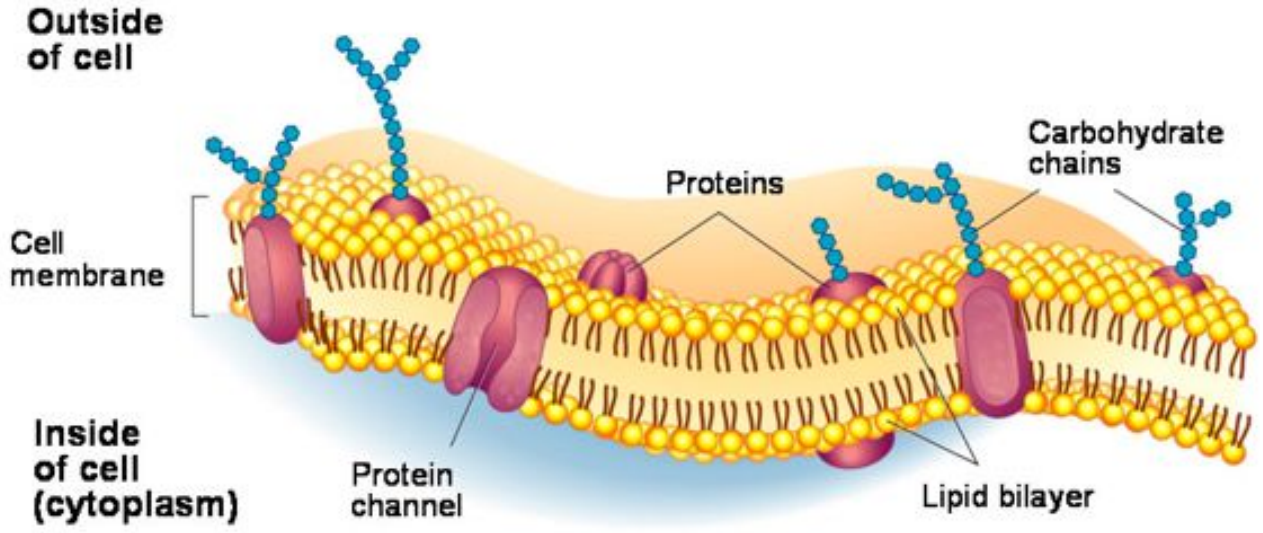
Eukaryotes (animal, plant, yeast, fungi, algae) - 80S

Prokaryotes (bacteria) - 70S

Viruses - do not carry ribosomes (therefore cannot live independent of a host cell)

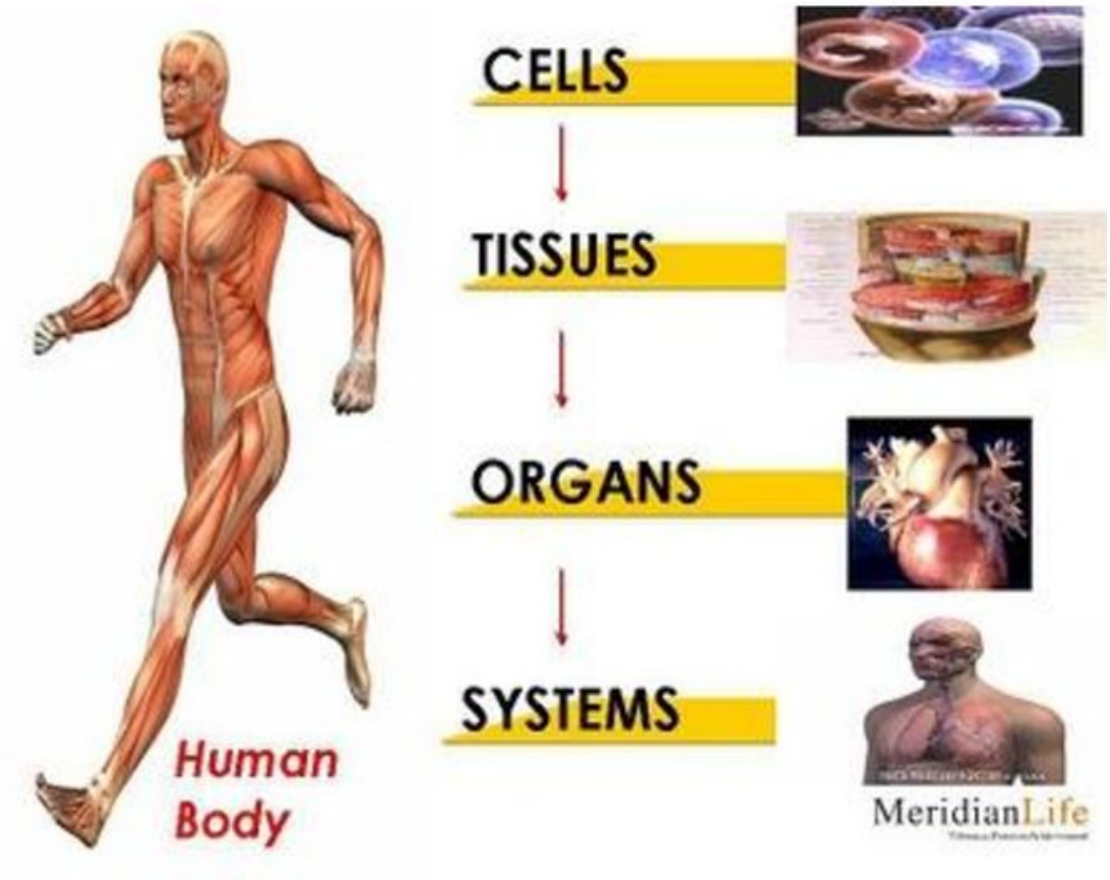
Cell membrane (pg 84)

