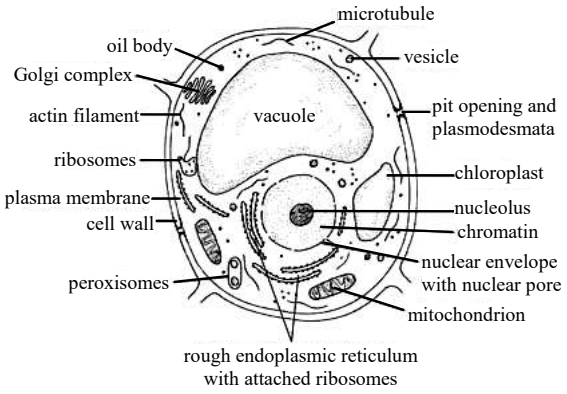
Cell

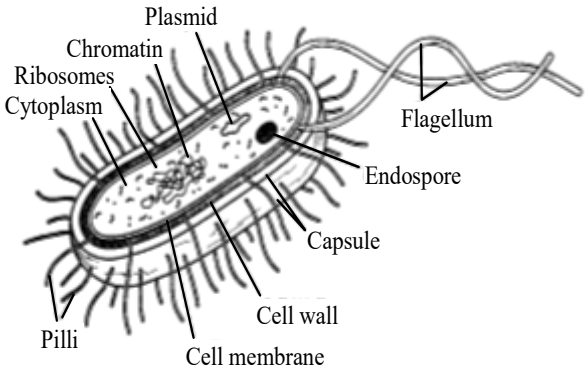
The Building Block of Life

Chapter Out Line

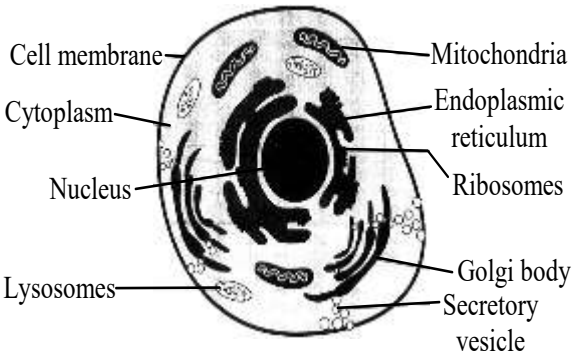
- Cell
- Microscope
- Cell theory
- Ultra structure of cell
- Cell organelles
- Cell Division



Plant cell



Bacterial structure



Animal cell

INTRODUCTION

Innumerable kinds of organisms live on our planet earth. These are broadly classified as bacteria, protists, fungi, plants and animals. All these organisms look different from each other. However, all of them are made up of microscopic units called cells.

In 1839 Johannes E. Purkinje noted living substance in the plant cells and named it **protoplasm**, "the first substance".

Cell is the basic structural and functional unit of living organisms.

CELL

All living forms are composed of microscopic units called as **'cell'**. Unicellular organisms are made up of single cell, on the other hand multicellular organisms are made up of multiples of these cell only.

A cell is the structural and functional unit of life. That is to say, it is the building block of which all living organisms are made and the smallest unit of life capable of all the living functions. It can be defined as a mass of protoplasm bounded by a plasma membrane.

Inspite of much diversity in the living organisms with regard to structure, functions, habitat, habits etc. one thing is common in all of them without exception is that they all are made up of cell (single cell or numerous cell)

◈ **Cytology/Cell Biology**

- Cytology is that sub-branch of biology which deals with the over-all study of cell.
- Cell is the smallest, basic, structural and functional unit of life.
- The word was derived from a Greek word **"cellulae"** which means small compartments or little room.

◈ **Discovery of cell :**

(i) The term cell was introduced by an English scientist **Robert Hooke** in his book **Micrographia** published in London in 1665. With this, he launched the study of **microscopic anatomy.** He examined thin slices of cork under a primitive microscope he had assembled. He saw tiny, empty compartments in the slices. He called them **cellulae** (now termed **cells)** and thought them to act as passages for conducting fluids. Since cork is the dead bark of a spanish oak, *Quercus suber*.

(ii) Anton Van Leeuwenhoek was Dutch merchant and pursued microscopy as a hobby. He designed remarkable simple microscopes, and with these he first described about living cells such as human sperm cells, bacteria, protozoans and red blood corpuscles from 1674 to 1680. He called the swimming creatures **''animalcules''**

(iii) Robert Brown (1831) discovered the **nucleus** in an orchid root cell.

(iv) A French zoologist **Felix Dujardin** (1835) discovered a semifluid living material (later called as protoplasm) in certain protozoans. He called this material **sarcode.**

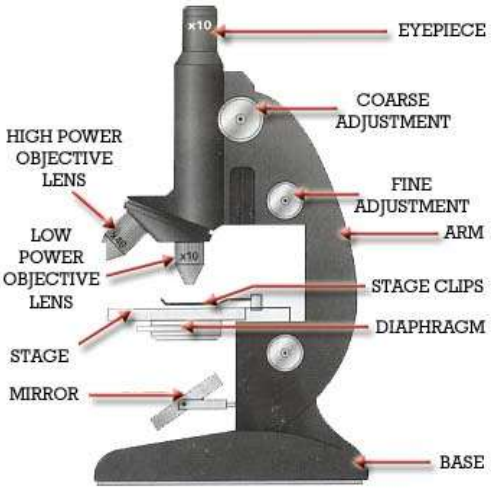
(v) Johannes E.Purkinje coined the term **protoplasm, 'the first substance'**
(G. protos = first ; plasma = substance)

(vi) Knoll and Ruska (1932) of Germany designed the electron microscope which was employed to study the **ultrastructure** (fine structure) of cell and various cell organelles in 1940s.

MICROSCOPE

- It is an instrument which is used to study those objects that cannot be seen with the naked eye or with the help of a hand lens. A microscope has more than one lens.
- The 1st compound microscope was built by **F. Janssen and Zacharias Janssen (1590).**

◈ **Structure of Microscope :** The microscope used in schools is called **compound microscope**. A compound microscope has following parts :



(1) Base : It is the basal, metallic, horse-shoe shaped structure. It bears the whole weight of microscope.
(2) Handle : It is the curved part to hold the microscope. It is also called as arm.
(3) Stage : It is strong metallic rectangular, horizontal plate fixed to the handle.
(4) Stage Clips : Two clips are attached to stage used to hold the slide in position.
(5) Condenser : Below the stage is present a condenser for concentrating the light rays.
(6) Body Tube : It is wide, hollow tube attached to the upper part of the arm. To this tube lenses are attached.
(7) Adjustment Screw :
a. Coarse adjustment : It is bigger sized screw used to move the body tube up and down.
b. Fine adjustment : It is a smaller sized screw for fine focussing.
(8) Reflecting mirror : It is meant for reflecting the light rays, so that light passes through the object which is to be seen.

