Cell

The study of the cell is termed as cytology.

- In 1938, *Schleiden* and *Schwann* discovered that all animals and plants are made up of cells.
- They put forward the '**Cell Theory**'. Later it was modified by Rudolf Virchow, who said that cells arise from pre existing cells.

Cell Theory consists of three principles:

- All living things are made of cells.
- Cells are basic units of structure and function in living things.
- All cells arise from pre-existing cells by cell division.

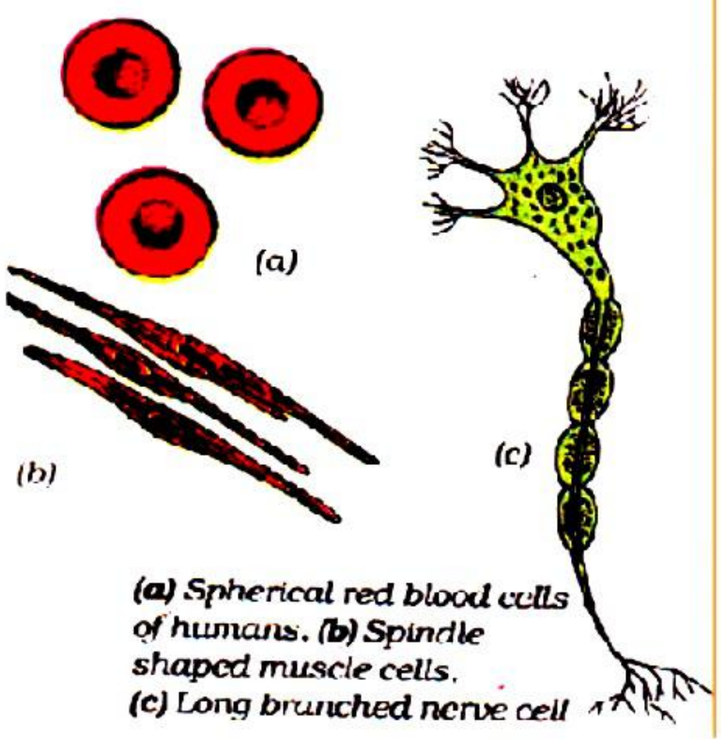
Organisms showing variety in shape, size and number:

- There are millions of living organisms of varying shapes and sizes. Similarly, in an organism itself there are cells present of varying shape and size, depending upon the function performed by them.
- The single celled organisms are called unicellular organisms. A single celled organism is able to perform all the necessary functions that multicellular organisms perform. For example – Bacteria, *Amoeba*, *Paramecium*, *yeast* etc.

- Organisms made up of more than one cell are called multi-cellular organisms. However, a multi-cellular organism, which may be made up of billion of cells, beings its life as a single cell in the form of fertilized egg.
- **Cell Size:** The size of cells varies in different organisms, even in the same organism the cell size may vary in different tissues. For example, in human body blood platelets are 2 - 3μm, red blood cells are 7.5μm and a nerve cells may be as long as 3 feet. However, most of the cells in the human body are between 20μm to 30μm in diameter.
- Prokaryotes are smaller in size than eukaryotic cell.
- The smallest cells are of Pleuro-pneumonia like organism (PPLO) or *Mycoplasma* (0.1μm), while largest animal cell is of ostrich egg (170 × 135 mm.)
- Nerve cell is the longest sized cell of human body.

Shape of cells

- Shape of cells varies not only in different organisms but also in different parts of the same organism.
- For example in man – Cheek cells – flat and polygonal
- Intestinal cells – Elongated column like
- Smooth muscles – spindle shaped
- Neurons – long thread like
- White blood cells – Irregular in shape
- Red blood cells – Round
- Shape of the cell mainly depends upon the function it performs



(a) Spherical red blood cells of humans. (b) Spindle shaped muscle cells. (c) Long branched nerve cell

