1 THE FUNDAMENTAL UNT OF LIFE

LEARNING OBJECTS

	♦	INTRODUCTION		♦	CELL MEMBRANE
	♦	DISCOVERY OF CELL		♦	STRUCTURAL ORGANISATION OF A CELL
	♦	VARIATION OF CELLS		♦	CELL ORGANELLES
	♦	TYPES OF CELLS			

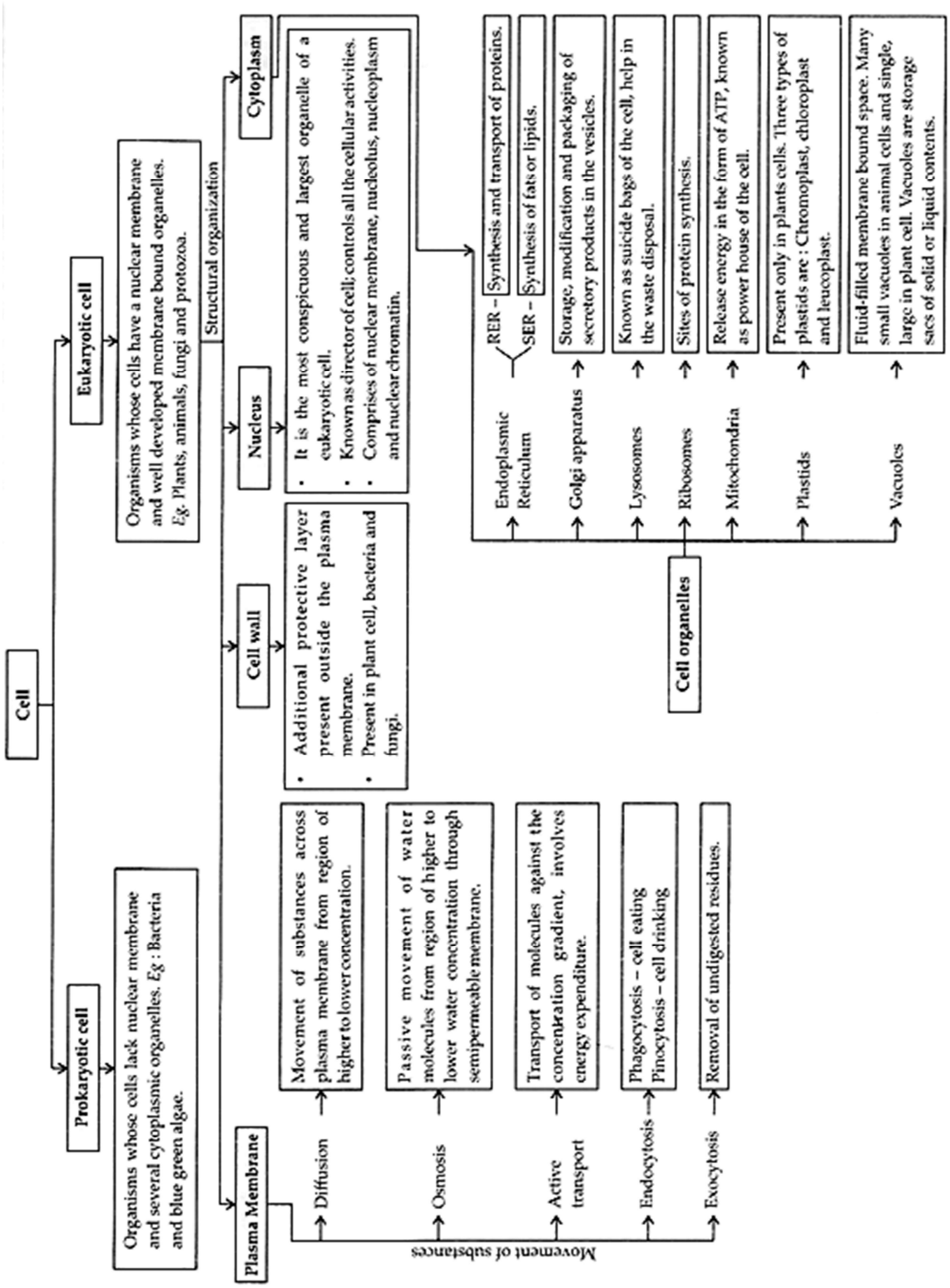
1. INTRODUCTION TO CELLS

INTRODUCTION

- The structural & functional unit of a living being is called **cell**. An unit of biological activity, delimited by a differentially permeable membrane and capable of self-reproduction in a medium free of other living system.
- The cell and its structures are studied under a branch of biology called **cytology** Father of cytology – **C.P. Swanson**.
- In 1665, **Robert Hooke**, an English scientist, saw cells for the first time in a thin slice of cork with its microscope. He observed and described the cells as **"Honeycomb"** like structures. He named the box – like compartments as cellulae or cells. The term **"cell"** from **Latin cella** means **little room** or hollow space.
- In 1674, **Van Leeuwenhoek**, a Dutch Scientist, studied living cells for the first time with the help of an improved **microscope**, which he himself had made. Though he was the first one to observe "cells", but he did not use the term "cell"

Largest cell in animals → Ostrich egg (17 × 18 cm)
Smallest cell in animals → Sperm cell
Longest cell in animals → Neuron (90 – 100 cm)
Largest cell in plant → Accta Bularia (16 – 10cm)
Smallest cell in plant → Myco Plasma (0.1 cm – 0.5 cm)
Longest cell in plant → Raminara (55 cm)

CONCEPT MAP


Cell
Prokaryotic cell
Organisms whose cells lack nuclear membrane and several cytoplasmic organelles. Eg : Bacteria and blue green algae.
Eukaryotic cell
Organisms whose cells have a nuclear membrane and well developed membrane bound organelles. Eg. Plants, animals, fungi and protozoa.
Structural organization
Cytoplasm
Nucleus
It is the most conspicuous and largest organelle of a eukaryotic cell.
Known as director of cell; controls all the cellular activities.
Comprises of nuclear membrane, nucleolus, nucleoplasm and nuclear chromatin.
Cell wall