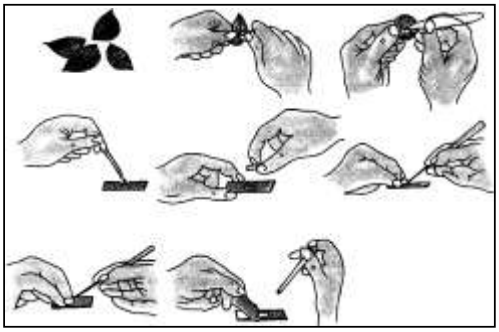
◈ **Activity**

- **Aim**

Observation of plant cells.

- **Method**

(i) Separate out a thin onion scale from an onion.
(ii) Tear it from the concave side to get a transparent, thin and membranous onion peel piece called epidermis.
(iii) Now keep this onion peel piece in a watch glass containing water.
(iv) Cut out a small portion of this peel and place it flat on a glass slide on a drop of water with the help of a thin camel-hair paint brush.
(v) Add a drop of safranin.
(vi) Drain out the excess stain and mount the onion peel in a drop of glycerine under a coverslip.
(vii) Examine the slide under low and high powers of a compound microscope.



Separation and mounting of onion peel

- **Observation**

The epidermal cells of onion peel can be seen as regularly arranged linear or rectangular compartments with rigid cell walls. Nucleus is pushed towards the periphery due to presence of a central vacuole.

- **Precautions**

(i) Immediately put the peel of onion bulb in a water containing petri-dish to avoid its folding and drying.
(ii) Spread the peel uniformly on the slide.
(iii) Excess of stain should be drained off.
(iv) There should be no air bubble under the coverslip.

CELL THEORY

It is was given by two eminent scientist named **M.J.Schleiden (1838) and T. Schwann (1839)** which was later on expanded by **Rudolf Virchow (1855)**. Cell theory states that.

- All plants and animals are composed of cells.
- Cell is the basic unit of life.
- All cells arise from pre-existing cells.
- Viruses are the exception of cell theory.

◈ **Cell shape :**

Variations are there on planet earth so different kind of cells are there which forms different kind of creatures. The different shape of cells are according to their functions.

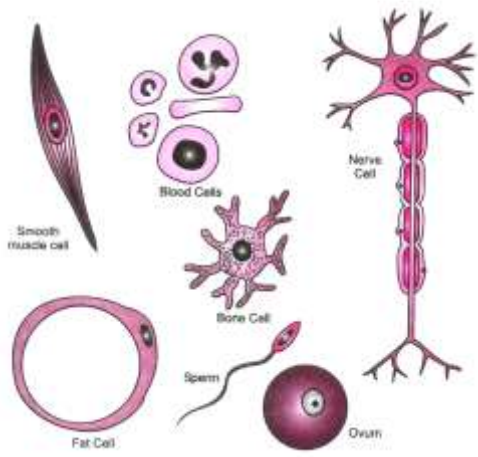


Figure : VARIOUS CELLS FROM THE HUMAN BODY

◈ **Cell size :**

Size of cell is variable depending upon the type of organism. Some are microscopic while some are visible with naked eyes.

Their size may vary from 0.2 μm to18 cm.

- Size of a typical cell in a multicellular organism ranges from 20-30 mm.
- Acetabularia is largest cell (6-10 cm, algae) in plants
- The largest cell is ostrich egg (18 cm. in diameter with shell & 15 cm. in diameter without shell) in animals.
- The longest cell is nerve cell (upto 1m. or more) in animals
- Hemp fibre is longest in plants.
- Smallest cells so far known are PPLOs (Pleuro pneumonia like organisms) or mycoplasma (0.1 to 0.5 mm)
- Human egg is 0.1 mm. in diameter.

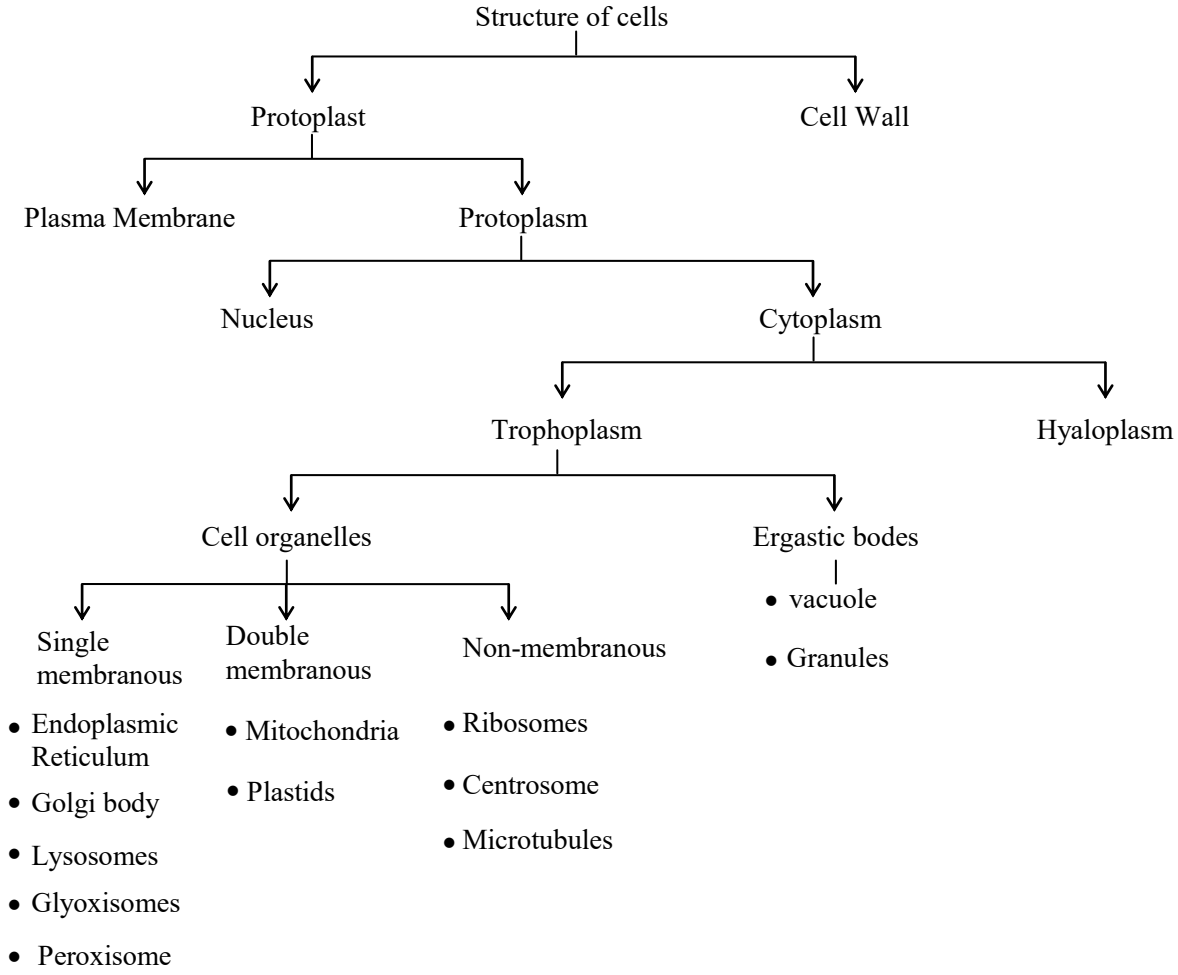
– **Boost your knowledge**

☛ Nerve cells are elongated, pigment cells are branched, muscle cells are spindle shaped.