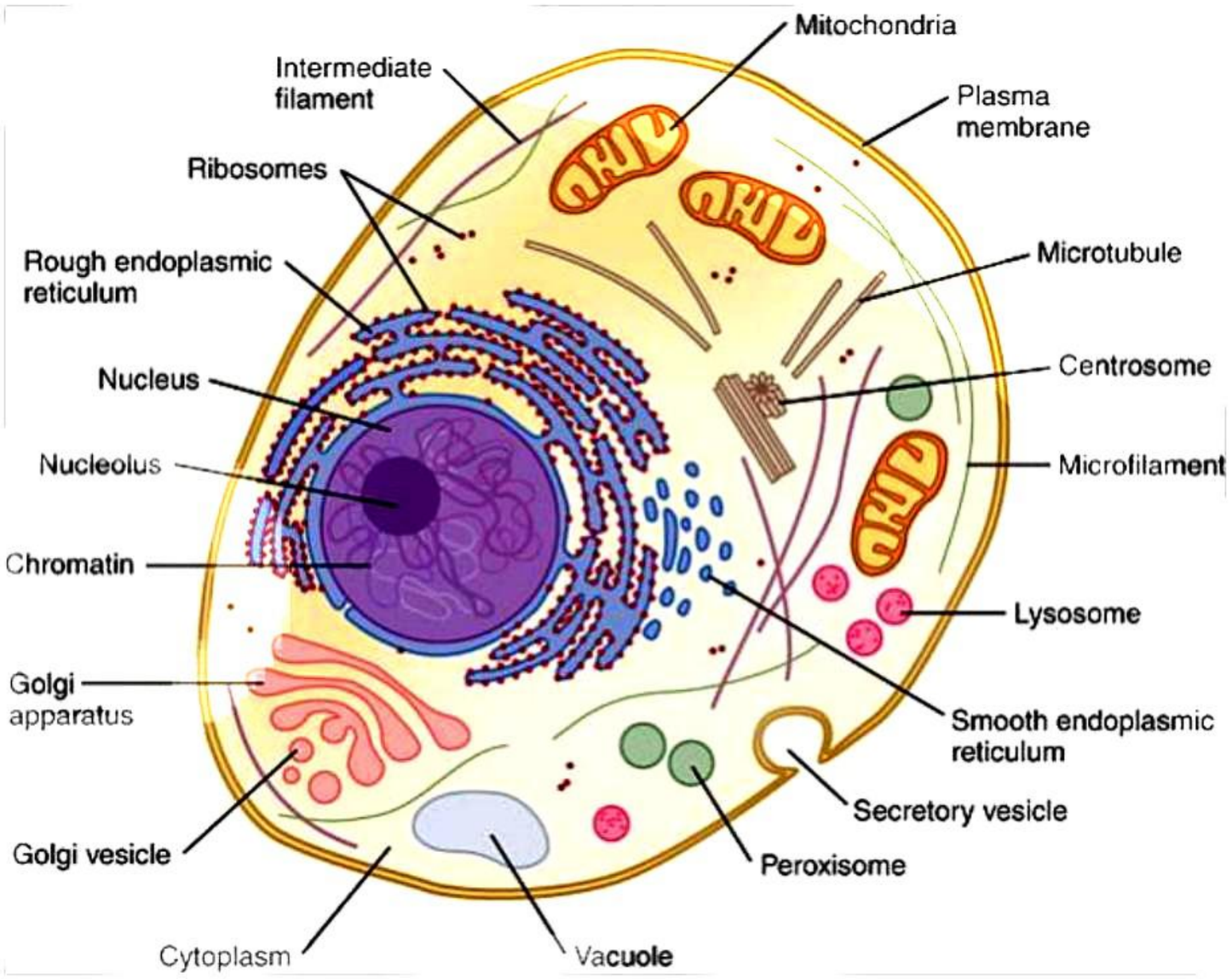
Cell Structure and Function

- In organism and plants a group of cells perform a specific function. This group of cells is called as tissue. Many tissues coordinate functionally to form an organ; therefore, cell is the basic structural unit of an organism.

  The increasing order of complexity in multicellular organisms is –

  Cell → Tissue → Organ → Organ System → Organism

- **There are three major functional structures present in every living cell.**
  - Plasma membrane
  - Nucleus
  - Cytoplasm
  - Nucleoplasm and cytoplasm together is termed as protoplasm.



CELL

Plasma Membrane

- This is the outermost covering of the cell that separates the contents of the cell from its external environment. The cell membrane functions like a gate controlling which molecules can enter and leave the cell.
- Plasma membrane is a living thin, elastic and selectively permeable membrane made up of proteins and lipids.
- Plasma membrane is present in animal, plant and bacterial cells.

Functions of Plasma Membrane

- It gives definite shape to the cell.
- It separates contents of the cell from its surrounding medium by acting as a barrier.
- Plasma membrane being a selectively permeable membrane regulates the movement of molecules across it.