Additional protective layer present outside the plasma membrane.
Present in plant cell, bacteria and fungi.
Cell organelles
Endoplasmic Reticulum
RER – Synthesis and transport of proteins.
SER – Synthesis of fats or lipids.
Golgi apparatus
Storage, modification and packaging of secretory products in the vesicles.
Lysosomes
Known as suicide bags of the cell, help in the waste disposal.
Ribosomes
Sites of protein synthesis.
Mitochondria
Release energy in the form of ATP, known as power house of the cell.
Plastids
Present only in plants cells. Three types of plastids are : Chromoplast, chloroplast and leucoplast.
Vacuoles
Fluid-filled membrane bound space. Many small vacuoles in animal cells and single, large in plant cell. Vacuoles are storage sacs of solid or liquid contents.
Movement of substances
Plasma Membrane
Diffusion
Movement of substances across plasma membrane from region of higher to lower concentration.
Osmosis
Passive movement of water molecules from region of higher to lower water concentration through semipermeable membrane.
Active transport
Transport of molecules against the concentration gradient, involves energy expenditure.
Endocytosis
Phagocytosis – cell eating
Pinocytosis – cell drinking
Exocytosis
Removal of undigested residues.

2. DISCOVERY OF CELLS

DISCOVERY OF CELLS:

Robert Hooke (1665): An English botanist, observed thin sections of cork of bark of a tree under a self – designed compound microscope and noticed – comb like compartments. He coined them as cells. Term cell was derived from a Latin word **cell- a little room**. He explained his observations in a book namely, Micrographia. He actually observed the rigid cell walls of dead cells.

Anton Von Leeuwenhoek (1674): A Dutch draper, was first to observe living cells like

1. Bacteria (From tartar of teeth)
2. Erythrocytes (of a fish)
3. sperms (were called animalcules)
4. Protozoans (e.g., Vorticella)

N. Grew (1682) proposed cell concept which states that cell is a unit of structure of organisms.

Robert Brown (1831): Discovered the **nucleus** in the root of orchid plant.