ULTRA STRUCTURE OF CELL

It is gives us detail about the over all structure of a cell in which matrix as well as microbodies are included. They are as follows.

(i) Cell Boundary (ii) Nucleus (iii) Cytoplasm



Boost your knowledge

☛ Many cells make up one tissue, and many tissues make up an organ, and many organs make up an organ system.

☛ Eukaryotic cells are 10 times larger than prokaryotic cells, simply because they have a nucleus.

CELL WALL

- It is present in plant cell, bacteria and fungus, forms the outer most layer.
- It is made up of cellulose, hemi cellulose in plants, chitin in fungus and peptidoglycan in bacteria and is dead, rigid and freely permeable.
- Cell wall of two adjacent cells are joined by a layer called middle lamella, it is made up of calcium and magnesium pectate.

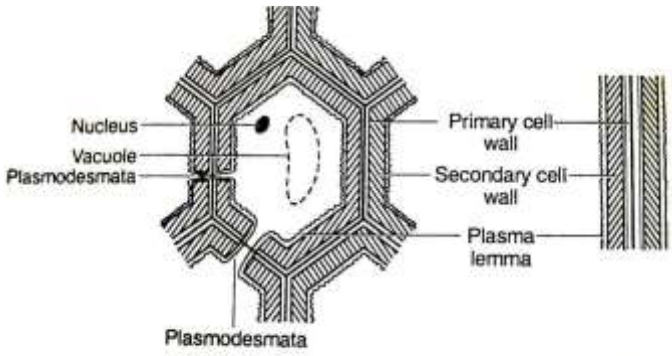


Fig. - **Arrangement of various layers of cell wall in a mature plant cell.**

- **Function :** Its function is to maintain shape of cell.
- It protect the cells from mechanical injury & prevents their dessication.
- It provide mechanical support against gravity. It is due to rigid cell walls that the aerial part of plant are able to keep erect & expose their leaves to sunlight.
- Cell walls permit the cells to with stand very dilute external media without bursting.

CELL MEMBRANE

- It is also called **plasma membrane** or **plasmalemma**.
- It is present in both plants and animals.
- It do not allow any material to enter inside the cell. But select the material according to the demand of cell metabolism hence called **'selectively permeable'**.
- **Singer and Nicholson** gave the fluid mosaic model of plasma membrane. According to him it is composed of a phospholipid bilayer with various protein molecules floating within it.

◈ Main characteristics of Plasma membrane are

- It is made up of proteins and phospholipids (fats).
- Proteins are scattered in the phospholipid bilayer.
- It is selectively permeable i.e. only selective solute can pass through the membrane.
- Most accepted model was given by Singer and Nicolson (1972) which is called fluid mosaic model.
- It is 75Å thick.

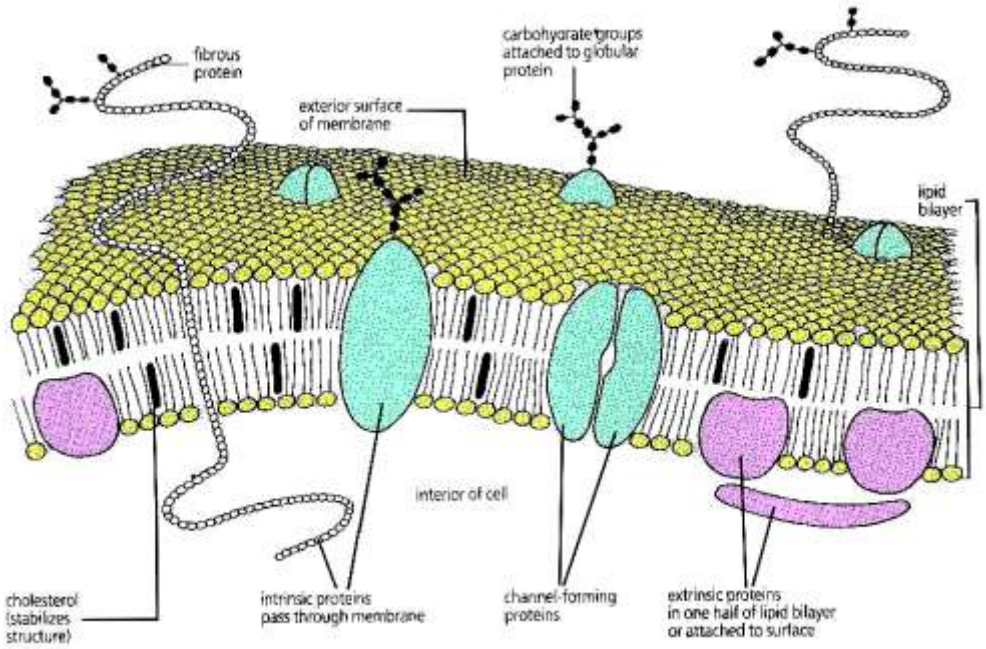


Fig. Fluid mosaic model of plasma membrane structure

◈ **Functions of Plasma membrane :**

1. It provides and maintains the shape of cell.
2. It provides mechanical support for the protection of internal structures of a cell.
3. It allows only useful substances to enter into the cells.
4. It provides specificity to the cell.
5. It is the limiting boundary of each cell which separates the cytoplasm from its surrounding.

◈ **Transportation of molecules across the plasma membrane :**

This can be done by following ways :

(A) Diffusion : Movement of molecules or ions from a region of their higher concentration to a region of their lower concentration is called as diffusion e.g., CO_2 & O_2 move across the membrane.

(B) Osmosis : The movement of solvent or water from a solution of their higher concentration to a solution of lower concentration through a semipermeable membrane is called as osmosis. Osmosis can also be called as "Diffusion of solvents".

- **Endomosis :** Movement of solvent into the cell is called as Endomosis.
- **Exosmosis :** Movement of solvent outside the cell is called as Exosmosis.

(C) Active transport : Active transport is the movement of any substance through the cell membrane that requires energy. The energy is provided by adenosine triphosphate (ATP) produced by aerobic respiration in the mitochondria. Active transport is a rapid process and is usually unidirectional.