Cell wall

1. In plant cells there is a rigid protective covering; cell wall present on the outer side of plasma membrane.

2. The cell wall is non living, freely permeable structure chemically made up of cellulose.
3. One of the most important features of all plants is presence of a cellulose cell wall.
4. Fungi such as Mushrooms and *Yeast* also have cell walls, but these are made of chitin.
5. The cell wall is freely permeable (porous) and so has no direct effect on the movement of molecules into or out of the cell.
6. The rigidity of their cell walls helps both to support and protect the plant.
7. Plant cell walls are of two types:

a) **Primary (cellulose) cell wall -** While a plant cell is being formed, a middle lamella made of pectin, is formed and the cellulose cell wall develops between the middle lamella and the cell membrane.

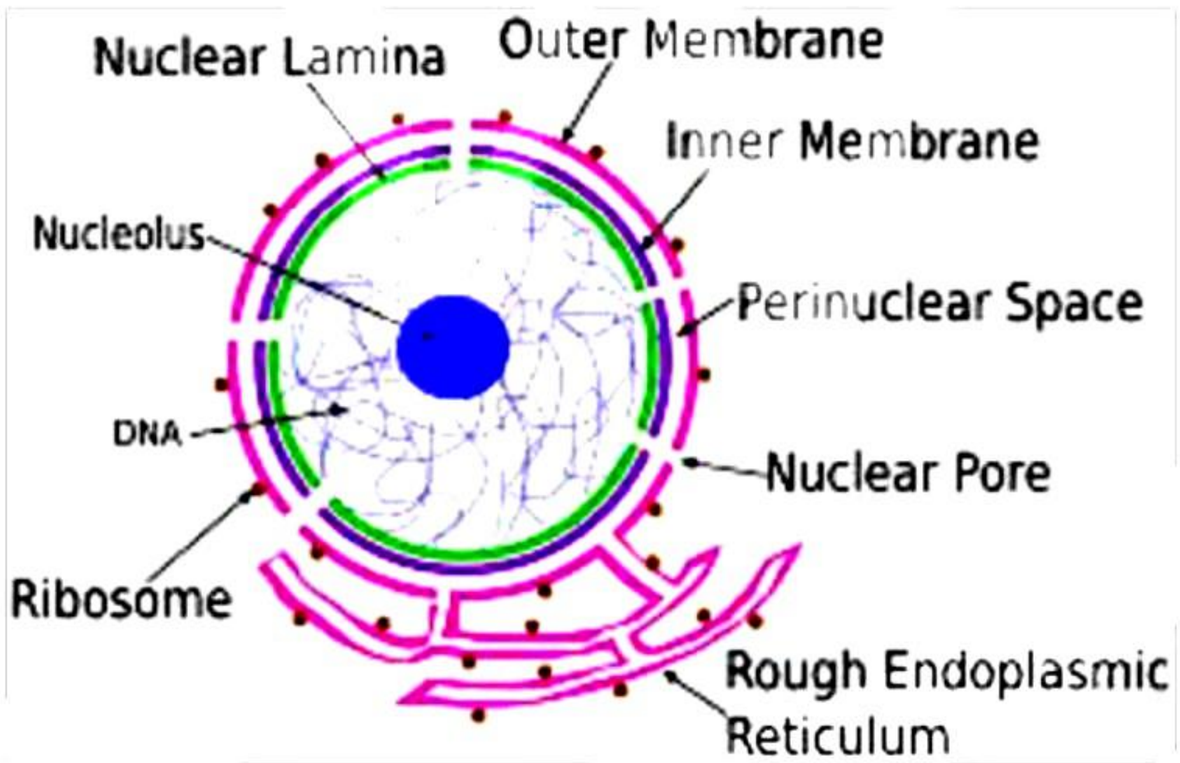
b) **Secondary (lignified) cell wall -** The secondary cell wall is formed only in woody tissue (mainly xylem). The secondary cell wall is stronger and waterproof. Once a secondary cell wall is formed, a cell can grow no more – it is dead!

Functions of cell wall

- Provide structural strength to the plant cells.
- Give definite shape to the cells.
- Due to the presence of cell wall plants cells are able to with stand changes in the surrounding medium.

Nucleus

- Nucleus was discovered by *Robert Brown* in 1831.
- It is oval or round prominent structure, usually present in the centre of the cell.



Structure of Nucleus

Nucleus consists of following parts:

- **Nuclear membrane:** It is double layered membrane separating the nuclear contents from the cytoplasm. It is perforated by nuclear pores which allow transport of molecules selectively, between cytoplasm and nucleoplasm.
- **Nucleoplasm:** It is a granular, dense fluid present inside the nucleus. Chromatin and nucleolus are present inside the nucleoplasm.
- **Chromatin material:** It is made up of deoxyribonucleic acid (DNA) and basic protein histones. Chromatin is in the form of highly coiled network of thread like structure.