Creates a barrier between the inside and outside



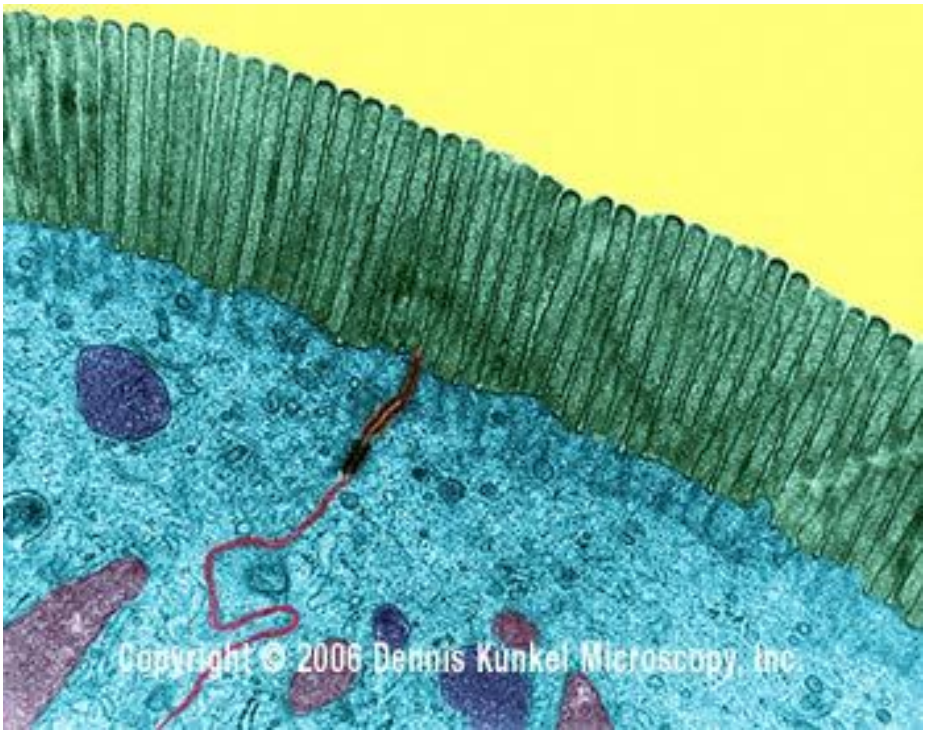
- Regulates entry and exit of substances, e.g. glucose
- Cell surface receptors - glycoprotein and glycolipid - used to sense the external environment and cell-to-cell communication

Cell specialisation (pg 73)



Specialised animal cells

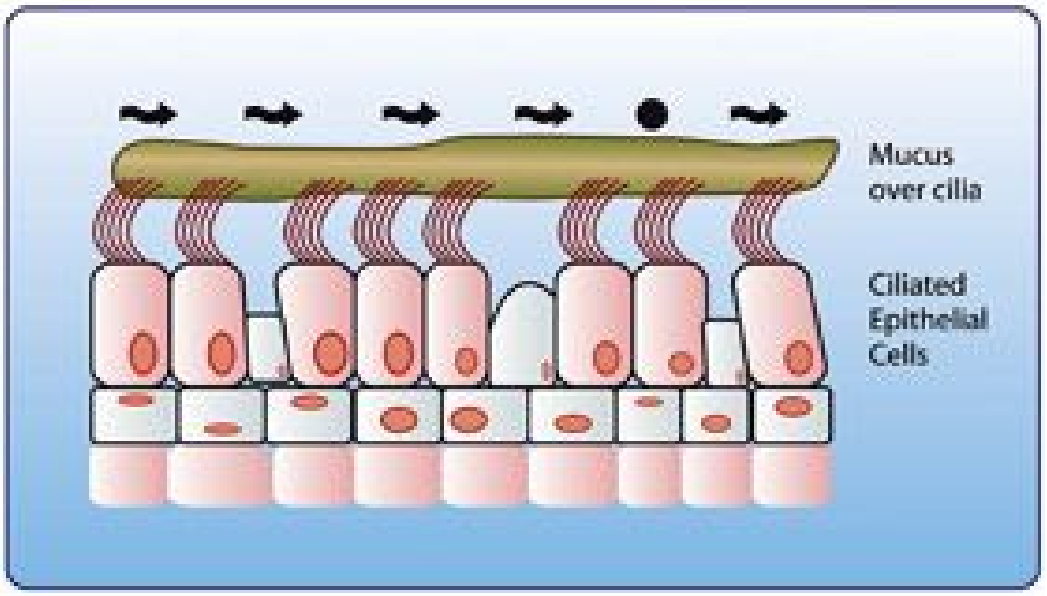
(a) Epithelial cells of small intestine (ileum) - pg 95



- Inner surface of small intestine (ileum) is folded into large finger-like folds called villi.