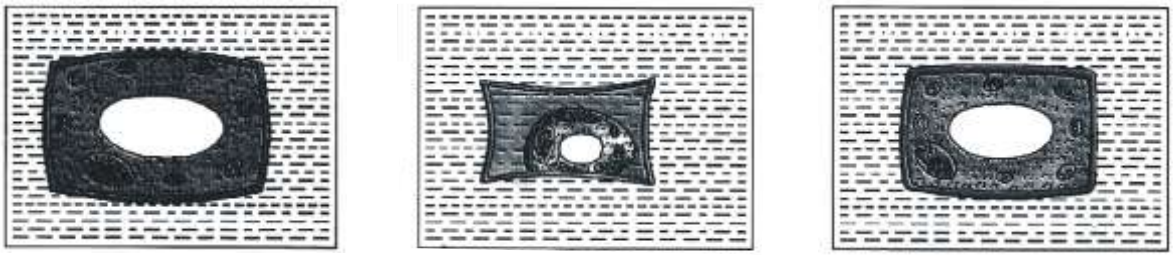
(D) Facilitated transport : Some membrane proteins act as carrier molecules and transport the substance to the other side of the membrane. Such proteins are called **transport proteins** or **permeases.** Transport proteins are complex molecules embedded in the cell membrane which help move substances into and out of the cell.

◈ **Types of solutions on the basis of concentration:**

(A) Isotonic solutions : When the concentration of the solution outside the cell is equal to the concentration of cytoplasm of the cell it is called as **isotonic solution.**

(B) Hypertonic solution : When the concentration of the solution outside the cell is more than that inside the cell. Due to this cell looses water and becomes plasmolysed.

(C) Hypotonic solution : When the concentration of the solution outside the cell is lesser than that of cytoplasm. Such solution is called as **hypotonic solution.** Cell swells up and bursts in this condition.



Hypotonic solution | Hypertonic solution | Isotonic solution

Cells placed in different types of solutions

DIFFERENCES BETWEEN DIFFUSION AND OSMOSIS		
S.no.	**Diffusion**	**Osmosis**
1.	Diffusion can occur in any medium	It occurs only in liquid medium
2.	The diffusing molecules may be solids, liquids or gases	It involves movement of solvent molecules only
3.	Semipermeable membrane is not required	Semipermeable membrane is required
4.	It is dependent upon the free energy of the molecules of diffusing substance only; presence of other substance in the system is of no importance	Though it is the diffusion of solvent molecules only, yet influenced by the presence of other substances (solutes) in the system.

Boost your knowledge

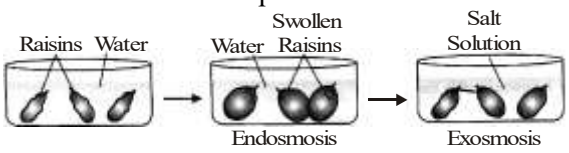
☛ Shrinking of protoplasm
In plant cell → Plasmolysis
In animal cell → Crenation
Bulk Transport: The process of taking in a bulk of materials from external environment into the cell is known as Endocytosis. It is of two types :
Phagocytosis (cell eating) and **Pinocytosis** (cell drinking).

☛ Phagocytosis + Pinocytosis → **Endocytosis**.

☛ **Exocytosis:** The process by which materials move from inside to outside of the cell is known as exocytosis.

◈ **Activity**

- **Aim**
  Demonstration of endosmosis and exosmosis
- **Method**
  Put dry raisins or apricots in a petri dish having plain water. Observe after about 30 minutes.
- **Observation**
  Raisins or apricots swell up due to endosmosis. Some swollen raisins can be placed in concentrated sugar or salt solution. After some time, the raisins will shrink to previous form. It is due to exosmosis.



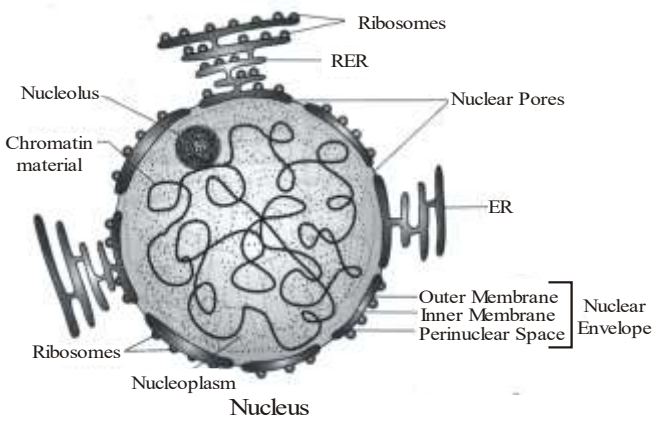
Dried raisins placed in water

◈ **Activity**

- **Aim**
  Demonstration of endosmosis and exosmosis.
- **Method**
  Dip two equal sized raw eggs in dilute hydrochloric acid for an hour or so. The shells made up of calcium carbonate get dissolved. Wash the two eggs with water 2-3 times. Each egg is now surrounded by semipermeable membrane. Place one egg in water and the other in concentrated salt solution. Observe after 1 hour.
- **Observation**
  The egg placed in water swells up because of endosmosis. The egg placed in salt solution shrinks due to exosmosis.

NUCLEUS

- Nucleus-Headquarter of the cell
- Discovered by – Robert Brown (1831)
- "Nucleus is double membrane bound dense protoplasmic body, which controls all cellular metabolism and encloses the genetic information of cell".
- Nucleus is consider as controller or director of cell.



Nucleus

◈ **Structure :** It is made up of following four contents

(a) Nuclear envelope : Nucleus is surrounded by two membranes, that separates nucleoplasm from cytoplasm. The nuclear membrane has minute pores. These are called nucleopores. Nucleopores takes part in exchange of different substances between nucleoplasm and cytoplasm.

(b) Nucleoplasm : The part of protoplasm which is enclosed by nuclear membrane is called nucleoplasm. It contains chromatin threads and nucleolus.

(c) Nucleolus : Discovered by Fontana. Usually one nucleolus is present in each nucleus but sometimes more than one nucleoli are present. It is a store house of RNA.

(d) Chromatin threads : A darkly stained network of long fine threads called chromatin threads. Chromatin threads are intermingled with one another forming a network. Whenever the cell is about to divide the chromatin material gets organized into chromosomes.

– Boost your knowledge

☛ Chromosomes are chemically made up of DNA and histone proteins. DNA carries all genetic information which is passed on to next generation. The functional segment of DNA is called genes.

☛ The Nucleoid (meaning nucleus-like) is an irregularly shaped region within the cell of a prokaryote that contains all or most of the genetic material.

◈ **Functions of nucleus :** The nucleus performs following functions :

1. It controls all the metabolic activities of the cell.
2. It brings about growth of the cell by directing the synthesis of structural proteins.
3. It takes part in the formation of ribosomes.
4. It regulates cell cycle.
5. It contains genetic information and is concerned with the transmission of hereditary traits from one generation to another.

◈ On the basis of the presence or absence of a well developed nucleus, organisms can be of two types
(1) **Prokaryotes :** Organisms, whose cells lack a nuclear membrane and the genetic material (DNA, RNA) lies freely in the form of nucleoid, are known as prokaryotes. e.g. Bacteria, blue green algae.
(2) **Eukaryotes :** Organisms, whose cells have a well organized nucleus with nuclear membrane are known as eukaryotes. e.g. All plant and animal cells.