- Chromatin takes the shape of rod like structures, called as chromosome, at the time of cell division.
- The DNA present in the chromatin is responsible for storing and transmitting hereditary characteristics from one generation to the next
- Segments of DNA are called genes.
- **Nucleolus:** It is more or less round structure not bounded by any membrane, consisting of ribosomal RNA (*rRNA*).
- *rRNA* is transported to the cytoplasm, where it takes part in the synthesis of ribosomes after combining with proteins.

Functions of Nucleus

- The nucleus controls all the metabolic activities of the cell.
- It transmits hereditary traits from parents to the offsprings.

Cytoplasm

- It is the fluid part of the cell which is present between the plasma membrane and nuclear membrane.
- It contains various cell organelles, performing different functions of the cell.

Functions of Cytoplasm

- It holds cell's organelles in place.
- It also gives the shape to cell structure.
- Most of the chemical reaction (which keeps the cell alive) takes place in cytoplasm.

Cell Organelles:

- Cells contain a variety of internal structures called organelles.

These are microscopic structures present in the cytoplasm, which perform various functions such as synthesis of macromolecules, secretion, ATP synthesis etc.

Endoplasmic reticulum

The ER is a system of membranous tubules and sacs. It is formed of membrane bound, tube like structures which form a network extending from nuclear membrane. Structurally it can be in the form of vesicles, tubes and cisternae (bag like).

Rough endoplasmic reticulum

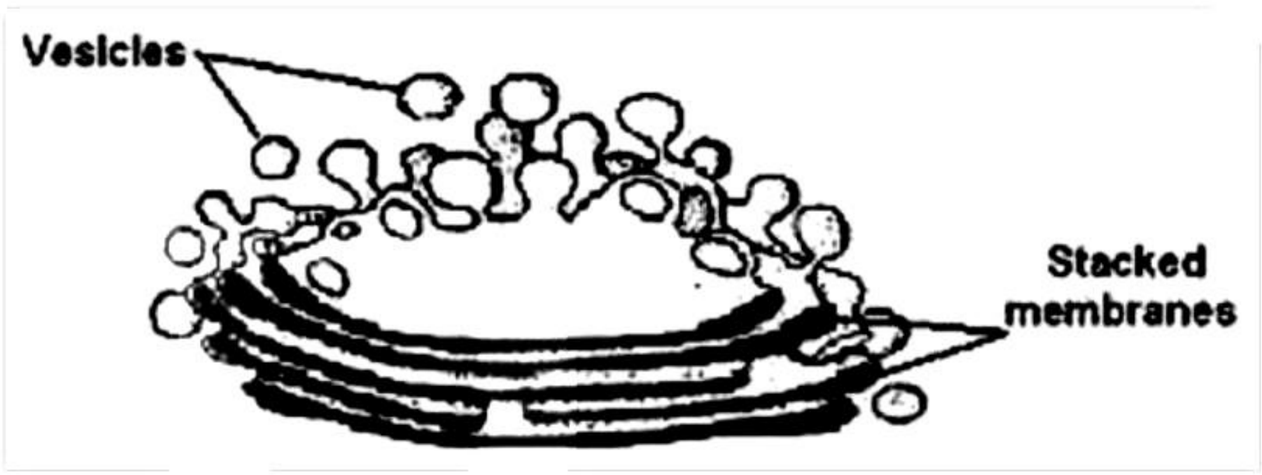
- Endoplasmic reticulum is of two types depending upon the presence and absence of ribosomes.
  - **Rough Endoplasmic reticulum**: Endoplasmic reticulum with ribosome attached to the surface of endoplasmic reticulum to synthesize proteins.

- **Smooth endoplasmic reticulum:** Endoplasmic reticulum in which ribosomes are not present, giving it a smooth appearance.

Functions of Endoplasmic reticulum

- The ER is the "transport system" of the cell. It transports chemical between cells and within cells.
- It provides large surface area for the organization of chemical reaction and synthesis.
- RER plays an important role in protein synthesis
- SER plays an important role in lipid synthesis.

Golgi apparatus



This is also a membrane bound structure in the form of stacks of cisternae. On the sides of cisternae are present small, fluid filled structures called as secretory vesicles.