Purkinje (1839): Gave the term protoplasm for the jelly – like semifluid material of the cell.

M.J. Schleiden (1839) and Theodore Schwann (1839): Proposed the cell theory which states that the basic structural and functional unit of all the plants and animals is cell.

Rudolf Virchow (1855): A German physiologist, proposed theory of Lineage which states "omnis cellula – e – cellula" which means that new cells are formed from the pre – existing cells.

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

3. VARIATION OF CELLS

VARIATION OF CELLS:

In 1838, two biologists, J.M Schleiden and T.Schwann proposed the cell **"Cell Theory"**. According to them. The cell is the structural and functional unit of all living beings.

In 1855, **Rudolf Virchow**, a German pathologist proposed that all cells arise from pre – existing cells. He stated this in Latin as "**Omnis cellula–e–cellula".** Cell theory', therefore, states that:

(i) All living organisms are composed of one or more cells.

(ii) The cell is the basic unit of life.

(iii) Cells develop from pre – existing cells.

Note: Virus is an exception to cell theory.

Cell Shape

- Cells show a great variation in their shapes. Most cells have a definite shape. In human body, cells may be
- spindle shaped – muscle cells
- elongated – nerve cells
- oval – red blood corpuscles
- cuboidal – germ cells
- branched – osteocytes and chromatophores
- Some cells may not have any definite shape, i.e., their shape changes e.g., Amoeba and leucocytes (white blood corpuscles).

Cell Size

In size of the cell also varies considerably in different animals and plants. The average cell size varies from 0.5 to 20 μm in diameter. In human body, the smallest cell is RBC (7 μm in diameter) and the longest one are the nerve cells which reach a length of about 90 – 100 cm. In plants, large cells occur in many algae. Among the plants, the largest cell is the ovule of Cycas.

The smallest known cell is **Mycoplasma** or PPLO (pleuropneumonia – like organism). Its size is 0.1 to 0.5 μm (micrometer).

Amongst multicellular animals, the **largest cell** is the **egg of ostrich**. It measures about 15 cm and 8 cm in diameter with and without its shell respectively.

Cell Volume

The volume of a cell is fairy constant for a particular cell type and is independent of the size of the organism.

Ex. Kidney or liver cells are about the same size in the bull, horse and mouse.

The difference in the total mass of the organ or organism depends on the number, not on the volume of the cells.

Thus, the cells of an elephant are not necessarily larger than those of other tiny animals or plants.

The large size of the elephant is due to the larger number of cells present in its body.

Cell Number: The number of cells varies in all living organisms. Based on the number of cells, the organisms are divided into two types:

1. Unicellular organisms

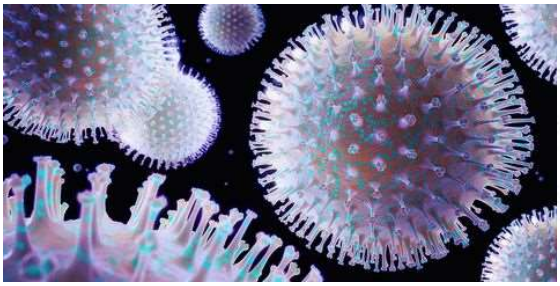
2. Multicellular organisms

Unicellular organisms (Single-celled organisms):

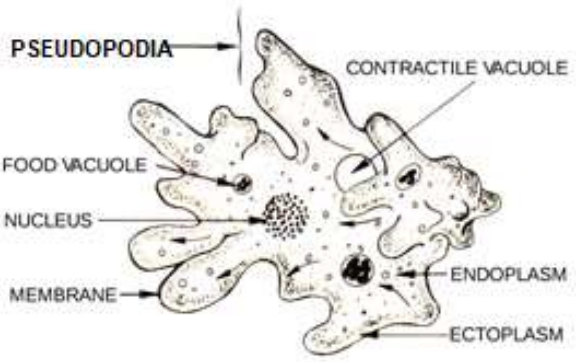
The organisms made up of single cells are called **unicellular organisms**.

