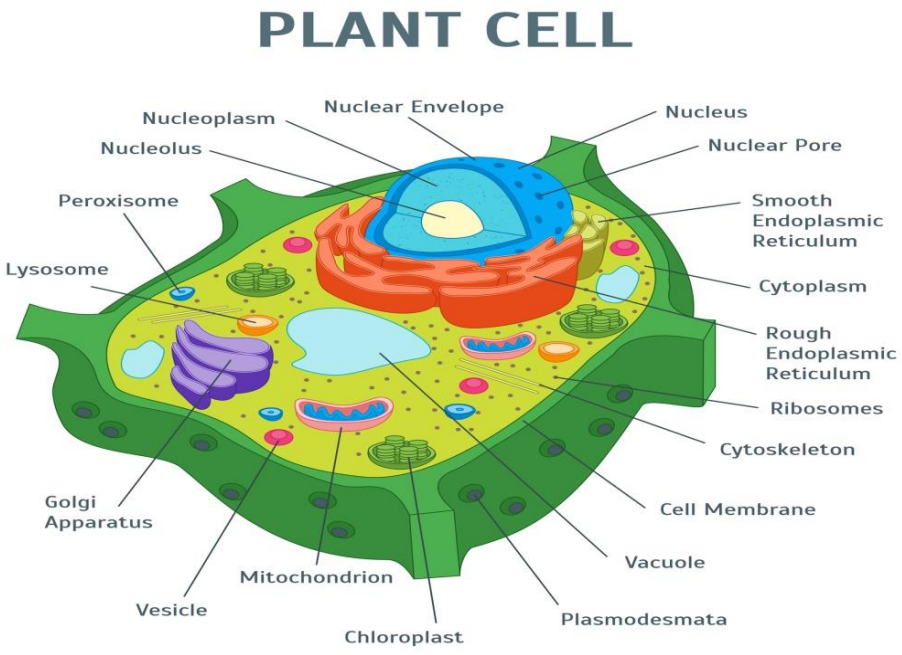
The Plant Cell

Cells are the basic structural and physiological units of plants for most plant reactions (cell division, photosynthesis, respiration, etc.) All plants (and every other living organism) are composed of cells. Plant cells are microscopic and typically range from 10 to 100 μm in length. In some algae and fungi, the whole organism consists of a single cell called **unicellular organism**, but angiosperms are complex **multi-cellular organisms** composed of many different types of cells.

Early studies of cells:

The **first person** to describe cells was the Englishman **Robert Hooke** in 1665. Hooke was examining the structure of cork with a **primitive microscope**, and noticed that it was organized into **small units**. Although the cork was not living, Hooke later looked at **living plants** and identified cells there also.

Other scientists in the **late seventeenth** and **eighteenth** centuries continued the microscopic examination and study of a variety of organisms. It was not until the mid-nineteenth century, however, that **Matthias Schleiden and Theodor Schwann**, and later **Rudolf Virchow**, firmly established the **Cell Theory**, which recognizes the cell as **the basic unit of life** and all organisms are composed of cells and all cells arise from preexisting cells. This theory is one of the major principles in biology. Use of the **electron microscope** has greatly expanded our knowledge of cellular structure and function. The structure in a eukaryotic plant cell includes the **protoplast** together with the **wall**.



Plant cell components

The main components of the plant cell are; **A- Cell wall. B-protoplast (comprised of cytoplasm and cell organelles):**

Cell wall:

The cell wall encloses all other parts of the plant cell (**protoplast)**. Plant cell walls may consist of **one** or **two layers**.

1. Primary wall it is he first layer or formed early in the life of a plant cell. It is composed of cellulose. The cellulose is in the form of fibrils embedded in a matrix of other polysaccharides.