- the epithelial cells facing the lumen have a brush border, called microvilli - this increases surface area for absorption of nutrients

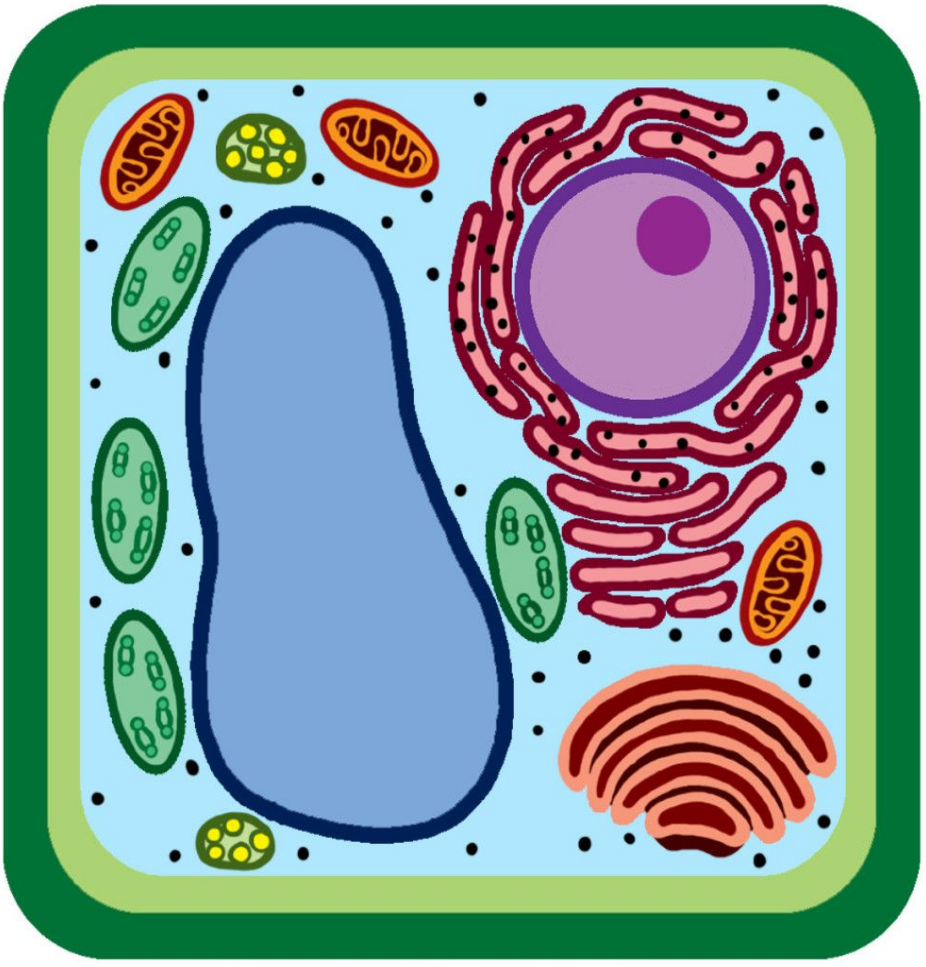
(b) Specialised lung cells



Goblet cells in the lungs produce mucous, that traps dust and bacteria

Epithelial cells in the lungs have cilia, which waft the mucous towards the oesophagus, and eventually into the stomach (where the bacteria are killed by the stomach acid)

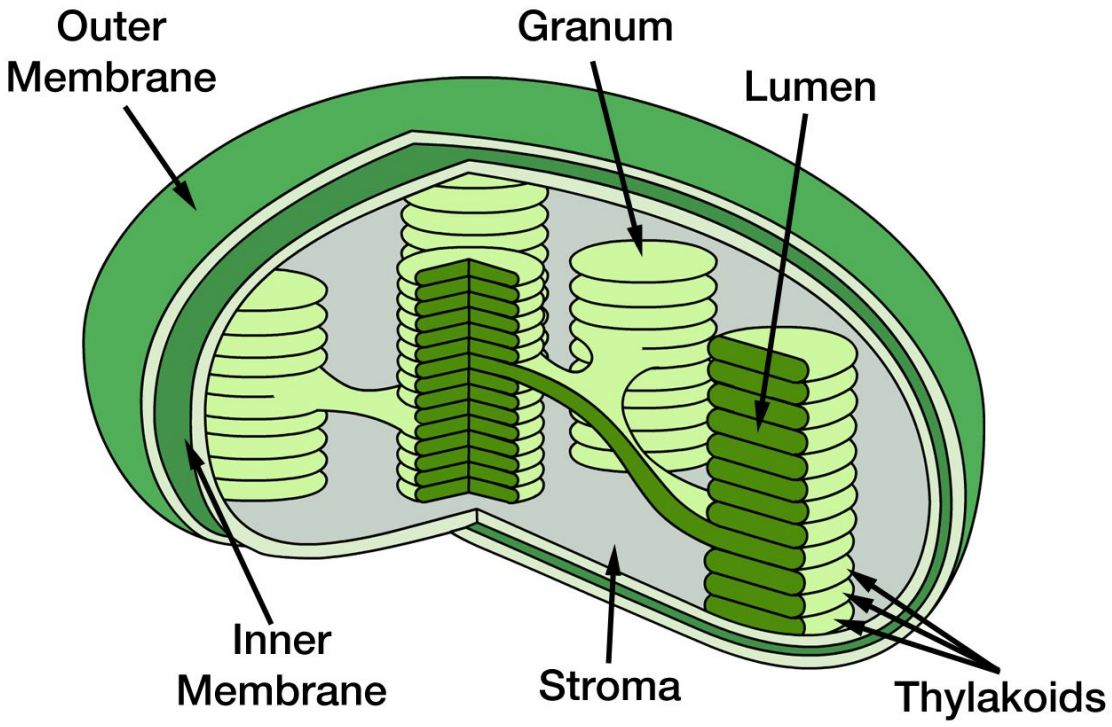
Plant Cells (Eukaryotic)



Have a cell wall and chloroplasts, in addition to other organelles

Chloroplasts (pg 68)

Site of photosynthesis - glucose production from CO_2



Chloroplasts

- double membrane structure

- contains membrane-enclosed sacs called thylakoids

- a stack of thylakoids is called grana (pl. - granum)

- Thylakoids contain photosynthetic pigments, including chlorophyll a, and carotene

- the cytoplasm of the chloroplast is called stroma

- just like the mitochondria, the chloroplast is a cell within a cell
- it contains it own DNA and ribosomes