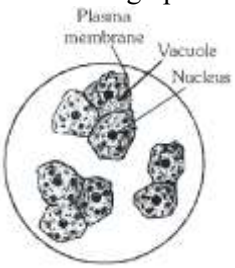
◈ **Activity**

- **Aim**

To prepare a temporary stained slide of squamous epithelial cells of cheek of man.

- **Method**

(i) Wash your mouth and scrap a little of the internal lining of your mouth with a clean tooth pick or spatula or ice-cream spoon.
(ii) Place the scrapping in a watch glass containing a very small quantity of normal saline with the help of needle.
(iii) After cleaning, transfer the material to a glass slide.
(iv) Put a drop of methylene blue and wait for a couple of minutes.
(v) Wipe off the extra stain with a dropper or blotting paper.
(vi) Put a drop of glycerine on the stained material.
(vii) Place a coverslip. Tap the coverslip with the blunt end of needle so as to spread the cells.
(viii) Observe the temporary mount under low and high power of microscope.



Cheek Cells

- **Observation**

The cells are flat and polygonal in shape with distinct rounded nucleus in the middle. Each cell is bounded by a thin cell membrane. Cytoplasm is lightly stained.

- **Precautions**

(1) Do not scrap the cheek too hard as it may injure the buccal mucosa.
(2) Scrapped material should be spread uniformly on the slide.
(3) Excess of stain should be drained off.
(4) There should be no air-bubble under the coverslip.
These activities prove that not only cheek of man but all the organisms that you observe around are made up of cells. This confirms that the basic structural unit of life is cell.

CYTOPLASM

- It is the fluid portion of a cell. It was discovered by Kolliker in 1862.
- About 90% component of cytoplasm is water and the remaining are amino acids, vitamins, enzymes, fats and carbohydrates.
- It can be divided into two parts.
  (i) Cytosol or Hyaloplasm : It the liquid portion which contain fibrous protein utilize for the formation of cytoskeleton
  (ii) Trophoplasm : In the cell's cytoplasm both living and non-living component are there.
- Living component are termed as cell organelles or protoplasmic inclusion.
- Non-living component are the deutoplasmic or ergastic bodies.

◈ **Role of cytoplasm :**

- Helps in exchange of materials between cell organelles.
- Acts as a site of chemical reactions like glycolysis, synthesis of fatty acids.

CELL ORGANELLES

- Small membrane bound structures, which perform a lot of chemical activities to support the function & structure of a cell, called cell organelles.
- **Single membranous :** Endoplasmic reticulum, Golgi apparatus, Lysosomes, Vacuoles, Peroxisomes, Glyoxysomes.
- **Double membranous :** Plastid and Mitochondria.
- **Non-membranous :** Ribosomes, Centrosome.

SINGLE MEMBRANOUS CELL ORGANELLES

◈ **Endoplasmic reticulum**

It forms the network with in the cell or we can say forms cytoskeleton of a cell.

- It was discovered by Porter, Claude and Fullan.
- These are present in all cells except prokaryotes and mammalian erythrocytes.
- They are made up of three components.

(A) Cisternae :

These are long, flattened, parallely arranged, unbranched tubules.
These form successive layers of nucleus.

(B) Vesicles : These are rounded or spherical. They are found in synthetically active cells.

(C) Tubules : These are small, smooth walled and have tubular spaces. These are found in non secretory as well as steroid synthesizing cells.

Cisternae Vesicles Tubules

◈ **Endoplasmic reticulum is of two types :**

(i) Smooth endoplasmic reticulum
(ii) Rough endoplasmic reticulum

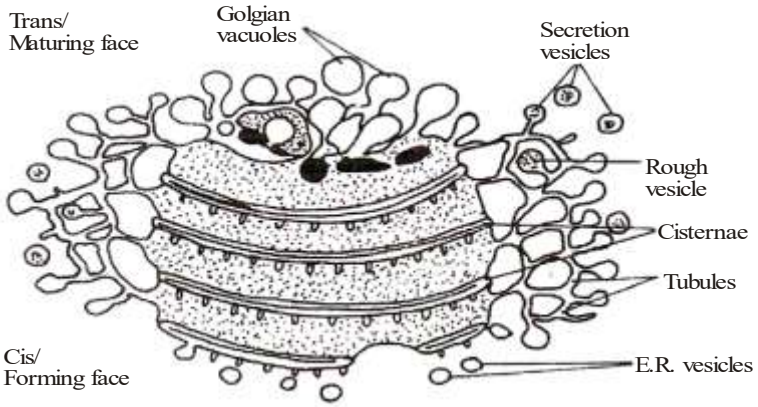
DIFFERENCES BETWEEN SMOOTH AND ROUGH ENDOPLASMIC RETICULUM

S. No.	CHARACTER	SER	RER
1.	Compounds	Made up of tubules mainly.	Made up of cisternae & vesicles.
2.	Ribosomes	Absent	Present
3.	Position	Mainly present near cell membranes	Mainly present near the nucleus.
4.	Functions	Helps in steroid, lipids & polysaccharide synthesis. Helps in membrane biogenesis.	Helps in protein synthesis.
5.	Occurrence	Mainly found in lipid forming cells like adipocytes (Fat cells).	Mainly found in protein forming cells like nerve cells.

◈ **Function**

(i) It is the only organelle which can move within a cell so it serves as a channel for the transport of materials between various regions of cytoplasm and between cytoplasm and nucleus.
(ii) It also functions as a cytoplasmic framework to provide space for some of the biochemical activities.
(iii) It forms endoskeleton of cell.
(iv) It helps in synthesis of fats, steroids, cholesterol.
(v) It contains secretory proteins and lipids, which act as enzymes and hormones.
(vi) SER plays a crucial role in detoxification of drugs and poisonous by-products and membrane biogenesis.

◈ **Golgi Apparatus**



Golgi Complex

(i) **Camillo Golgi** (1898), a zoologist, observed Golgi bodies in the form of a network in nerve cells of owl. Golgi carried out a method of staining individual nerve and cell structures. This method is referred to as the **'black reaction'**. This method uses a weak solution of silver nitrate and is particularly valuable in tracing the processes and most delicate ramifications of cells. Golgi received the Nobel prize in 1906 with Santiago Ramony Cajal for their work on the structure of the nervous system.

(ii) Golgi bodies are absent in prokaryotic cells. Golgi complex is found in all eukaryotic cells except RBCs and sieve cells.

(iii) It is also called **Golgi complex** or **Golgi apparatus** or **Dictyosome** (in plants cell).

(iv) The cytoplasm surrounding Golgi body have fewer or no other organelles. It is called Golgi ground substance or **zone of exclusion**.

(v) Golgi bodies are pleomorphic structure, because component of golgi body are different in structure. It contains a pile of flattened sacs named cisternae along with small vesicles and tubules.