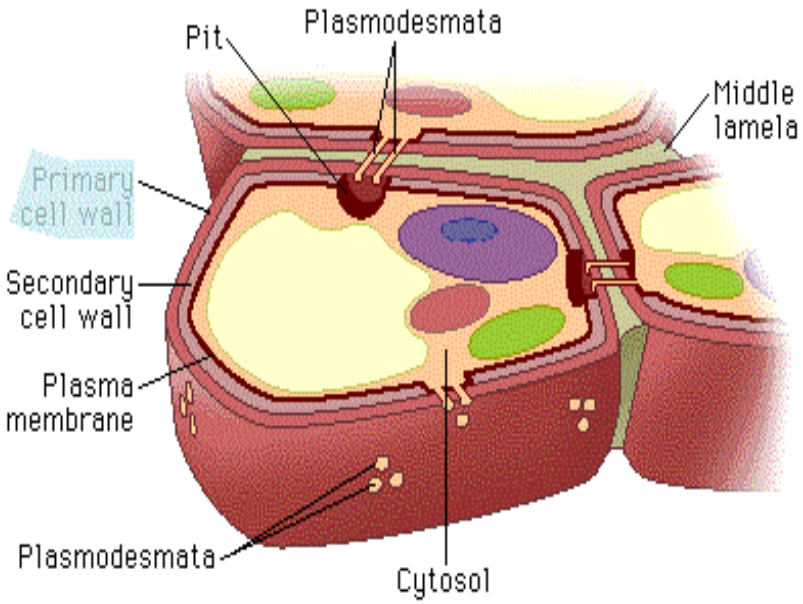
2. Secondary wall is laid down internal to the primary wall. Lignin is a major component of the walls, in addition to the cellulose and other polysaccharides. Only plant cells have secondary walls those specialized for **support**, **protection**, or **water conduction**.

Lignin is known for its **toughness**; it gives wood its characteristic strength and also provides protection against attack by pathogens (disease-causing agents) and consumption by herbivores.

Minute pores, or **pits**, exist; most of these are large enough to be seen with the light microscope. Pits allow for the **transfer of materials** through cell walls.

Cytoplasmic connections between adjacent plant cells called **plasmodesmata** and pass through the pits in the cell wall. These allow for the movement of materials from cell to cell .

A sticky layer called the **middle lamella** can be found between the walls of adjacent plant cells acts as cellular cement (composed of pectins), gluing cells together.



Cytoplasm:

Physically it is a **viscous** substance which is more or less transparent in visible light. **Chemically** the structure of the cytoplasm is very complex and the major component (85 – 90 %) is water.

Cell organelles:

1. **Plasma membrane**
2. **Mitochondria**
3. **chloroplasts**
4. **Golgi apparatus**
5. **Endoplasmic reticulum**
6. **Micro bodies**
7. **Ribosome**
8. **Vacuoles**
9. **Ergastic substances (non-living substances).**

Cell Organelles: A Typical plant cell contains the following organelles and parts:

1. Plasma Membrane (cell membrane):

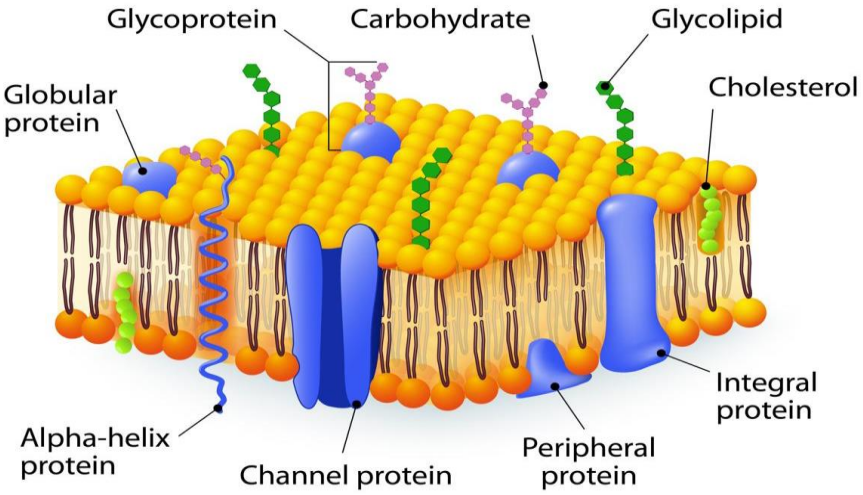
The outermost layer of the protoplast is the plasma membrane, which is composed of phospholipids and proteins. The **fluid mosaic model,** the currently is accepted idea of membrane structure.