Plant Cell wall

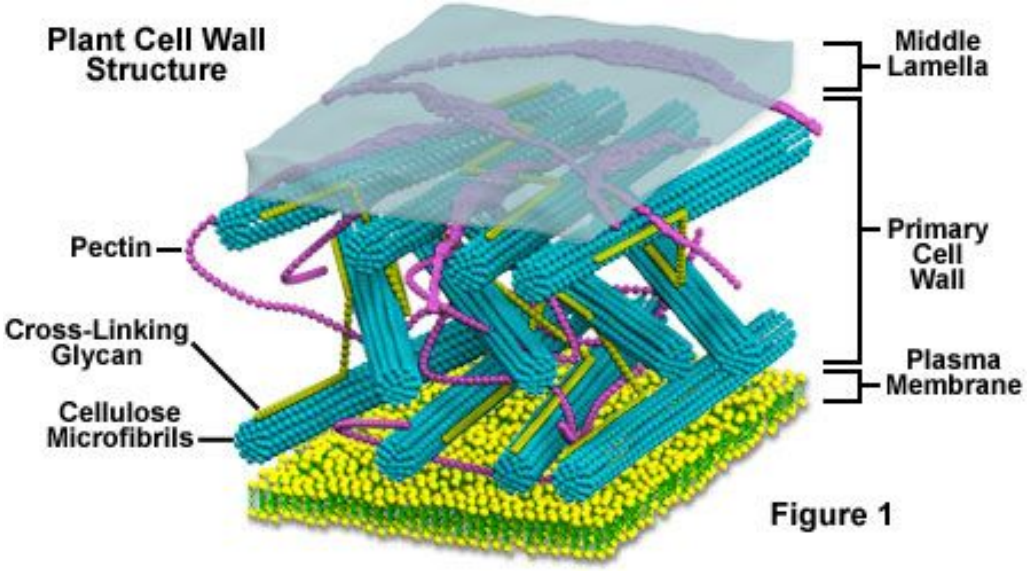
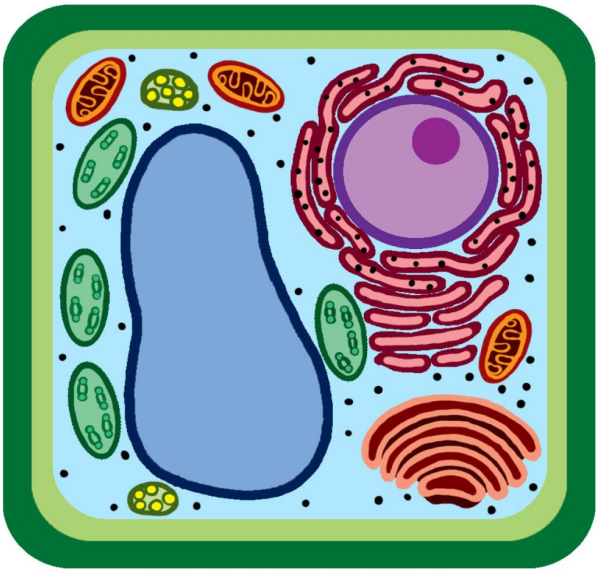


Figure 1

- Contains a large percentage of cellulose
- Rigid, provides structural and mechanical support
- Allows the plant to support its own weight and stand upright
- The middle lamellae acts as the boundary between two cells and cements adjacent cells together
- Allows for water to be drawn in through the roots

Algae - cellulose and/or glyoprotein
Fungi - chitin, glycan and glycoprotein

Vacuole



- Surrounded by a single membrane - tonoplast
- Contains cell sap - water mixed with sugars, amino acids, pigments like anthocyanins,etc.
- Keeps the cell turgid, allowing woody plants to stay upright
- Sugars and amino acids act as temporary food store
- Anthocyanins help to attract pollinating insects

Prokaryotic Cell (pg 75)

(Bacteria)