Functions of Golgi bodies

- The golgi apparatus is responsible for taking the proteins which were created by ribosomes and making them bigger and better. When the golgi apparatus is done, it releases the new proteins into the cell, where they can be used to strength and build up cells. It is also involved in formation of lysosomes and peroxisomes.
- It plays an important role in modification, secretion and storage of chemicals.
- The Golgi apparatus is the processing, packaging and secreting organelle of the cell, so it is much more common in glandular cells.

Lysosomes

- These are also membrane bound vesicles like structures present only in animal cells. Lysosomes contain lysosomal enzymes for intra-cellular digestion.
- Lysosomes are formed from pieces of the Golgi apparatus that break off. Lysosomes are common in the cells of animals, protista and even fungi, but rare in plants.

Functions of Lysosomes

- It contains powerful enzymes capable of either digesting or breaking down all organic material.
- They serve as an intracellular digestive system i.e. a mini-digestive system within the cell.
- Lysosomes destroy any foreign materials that manage to make it inside the cell such as bacteria etc.

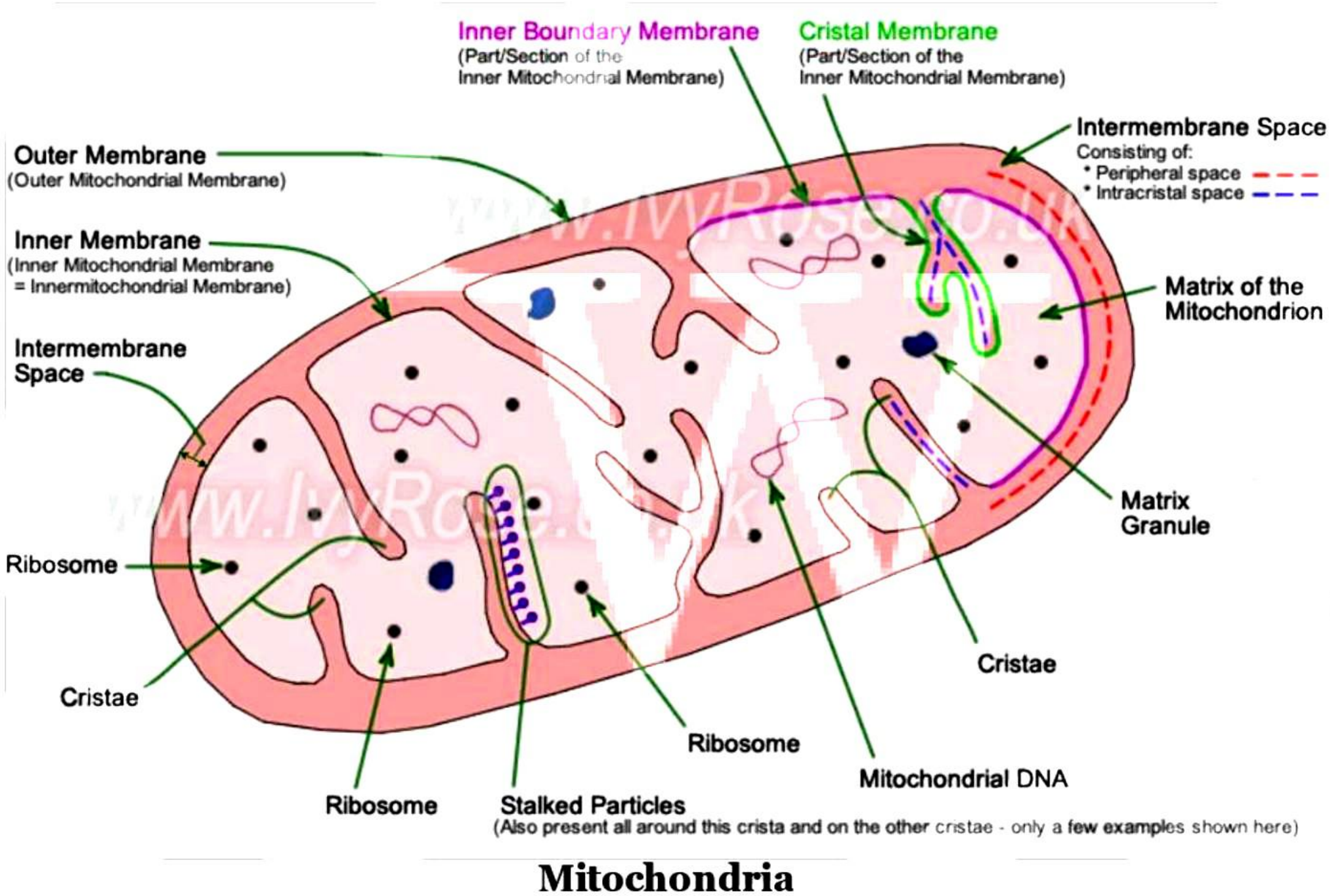
- They also remove worn-out or poorly functioning organelles from the cell. They may even sometimes digest the entire damaged or dead cells containing them. Hence, also known as suicide bags.