This model consists of a **double layer of phospholipids** with scattered **proteins**. Some of the proteins go through the lipid bi layer **(integral proteins)** while others are on either the inner or the outer surface **(peripheral proteins).**

Some of the membrane **proteins** and **lipids** have **carbohydrates** attached; they are called **glycol-proteins** and **glycol-lipids**, respectively. Some have described this membrane model as "**protein icebergs in a sea of lipids**." The plasma membrane is selective permeable barrier, allowing some molecules (such as water) to pass through but not others.

All eukaryotic cells contain a **membrane bound nucleus** and **organelles** in their cytosol.

CELL MEMBRANE



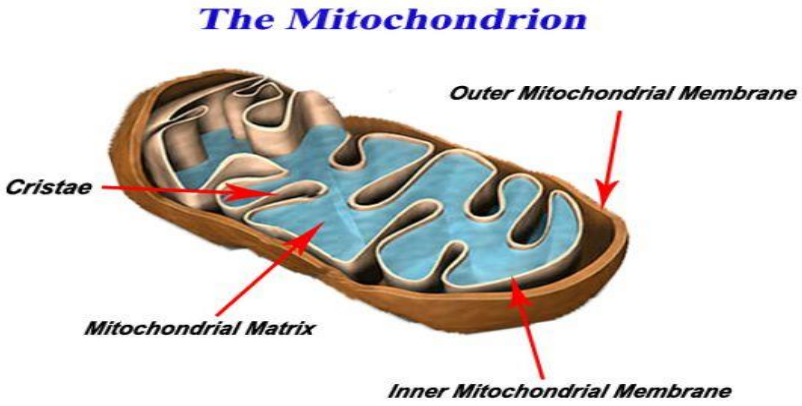
2. Mitochondrion (plural: Mitochondria):

A Mitochondrion is also called as the "**Power house of the cell**" because it stores and releases the energy of the cell. The **energy released** is used to **form ATP** (Adenosine Tri phosphate). Mitochondria are the principal sites of ATP production in aerobic cells. Most eukaryotic cells contain many mitochondria, which occupy up to 25 percent of the volume of the cytoplasm.

Typically the mitochondria are sausage shaped but these may be granular, filamentous, rod shaped, spherical or thread like.

Mitochondria contain two very different membranes:

a. **Outer** membrane: composed of about half lipid and half protein.
b. **Inner** membrane: composed of about 20 percent lipid and 80 percent protein and it is less permeable. The surface area of the inner membrane is greatly increased by a large number of in folding, or **cristae** that protrude into the matrix.



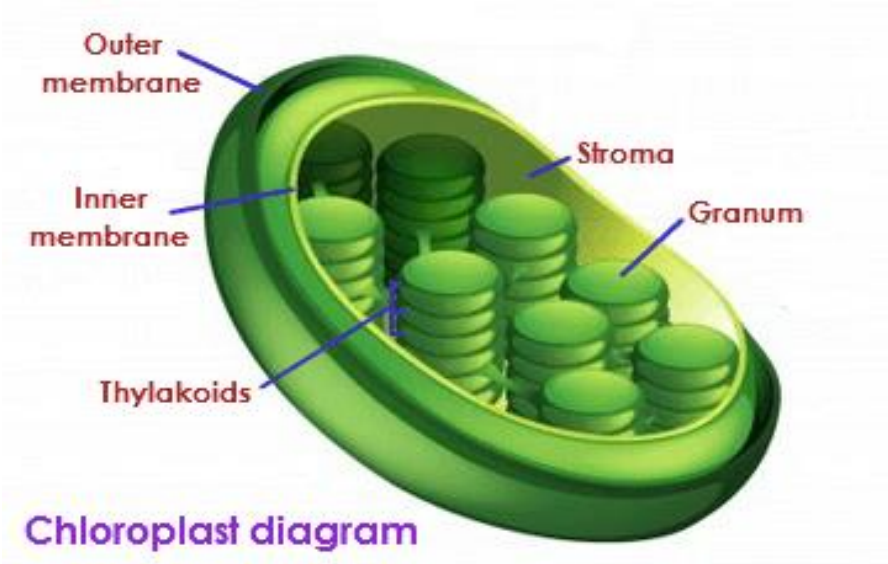
3. Plastids:

Plastids are the **largest cytoplasmic organelles** bounded by double membrane. These are found in most of the **plant cells** and in some **photosynthetic protists**. Plastids are of three types namely **chloroplasts, Chromoplasts** and **leucoplasts.**

1. **Chromoplasts** are **coloured** plastids other than green. They are found in colored parts of plants such as **petals** of the flower, **pericarp** of the fruits etc.

2. **Leucoplasts** are the **colorless** plastids. These colorless plastids are involved in the storage of carbohydrates, fats and oils and proteins.

3. **Chloroplasts** can be as long as 10mm and are typically 0.5 - 2.0 mm thick, but they vary in size and shape in different cells, especially among the algae. Like mitochondrion, the chloroplast is surrounded by an **outer** and **inner** membrane. In addition to this, chloroplasts contain an internal system of extensive inter connected membrane- limited sacs called **thylakoids** which are flattened to form disks. These are often grouped in stakes of **20-50 thylakoids** to form what are called **grana** and embedded in a matrix called **stroma.** About 40-100 grana may occur in a chloroplast. Many membranous tubules called stroma lamellae (intergranal thylakoids) inter connect thylakoids of different grana. The thylakoid membrane contains green pigments (Chlorophylls) and other pigments and enzymes that absorb light and generate ATP during photosynthesis.

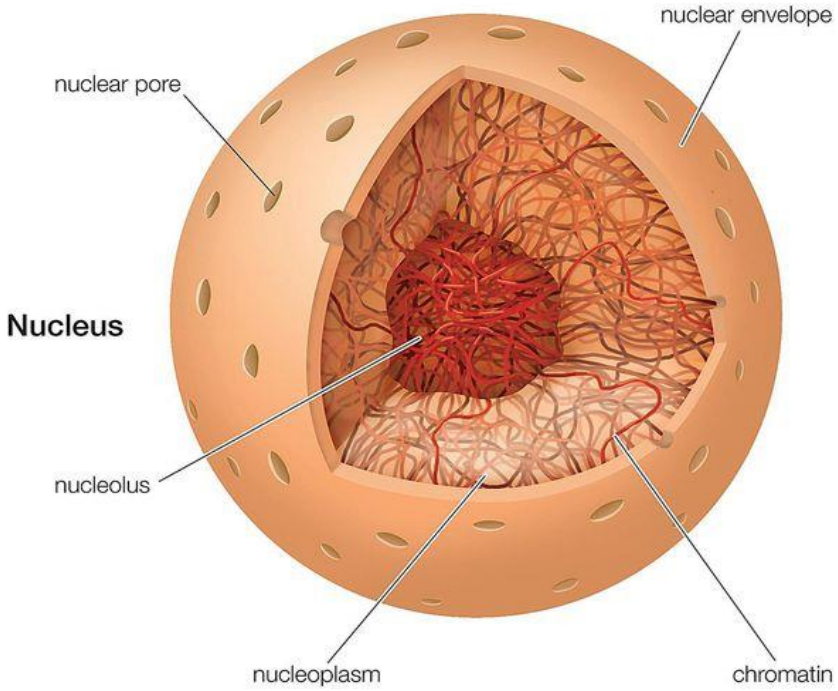


4. Nucleus

Nucleus is the center of control and hereditary information. The nucleus is surrounded by a double membrane with small openings called **nuclear pores,** which lead to the cytoplasm. Another structure within the nucleus is the **nucleolus**; one or more dark-staining nucleoli are always present.