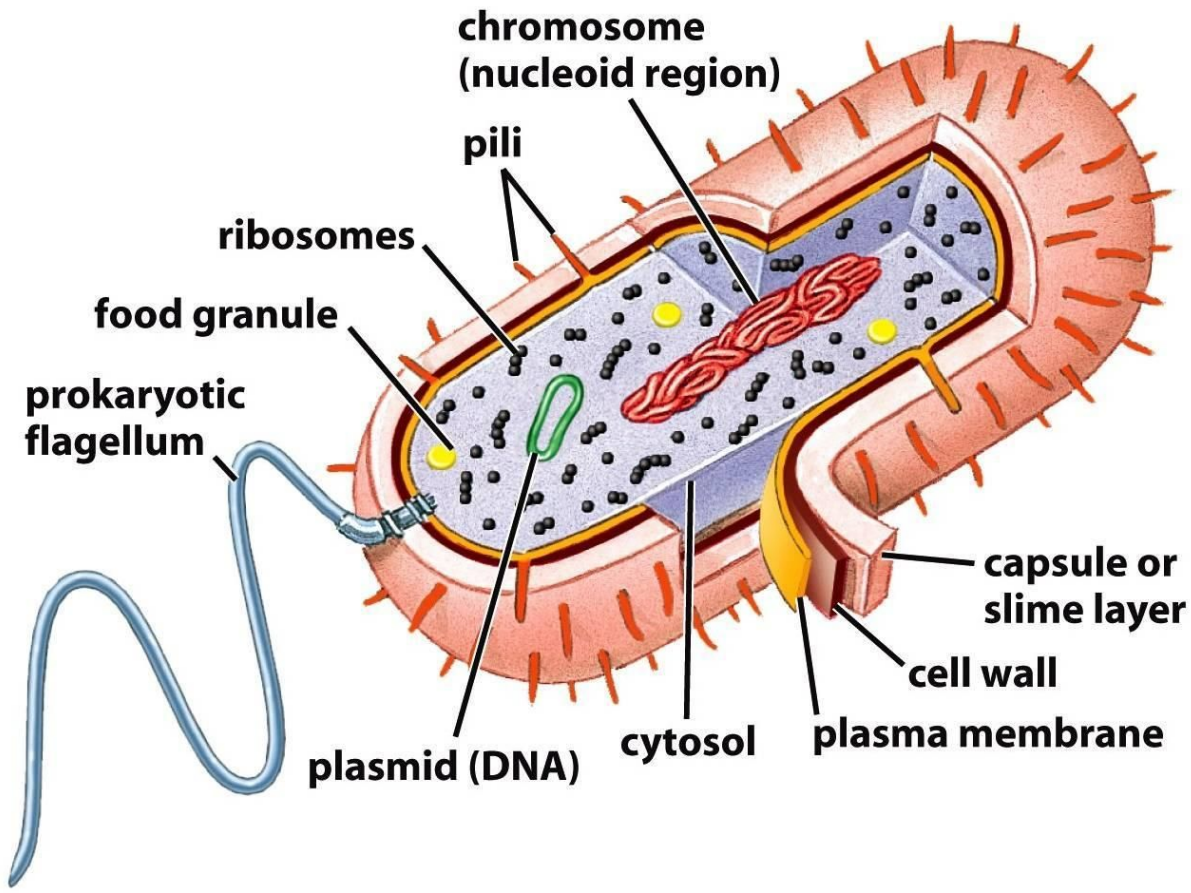


Figure 4-20a Biology: Life on Earth, 8/e

0.1-10 µm

- Lack internal membrane bound organelles
- Ribosomes are 70S type
- DNA is circular - only one strand, and not enclosed in a nuclear envelope (‘naked’ DNA)
- Always have a cell wall (peptidoglycan/murein = sugars and amino acids)
- Flagella - movement
- Pili - attachment to surfaces (like intestinal cells)
- Capsule (mucilage) - attachment to surfaces (like lungs) and protection
- Carry extra pieces of DNA called ‘plasmids’ - plasmids carry genes not found in the bacterial cell. Cells can add/remove plasmids or exchange them with each other.

Mitochondria/Chloroplasts vs. Bacteria

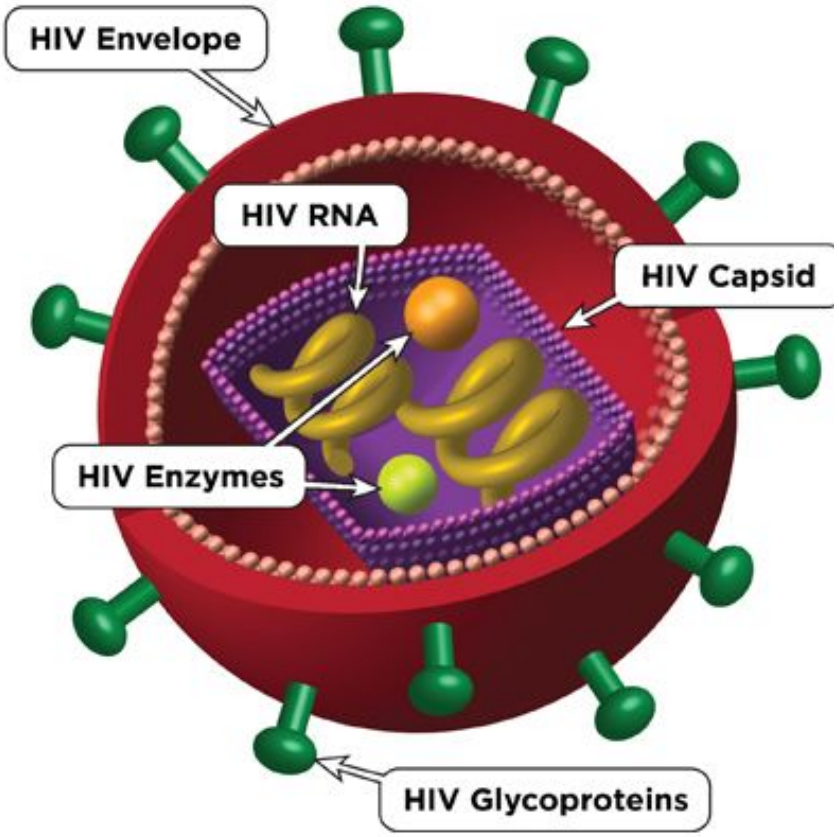
- Mitochondria and Chloroplasts are organelles, bacteria are cells

- all contain 70S ribosomes

- all contain ‘naked’ DNA

- only a bacterial cell can reproduce independently - mitochondria and chloroplasts have lost the ability to replicate outside of the eukaryotic cell