Functions of Golgi Apparatus :

- It is involved in cell secretion and acts as storage, modification and condensation or packaging membrane.
- It forms the acrosome of sperm.
- It forms the lysosomes and secretory vesicles.
- It is the site of formation of glycolipids and glycoproteins.
- Synthesis of cell wall material (polysaccharide synthesis).
- Cell plate formation during cell division.

– Boost your knowledge

☛ Golgi bodies receive substances from ER for export.
☛ Golgi apparatus is a structure that originates from smooth E.R.
☛ Acrosome is a bag like structure filled with lytic enzymes which dissolve egg membrane at the time of fertilization.

◈ Lysosomes

- The term **lysosome** was introduced by **De Duve** in 1955.
- Lysosomes are generally found in the cytoplasm of animal cells. Lysosomes exhibit polymorphism.
- It is also called **demolition squads, scavengers, cellular house keepers and suicidal bags.**
- Lysosome are simple tiny spherical sac like structures evenly distributed in the cytoplasm.
- Lysosome is small vesicle surrounded by a **single membrane** and contains powerful enzymes.
- It contain 40 type of enzymes which are called as **hydrolases**.
- Lysosomes exhibit polymorphism i.e. they occur in different forms.
- Lysosomes serve as intracellular digestive system, hence called **digestive bags**.
- Lysosomes also remove the worn out and poorly working cellular organelles by digesting them.
- During disturbances in cellular metabolism i.e. in case of cell damage lysosomes burst and their enzymes are released into the cytoplasm and they digest their own cell so they are also called as **"Suicidal Bags"**.

◈ Peroxisomes

- The term 'peroxisome' was first used by the Duve and also called as **uricosomes**.
- Peroxisomes are ovoid or granular structures, limited by a single unit membrane and have a diameter of 0.5 to 1.0 μm.
- In green plants, Peroxisomes carry out photorespiration.
- In animal cells they carry out lipid metabolism.
- They contain important enzymes as oxidases (peroxides producing enzymes), peroxidases and catalases (which break down toxic peroxides to water and oxygen).

– Boost your knowledge

☛ Lysosomes, Peroxisomes, Glyoxysomes together are called as microbodies.

◈ Glyoxysomes

- They are found in plant cells, particularly in germinating fatty seeds e.g. Ricinus (castor) and groundnut where fat is being converted into carbohydrates by a process called **glyoxylate cycle**.
- Glyoxysomes contain important enzymes, isocitrate lyase, maltase and synthetase along with several others.
- Structure of glyoxysome is similar to peroxisome.

◈ **Sphaerosomes**

- Sphaerosomes occur only in plant cells. They are major site of lipid storage and synthesis in plants.
- Sphaerosomes also have lysosome like activity so they also termed as plant lysosomes.

DOUBLE MEMBRANOUS CELL ORGANELLES

◈ **Plastid**

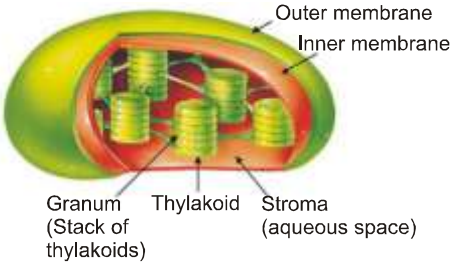
- **E. Haeckel** (1865) gave the term plastid. Plastids are largest cell organelles.
- Plastids occur in most plant cells and protists are absent in animal cells.
- **Schimper** divided plastids into three types :
  (a) **Chromoplast** - Coloured plastids (except green colour)
  (b) **Chloroplast** - Green coloured plastids
  (c) **Leucoplast** - Colourless plastid.
- Plastids also have double membrane but no cristae.

Leucoplast	Chromoplast	Chloroplast
Non pigmented white in colour	Coloured pigments includes all colour except green, i.e. they are brown, red, orange etc in colour.	Green pigment chlorophyll is found in them
Generally found in underground parts like roots important for food storage e.g. Aleuroplast (Protein), Elaioplast (Oil), Amyloplast (Starch)	Found in flowers, Fruits, Leaves etc.	Found in aerial parts of plant which are green in colour.

– **Boost your knowledge**

☛ In each thylakoid Quantasomes are present which are called as Photosynthetic units.
☛ Each quantasome possesses 230 chlorophyll molecules.

◈ **Chloroplast :**

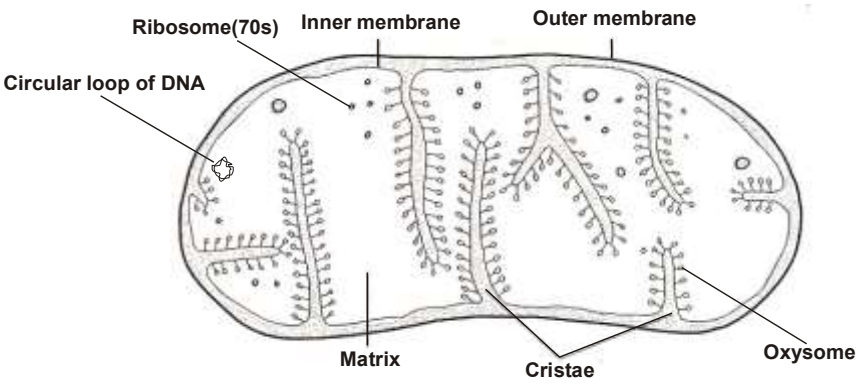


- Chloroplast was discovered by A.V. Leeuwen hoek and named by Schimper.
- It is a double membranous discoidal structure, found in plant cells and few protists.
- Each chloroplast consists of two parts.

(i) Grana : It constitutes the lamellar system. Each granum of the chloroplast is formed by superimposed closed compartments called **Thylakoids**. There are flat membranous tubules called the stroma lamellae or fret channels connecting the thylakoids of the different granum.
Functions : Grana are the sites of light reaction of photosynthesis as they contain photosynthetic pigment chlorophyll.

(ii) Stroma : It is a granular transparent substance also called as matrix. It contains 70s ribosomes and double stranded circular DNA
Function : This is the site of dark reaction of photosynthesis.

◈ **Mitochondria**



- **C.Benda** (1897) gave the name Mitochondria (Mitos, thread + Chondrion, granules).
- Term 'Bioplast' for mitochondria was used by **Altman.**
- A single mitochondrion is present in unicellular green alga, Microsterias. Number of mitochondria varies from **50–50,000** per cell. Mitochondria of a cell are collectively known as **chondriome.**
- Mitochondria are rod shaped organelles, bounded by a double membrane envelope.
- The outer membrane is smooth, the inner membrane surrounds a central cavity of **matrix.** Central cavity is filled with jel like substances. It contains 70s ribosomes and double stranded circular DNA
- Inner membranes folds are called **cristae**, these folding are tubular and called **microvilli**.
- Mitochondria contain electron transport systems aggregated into compact structure, **F_0-F_1 particles or Fernandez Moran particle or oxysome**, tennis racket like bodies on inner membrane involved in oxidation & phosphorylation.