Mitochondria

- These are mostly rod shaped structures with double membrane. The inner membrane is folded into finger like projections, called cristae.
- Cristae greatly increase the surface area of the inner membrane. The fluid inside the mitochondria is called matrix.

Functions of Mitochondria

- Mitochondria are the sites of aerobic respiration, in which energy from organic compounds is transferred to ATP. Thus mitochondria are the sites of ATP synthesis.
- Mitochondria contain enzymes for cellular respiration in which energy is released.
- During respiration, you take in oxygen which the blood transports to all the cells in the body. During cellular respiration, using this oxygen, glucose gets oxidized to form ATP molecules. ATP is a form of energy that the body can use.



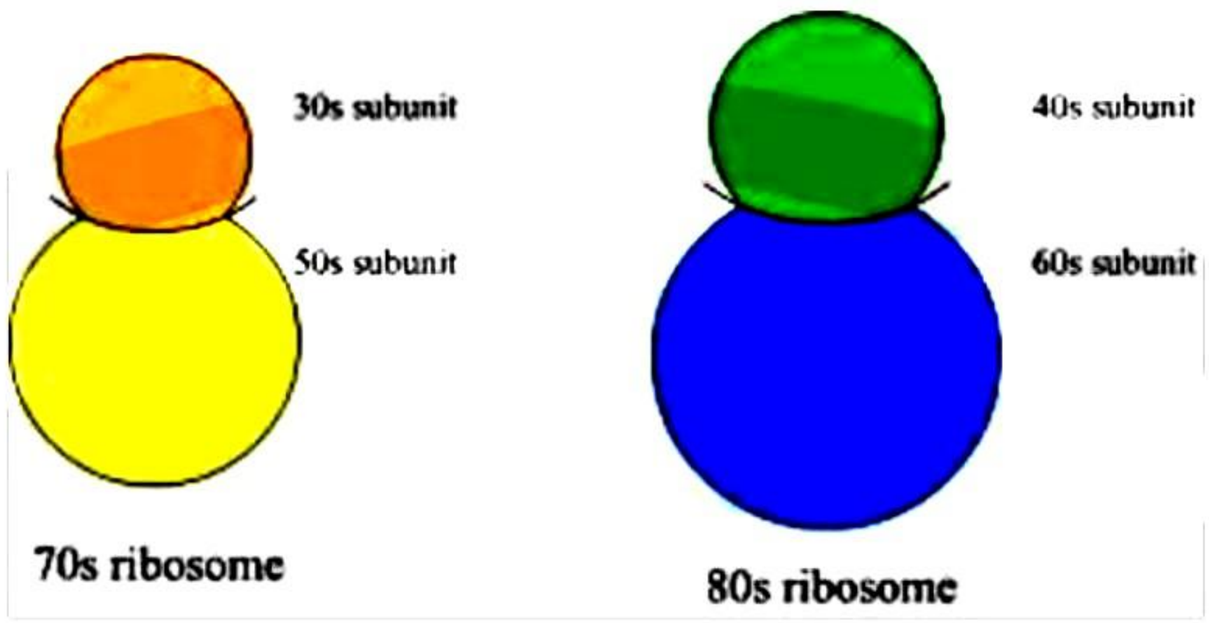
Mitochondria

$$\text{Glucose} + \text{Oxygen} \longrightarrow \text{Carbon dioxide} + \text{Water} + \text{Energy (ATP)}$$

- For this reason they are sometimes referred to as the 'powerhouse' of the cell.
- ATP is the molecule that most cells use as their main "energy 'currency".
- Mitochondria are more numerous in cells that have a high energy requirement - our muscle cells contain a large number of mitochondria, as do liver, heart and sperm cells.

Ribosomes

- These are round, granular structures not bound by any membrane. They either occur free in the cytoplasm or remain bound to rough endoplasmic reticulum.
- Ribosomes are the sites of protein synthesis.