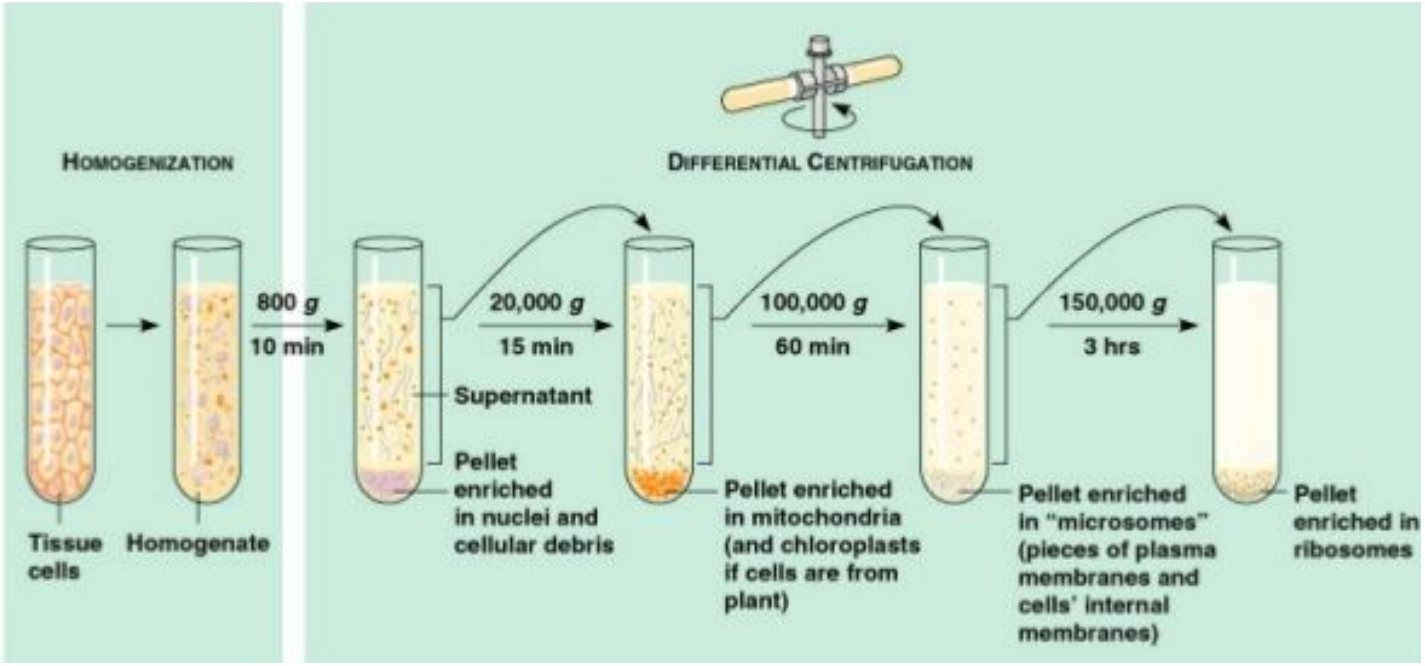
Viruses (pg 76)



20-200 nm

- Non-living - can only replicate inside host cell
- Genetic material can be DNA or RNA, single or double-stranded
- Genetic material enclosed in a capsid
- Outermost layer (envelope) is a lipid bilayer, with proteins for attachment to host cells

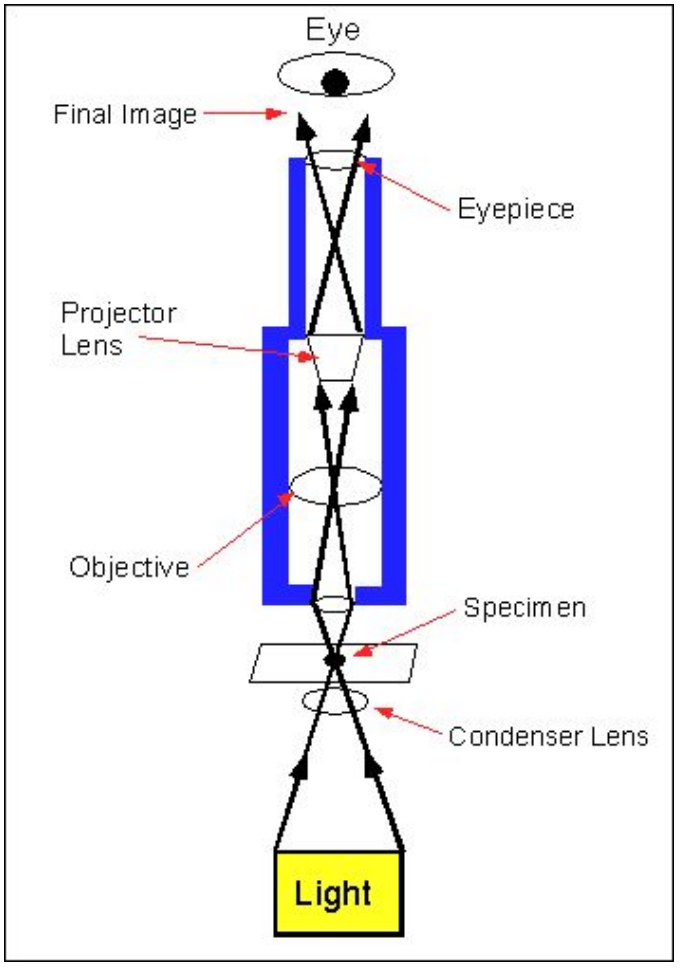
Cell fractionation (pg 59)



- Cold - reduce enzyme activity
- Isotonic - same water potential
- Buffered - pH constant

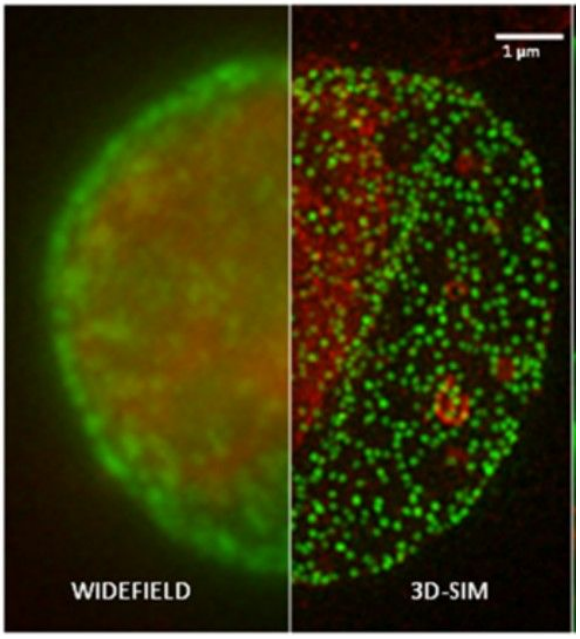
Ultracentrifugation - the heaviest organelles will move to the bottom of the tube, whereas the lighter organelles stay near the top