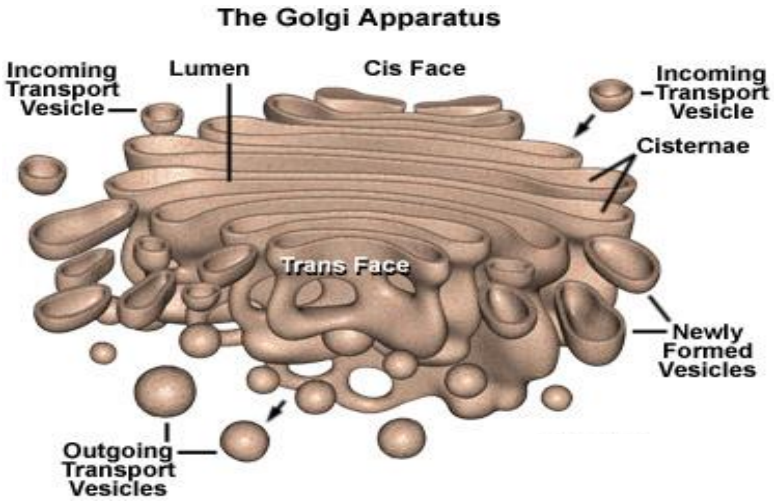
Functions of Nucleus

1. It controls all the metabolic activities of the cell by controlling the synthesis of enzymes required.
2. Nucleus controls the inheritance of characters from parents to offspring.
3. Nucleus controls cell division.



Golgi body or Golgi apparatus (GA) (Dictyosomes):

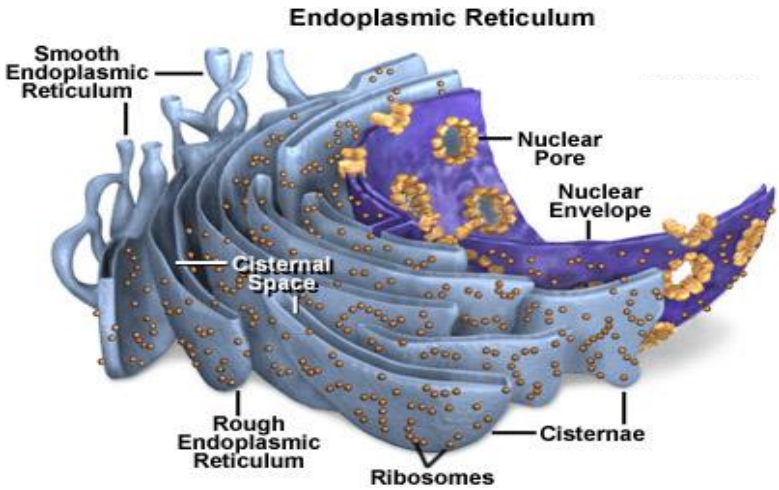
Golgi body is a series of flattened sacs usually curled at the edges. Proteins which were formed on ribosome of rough endoplasmic reticulum are processed in GA and break away in a vesicle known as **secretor vesicle**. The **vesicles** move outward to the cell membrane and either insert their protein contents in the membrane or release these contents outside the cell.



Endoplasmic reticulum

These are a **network** of **inter connected** folded membranes. There are spaces within the folds known as **cisternae. It** is responsible for **protein synthesis** in the cell. Two types of Endoplasmic Reticulum are recognized;

1. **Rough E.R:** ribosome is present on the surface
2. **Smooth E.R**.

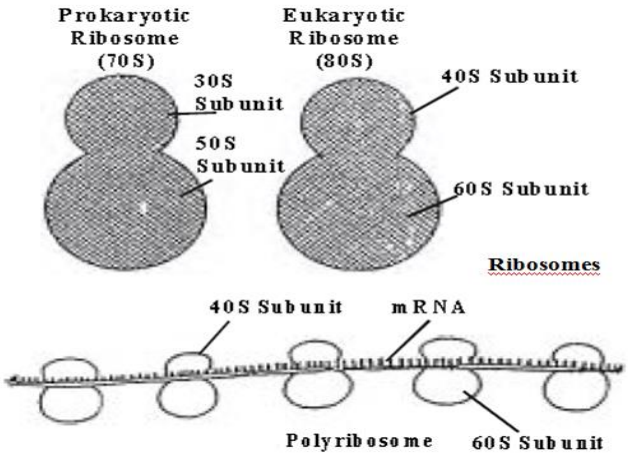


Ribosome:

Ribosomes are small sub spherical granular organelles, **not enclosed** by any **membrane**. They are composed of **ribonucleic proteins** and they are the site of **protein synthesis**. They occur in large number. Each ribosome is 150-250A in diameter and consists of two unequal sub units:

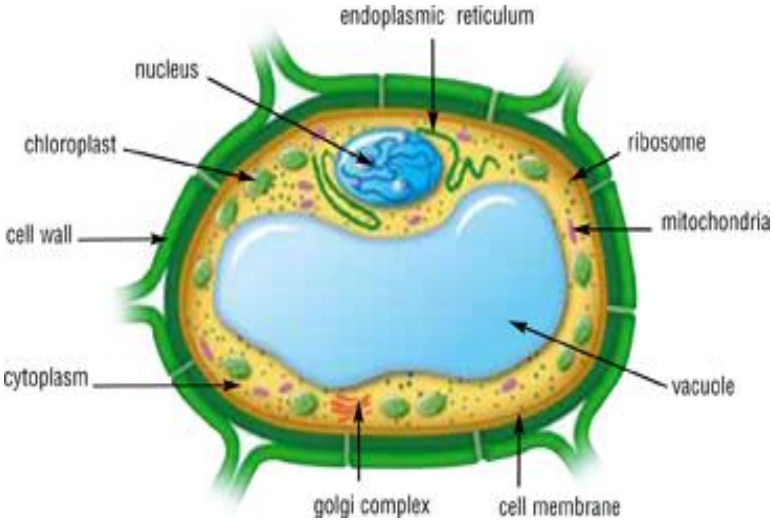
1. large dome shaped
2. smaller ovoid one

The smaller sub unit fits over the larger one like a cap. These two sub units occur separately in the cytoplasm and join to form ribosomes only at the time of protein synthesis. At the time of protein synthesis many ribosomes line up and join an mRNA chain such a string of ribosomes is called **polysome.**



Vacuoles:

Most mature plant cells are characterized by a large **central vacuole**. In some cells, the vacuole takes up **90%** of the **cell volume**, pushing the cytoplasm into a thin layer against the plasma membrane. The vacuole contains the **cell sap;** it is a watery solution of sugars, salts, amino acids, proteins, and crystals. Some of the substances in the vacuole are waste products. The cell sap is **often acidic**; the tartness (acidic) of lemons is due to their very acidic cell sap.



Micro bodies:

It is an organelle bound by a **single membrane**. Microbodies in plants convert oils and/or fats to sugars that are used in energy-releasing reactions in mitochondria. Four different types of micro bodies include: peroxisomes, glyoxysomes, glycosomes, and hydrogenosomes.

Ergastic substances (non- living substances):

They are non-protoplasm (non- living) materials found in cells. usually organic or inorganic substances that are products of metabolism, and include crystals, oil drops, gums, tannins, resins and other compounds that can aid the organism in defense or just storage substance. Ergastic substances may appear in the **protoplasm** in vacuoles, or in the **cell wall**.

Types of Ergastic substances:

1. **Carbohydrates: Cellulose** and **starch** are the main carbohydrate content in the cell. **Cellulose** is the chief component of the **cell wall**, and **starch grains** occur in the protoplasm in **leucoplasts** and **amyloplasts**.
2. **Proteins:** Although proteins are the main component of living protoplasm, proteins can occur as inactive, ergastic bodies—in an amorphous or crystalline (or **crystalloid**) form. A well-known **amorphous** ergastic protein is **gluten**.
3. **Fats and oils**: All plants contain oils (ex. olive oil) or fats (ex. cocoa butter) and mainly in their seeds. ... In most plants' storage lipids are in the form of triglycerides
4. **Crystals**: Animals eliminate excess inorganic materials. While plants mostly deposit such material in their tissues. Such mineral matter is mostly **salts of calcium** and **anhydrides of silica**.