Functions :

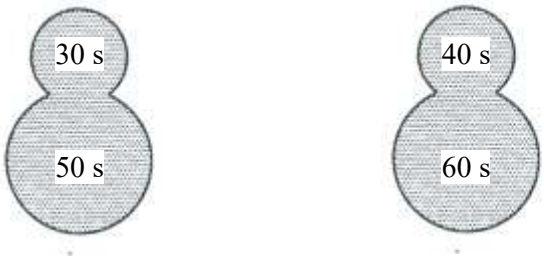
- Its main function is to produce and store energy in the form of ATP hence mitochondria are called **power plants** or **power houses** or **cellular furnaces**.
- Kreb's cycle occurs in mitochondria.
- Oxysome contains enzymes for ATP production.

– Boost your knowledge

☛ Mitochondria and chloroplast are strange organelles in the sense that they have their own DNA and ribosomes. That is why also called as **semi-autonomous organelles.**

NON-MEMBRANOUS CELL ORGANELLES

◈ **Ribosome**



70S Ribosome
(a) Prokaryotic ribosome

80S Ribosome
(b) Eukaryotic ribosome

- First reported by Claude and named by G. Palade.
- They are small granular structures visible only under electron microscope.
- They are usually attached on the outer surface of endoplasmic reticulum as well as freely in the cytoplasm.
- They are the only organelles which are present in all types of cells.
- They help in protein synthesis and are known as 'protein factories'. It is also called organelle within an organelle.
- Each ribosomes consists of two unequal subunits, larger dome shaped and small ovoid.
- The cytoplasmic ribosomes of eukaryotes are 80S and in prokaryotes and cell organelles like mitochondria and chloroplast. It is of 70S type. The two sub units of 80S ribosomes are 60S and 40'S while 70S type ribosomes have 50S and 30S subunits. They are composed of RNA and proteins.

◈ **Centrosome :** Centrioles are found in all animal cells except the mature mammalian RBCs. They are absent in prokaryotes, fungi, and higher plant such as gymnosperms and angiosperms. It is located near the nucleus. It is differentiated into a clear homogeneous mass of cytoplasm called **centrospheres** and one or a pair of microtubular **centrioles**.

- **Functions of centrosome :** The centrosome is concerned with cell division and formation of basal bodies of cilia and flagella.

◈ **Microtubules**

These are very fine microscopic tube-like structures which may be present in dependently or as parts of some organelles such as centrioles, basal bodies, cilia, flagella etc.

Functions of Microtubules :

- The microtubular structures provide strength.
- They also help in bringing about various movements inside the cell.

ERGASTIC BODIES

It include non-living structures.

◈ **Vacuole**

- Vacuoles are non-living structures of cytoplasm.
- They are bounded by a single membrane called **Tonoplast**.
- In animal cells vacuoles are smaller in size and numerous while in plant cells a single large vacuole is found which occupies about 90% of the volume of cell.

Functions :

- It helps in the storage and disposal of various substances.
- It helps in maintaining osmotic pressure in a cell.
- It stores toxic metabolic products of plant cell.
- It contains various coloured pigments like anthocyanins.

◈ **Granules**

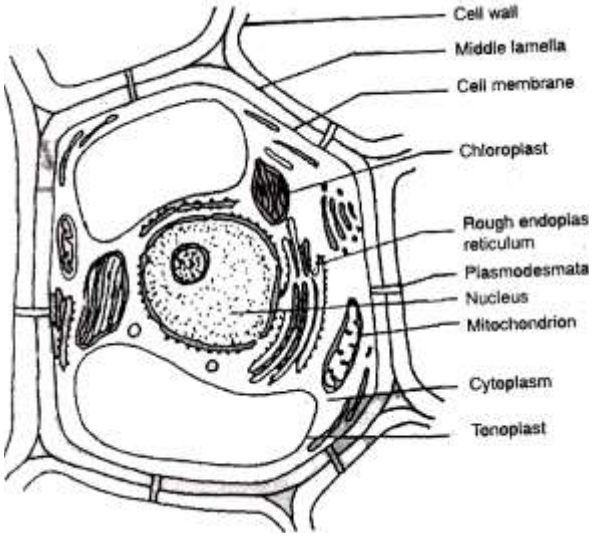
These are also non-living cytoplasmic inclusions. These are small particles, crystals or droplet.

Function

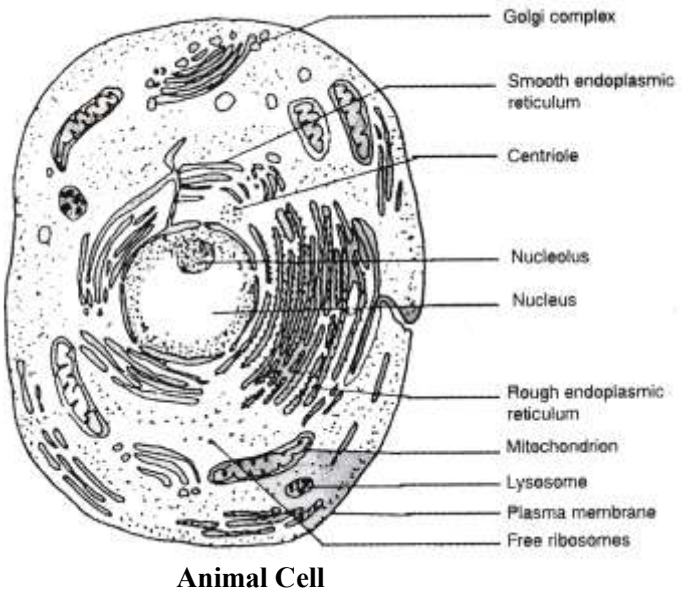
Starch grains, fat droplets help in the storage of food in cells

◈ **Plant cell and Animal cell :-**

COMPARATIVE STUDY OF PLANT AND ANIMALS CELL			
S.No.	**Characters**	**Animal Cell**	**Plant Cell**
1.	Cell wall	Absent	Present
2.	Plasma membrane	Only cell membrane	Present
3.	Microtubules/Microflaments	Present	Present
4.	Lysosomes	Lysosomes occur in cytoplasm	Lysosomes usually not evident
5.	Nucleus	Present	Present
6.	Shape	Round (irregular shape)	Rectangular (fixed shape)
7.	Chloroplast	Animal cell don't have chloroplasts	Plant cell have chloroplasts because they make their own food
8.	Cytoplasm	Present	Present
9.	Endoplasmic Reticulum	Present	Present
10.	Ribosomes	Present	Present
11.	Mitochondria	Present	Present
12.	Vacuole	One or more small Vacuole (much smaller than point cells)	One, large central Vacuole taking up to 90% of cell volume
13.	Centrioles	Present in all animal cells	Only present in lower plant forms