Looking at Cells - Light (Optical) Microscope (pg 61)



Pro: Can observe living specimens *in situ*
Con: Low resolution, 200 nm, difficult to see bacteria, impossible to see viruses

Resolution: How well a microscope can distinguish between two points that are close together

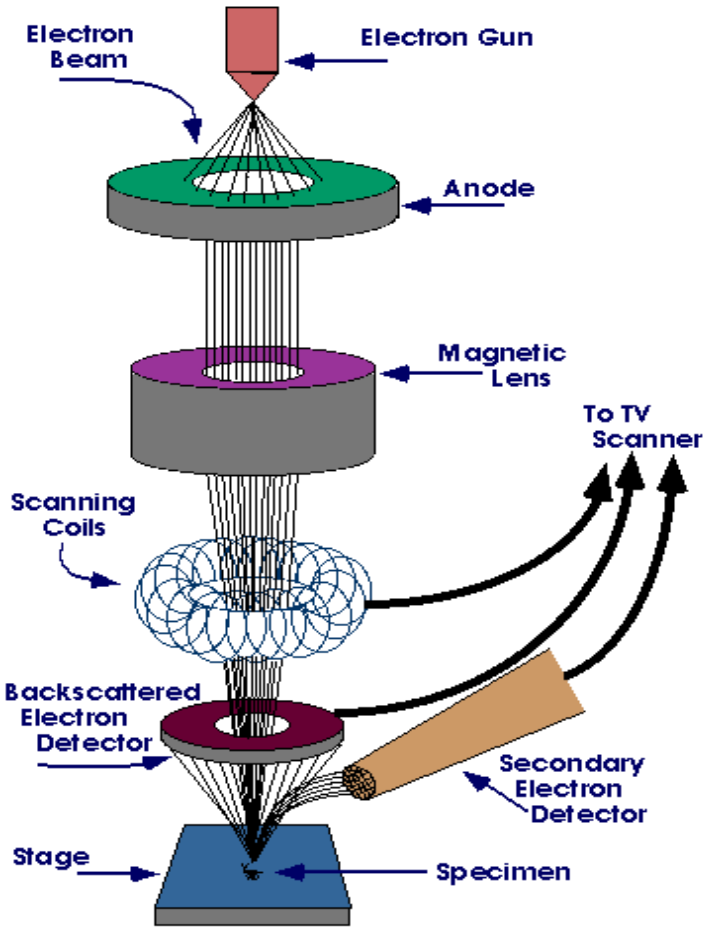


Resolution is capped at half the wavelength of the microscope's illumination source

Light - lowest wavelength = 400 nm
Resolution of light microscope = 200 nm

Electrons = picometre scale (1 nm = 1000 picometre)
Therefore give much higher resolution
Limited by microscopes available, not by wavelength of light

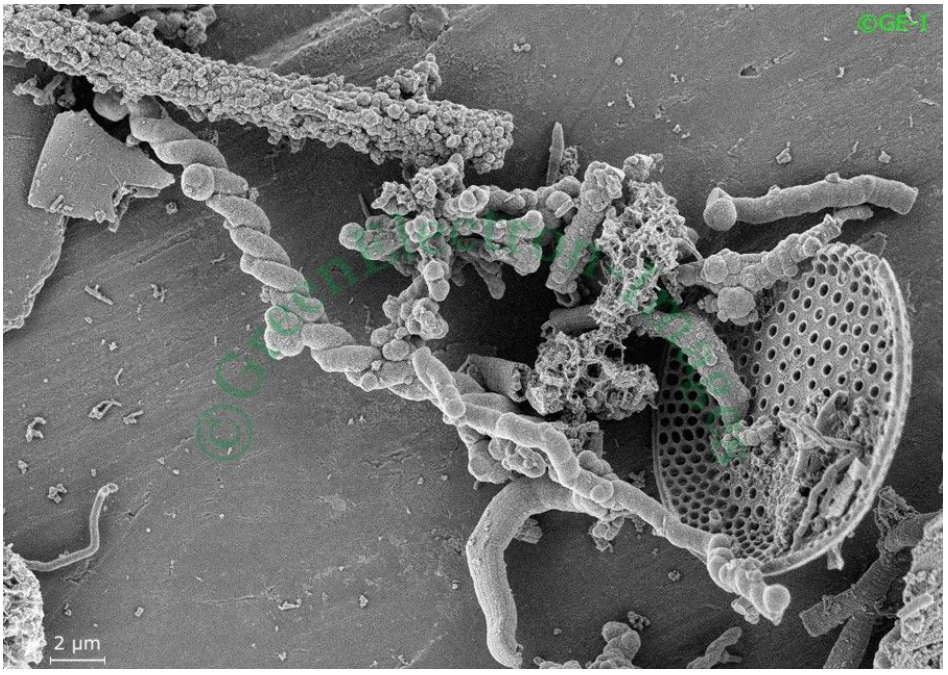
Electron Microscopes - Scanning Electron Microscope (SEM)