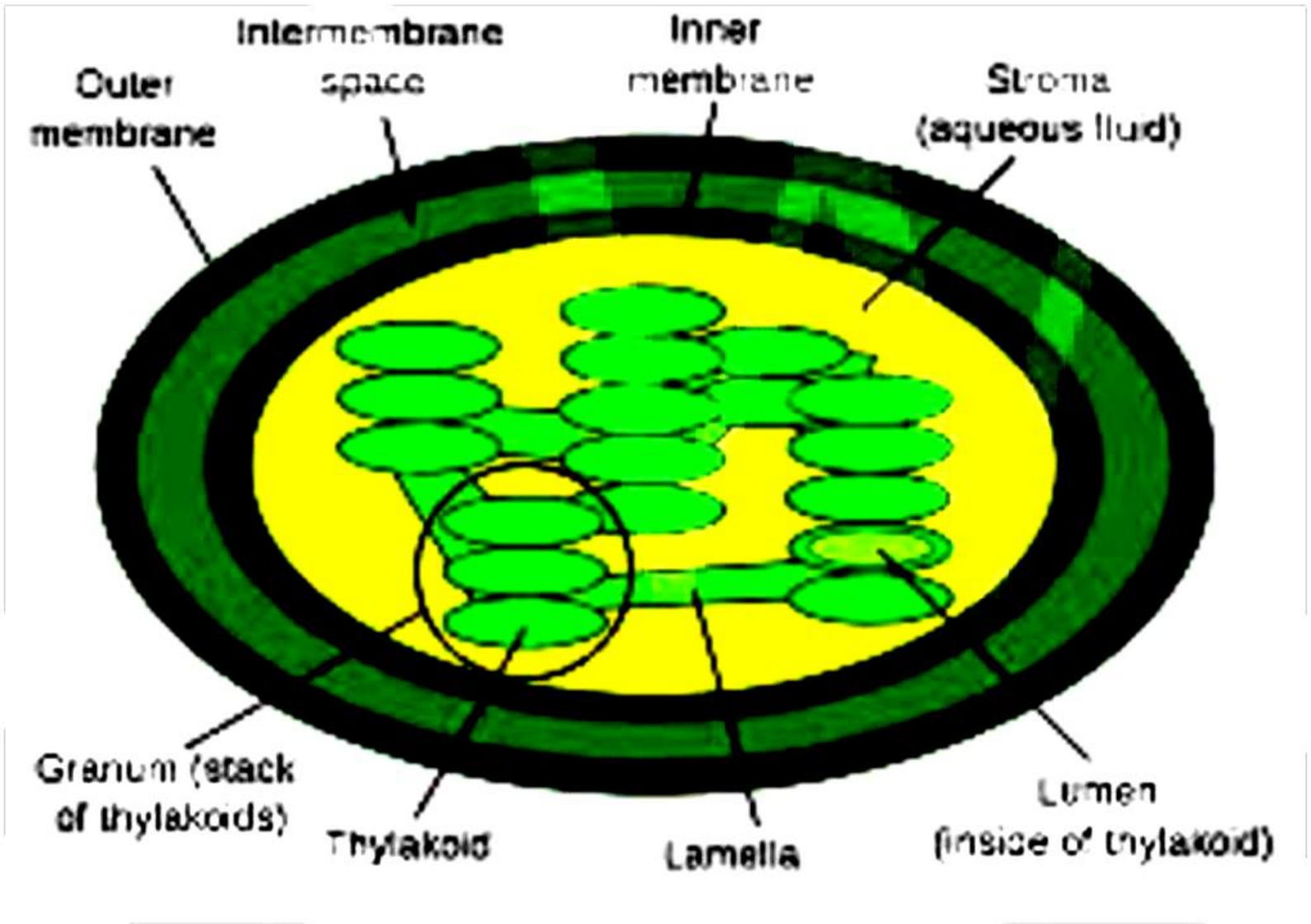
Ribosome

Plastids

Plastids are the largest cell organelle found only in plant cells.

On the basis of pigments present in plastids, they are divided into three types:

- **Leucoplasts:** These are colorless plastids, which store starch, protein and oil.
- **Chromoplasts:** Plastids with different color pigments except green. They give color to flower and fruits which help in pollination and fruit dispersal.