Plant cell



Animal Cell

DIFFERENCE BETWEEN PROKARYOTIC AND EUKARYOTIC CELL			
S. No.	**Characters**	**Prokaryotic Cells**	**Eukaryotic Cells**
1.	Nuclear body	Incipient nucleus, No nuclear membrane nucleolus absent	True nucleus, Nuclear membrane present, Nucleolus present.
2.	Mitosis	No mitosis	Mitosis found
3.	Respiratory system	In plasma membrane, (mitochondria absent), mesosomes present.	In Eukaryotic cells mitochondria is present
4.	Respiratory system	Single closed loop, (histones absent)	Multiple chromosomes, (histones present in chromosome)
5.	Photosynthetic apparatus	In internal membranes, (chloroplasts absent)	Chloroplasts present.
6.	Ribosomes	70 S type	80 S type
7.	Cell wall	Generally present, complex chemical composition	Present in some types, simple chemical composition
8.	Flagella and cilia	Submicroscopic, have 9 + 0 fibrillar structure	Microscopic size have 9 + 2 fibrillar structure
9.	Cytoplasmic movements	Cytoplasmic streaming rare or absent	Cytoplasmic streaming often occurs
10.	Vacuoles	Absent	Present
11.	Capsule	May be present	Always absent

Boost your knowledge

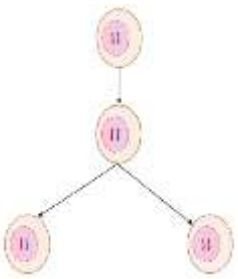
- **Pleuripotent :** Pleuripotent cells can give rise to all of the cell types that make up the body; embryonic stem cells are considered pleuripotent. Multipotent cells can develop into more than one cell type, but are more limited than pleuripotent cells; adult stem cells and cord blood stem cells are considered multipotent.

CELL DIVISION

Every day, an estimated hundreds of billions of cells in our body are replaced, which is almost 1 per cent of the total number of cells in our body Both prokaryotic and eukaryotic cells divide, but eukaryotic cells divide in a more controlled and orderly manner by a process called the cell cycle.

Cell division is the process by which new cells are formed from pre-existing cells. It allows living organisms to grow, repair damaged tissues and reproduce. Some cells, such as skin cells divide continuously to replace cells that are lost regularly. There are two major types of cell division - **mitosis** and **meiosis**. Mitosis is important for normal growth, repair, maintenance and asexual reproduction, while meiosis is important for sexual reproduction for creation of genetic diversity.

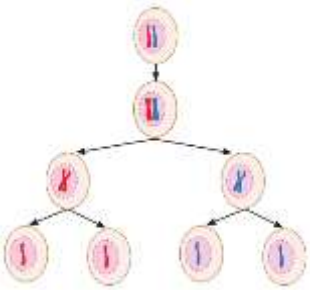
◈ Mitosis



Every human begins life as a single fertilised egg. This one cell divides repeatedly to form trillions of cells in the body. Cells increase in number through mitosis, which is the most common type of cell division (Fig).

Mitosis produces two genetically identical daughter cells from one parent cell. Each new cell gets the same DNA and the same number of chromosomes as the parent cell. This ensures that genetic information is largely maintained across body cells.

◈ Meiosis



Meiosis is a type of cell division that produces gametes and occurs only in the cells of reproductive organs. Gametes produced for sexual reproduction create variations and diversity among living organisms. Therefore, children resemble their parents but are not the same. In animals, including humans, meiosis occurs only in the cells of the testes of males to produce sperm and the ovaries of females to produce eggs. In plants, meiosis occurs in the anthers (male parts) to form pollen grains (that later produce sperm cells) and the ovaries (female parts) to produce egg cells. In meiosis, the parent cell divides twice, one after the other, to form four daughter cells (Fig.). During the first division, the cells divide into two daughter cells and the number of chromosomes in each daughter cell is reduced to half. The second division is similar to mitosis, where each daughter cell divides into two, thus forming four daughter cells with half the number of chromosomes. As a result, each gamete has half the number of DNA compared to the parent cell. During fertilisation, when gametes from two individuals combine, the original chromosome number is restored.

Bridging Science and Society

Scientists have developed methods to grow plant and animal cells outside the body in special conditions. This is called cell culture. In this process, cells are taken from an organism and placed in a nutrient-rich medium that allows them to grow and multiply. To keep the culture safe, the right temperature, acidic or alkaline conditions and moisture under sterile conditions are maintained. Cell culture is crucial for studying how cells work and for the production of biochemicals, food, medicines, vaccines, and more.

The processes of mitosis and meiosis must occur in a proper and controlled manner. What happens if meiosis and mitosis do not happen properly? If there is any error in these processes, it can lead to various problems in the body of an organism.

Errors in mitosis lead to uncontrolled cell divisions. This can lead to the formation of tumours and abnormal number of chromosomes in body cells.

Errors in meiosis may result in genetic disorders, which may be associated with developmental problems or distinctive physical features. Faulty meiosis may also cause early pregnancy loss or reduced fertility.

◈ Do cells grow and reproduce forever?

Cells grow and divide in a controlled way, stay in the right place, carry out their functions, and eventually die when they are no longer needed. Dead cells are replaced by new cells that carry out the same function. Thus, every cell has a definite life span. If cells do not die when they should or if they die too early problems can arise in the body. In many animal cells, cell division usually stops when cells come in contact with **neighbouring** cells. This process is called contact inhibition. However, cancer cells lose this control and keep dividing uncontrollably, leading to the formation of **tumours.** Plant cells grow differently. Due to their rigid cell walls plant cells do not show contact inhibition and follow a different pattern of growth.

Even though cells are extremely tiny they perform remarkable functions. They produce energy, synthesise and secrete substances, divide to form new cells, and work together to maintain the proper functioning of the body. Every living being from a tiny bacterium to a giant tree is made up of cells. You are one of the products of these tiny hardworking cells.

In 1902, the Austrian botanist, Gottlieb Haberlandt, proposed that any living plant cell, even a fully mature cell from a permanent tissue, can develop into a complete plant if it is provided with suitable nutrients and favourable conditions. He suggested that plant cells have the ability to form different types of cells and also change them. This special ability of plant cells is called totipotency. Haberlandt's idea laid the foundation for a new branch of biology known as Plant Tissue Culture Technology.

◈ How do cancer cells grow and spread?

Normal cells grow, age and die in a controlled manner. Sometimes, this system breaks down, and abnormal cells start growing and dividing uncontrollably. This results in the formation of tumours, which may be benign or malignant. Cancerous tumours can invade nearby tissues and even spread to other parts of the body to form new tumours.

◈ How do cells monitor their growth to maintain a balance?

Cells also have natural ways of dying to maintain a balance. Programmed Cell Death (PCD) is a genetically regulated and organised process of selective cell destruction. It is essential for normal development, cellular quality control and immune function. When an embryo develops, the PCD helps form fingers by eliminating cells between digits, without it we would have webbed hands.

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