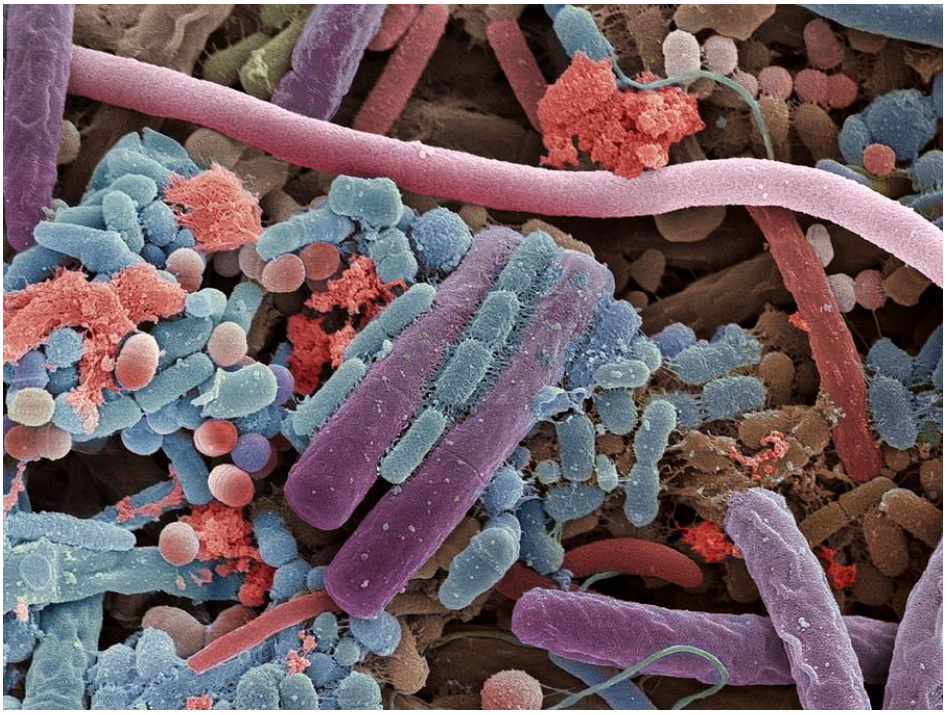


Pros: 3-D image, surface structures can be observed, does not need very thin specimens

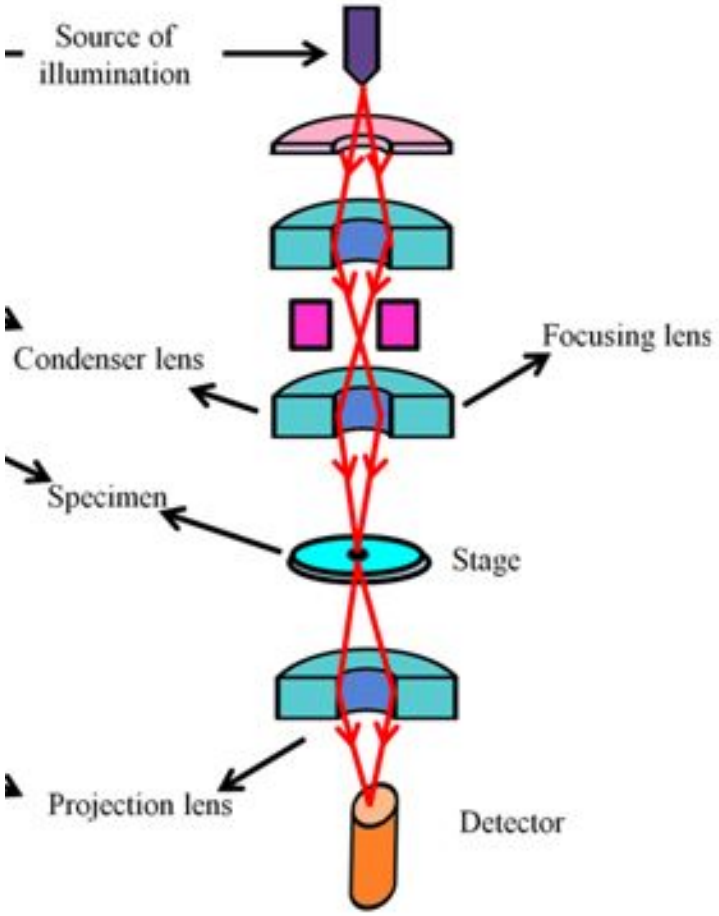
Cons: Low contrast, specimen dried - loses shape, vacuum needed

Resolution: 20 nm



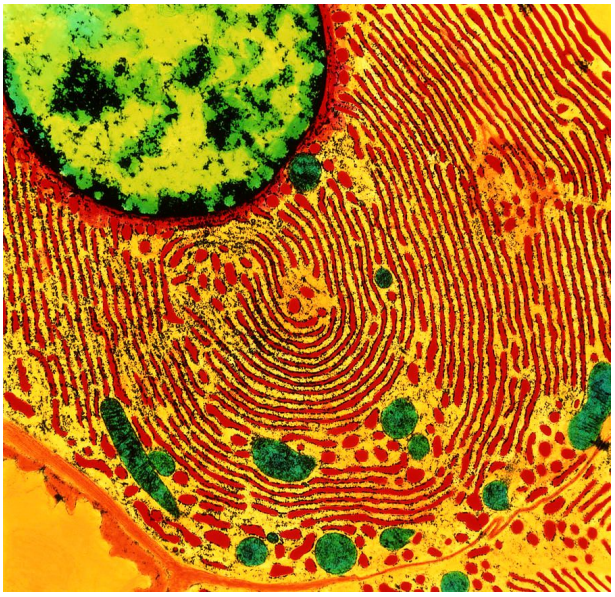


Transmission Electron Microscope (TEM)



Pros: better contrast, electrons pass through the sample, internal details visible
Cons: 2-D image, staining artefacts, sample needs to be thin, high radiation can damage thin specimens, vacuum needed
Resolution: 0.1 nm

TEM



False colour TEM