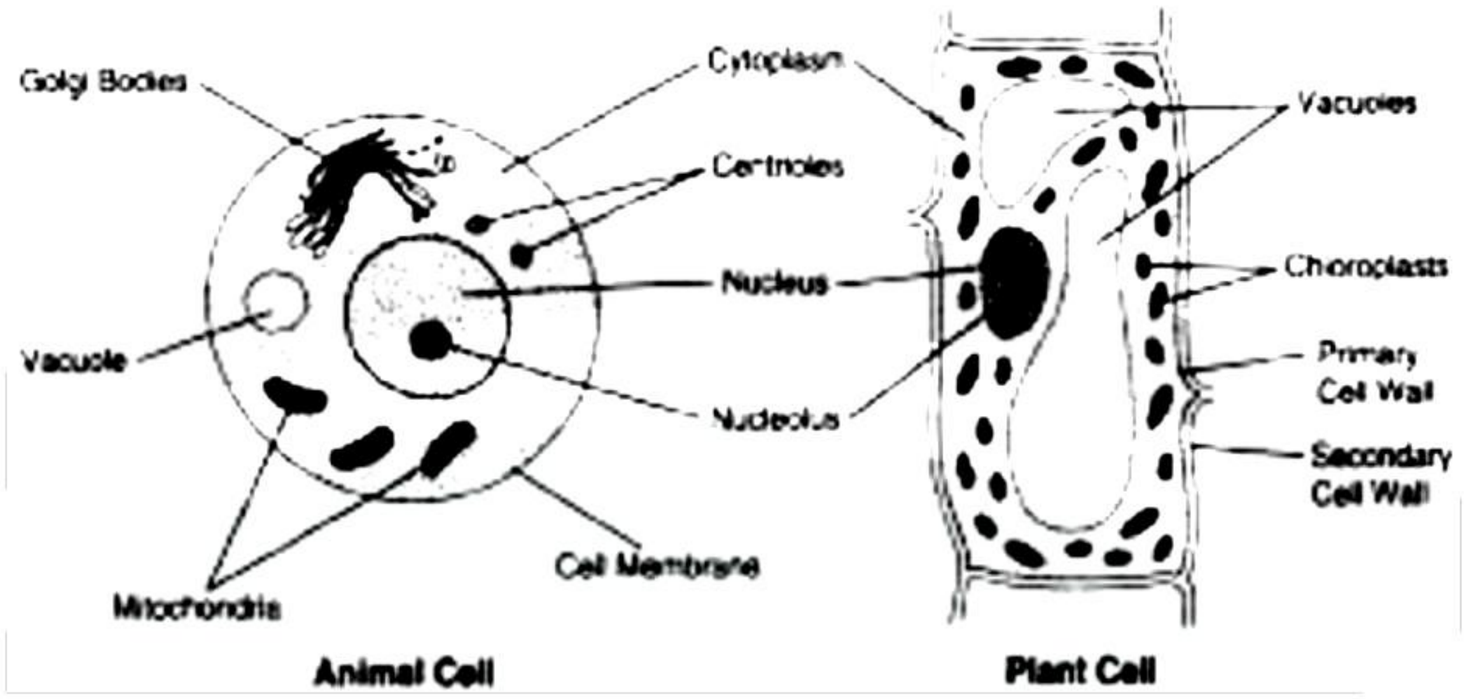
Structure of chloroplast

Chloroplasts: These are the most important plastids containing green pigment chlorophyll. Chloroplasts carry out the function of photosynthesis, capturing sun energy.

Internal structure of chloroplast:

Chloroplast is bounded by two membranes. The inside of the chloroplast is filled with colorless, matrix called stroma, which contains DNA and ribosomes. A large number of

membrane bound flattened sac like structures called grana are also present in the chloroplast. Grana contain chlorophyll molecules which capture the light energy.



Vacuoles

- These are fluid filled structures bound by a membrane, present in the cytoplasm. In animal cells they are small in size and many, but in plant cells a single large vacuole occupies most of the cytoplasm of plant cell.
- The plant vacuole is filled with a liquid called "cell sap" that contains dissolved sugar and salts.
- In plant cells, vacuole is bounded by a membrane called **tonoplast**. Sugars, organic acids and some proteins are present in plant vacuoles.

Centrosome

It is found only in animal cells as a pair of granule like structures at the boundary of nucleus. It helps in cell division in animal cells.

Centrioles

- A **centriole** is a cylinder shaped cell structure found in most eukaryotic cells, though it is absent in higher plants and most fungi.
- *Edouard van Beneden* and *Theodor Boveri* made the first observation and identification of centrioles in 1883 and 1888 respectively.
- Centrioles are involved in the organization of the mitotic spindle and in the completion of cytokinesis.
- Centrioles are a very important part of centrosomes, which are involved in organizing microtubules in the cytoplasm.