Ex. **Amoeba, Paramecium, bacteria,** etc.

- The single cells have the ability to perform all the life processes like digestion, respiration, excretion, growth and reproduction.
- In these cells, there is no division of labours: single cells have to perform all the activities.



Bacteria



amoeba

Multi-cellular organisms (Multi-celled organisms):

- The organisms made up of a number of cells are called multi-cellular Organisms.
- All the cells of multi-cellular organisms have a similar basic structure and similar basic life activities.
- These cells group together to produce different tissues. Tissue forms organs and organs give rise to organ system that performs specialized functions.

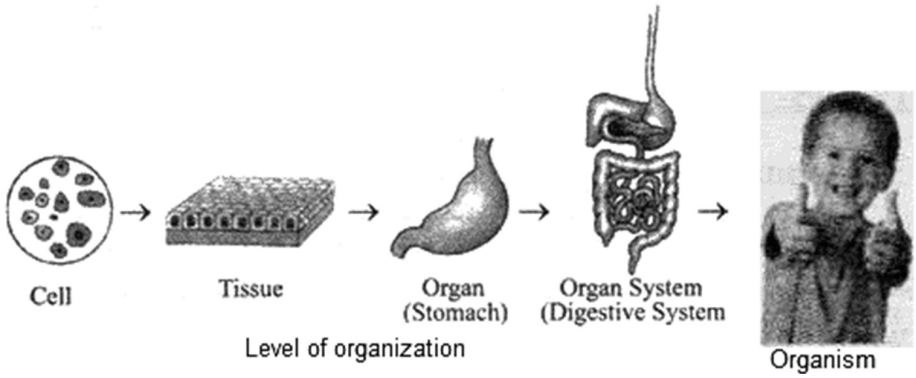
Ex. **Fungi, plants** and **animals**

Elephant

A Tree

The increasing order of complexity in multicellular organisms is:

Cell — Tissue — Organ— Organ System — organism



Note: All the cells of a multi-cellular organism develop from single cell called zygote. The zygote divides to form a number of cells that differentiate to have different shapes, structures and functions.

Difference between unicellular and multi-cellular organisms

S.No.	Unicellular organisms	Multi-cellular organisms
1.	The organisms made up of single cells are called unicellular organisms.	The organisms made up of large number of cells are called multi-cellular organisms.
2.	There is no division of labour. A single cell performs all the activities of the organism.	There is division of labour. Cells are specialized to perform different functions.
3.	The life span of the organism is short.	The life span of the organism is long
4.	Examples include Amoeba, Paramecium, bacteria etc.	Examples include Fungi, Plants, and Animals.

Prokaryotic Cells

- The organisms whose cells lack a nuclear membrane are called **prokaryotes**.
- Those cells have primitive organization of genetic material. The genetic material is equivalent to a single molecule of DNA.
- These cells do not have a well – organized nuclear region due to absence of nuclear membrane.
- These cells lack several cytoplasmic organelles like mitochondria, lysosome, endoplasmic organelles like mitochondria, lysosome, endoplasmic reticulum, chloroplast, nucleolus, etc.
- Many of the functions of these cells are performed by poorly organized parts of cytoplasm.
- The chlorophyll is found attached to membranous vesicles and not plastids as in eukaryotes.

Ex. Bacteria and blue – green algae

Eukaryotic Cells

- Organisms whose cells have a nuclear membrane are called **eukaryotes**.
- In this cell, the genetic material is made of two or more DNA molecules. The nuclear material is enclosed in a nuclear membrane.
- These cells have a well – organized nucleus. These cells have well – developed membrane – bound organelles, such as mitochondria, endoplasmic reticulum, lysosome, chloroplast, nucleolus, etc.
- Eukaryotic cells occur in plants, animals, fungi etc.

Prokaryotes (pro= primitive, karyon= nucleus): Organisms whose cells do not possess a well-formed nucleus is known as prokaryotes.

Ex. Bacteria, Cyanobacteria, etc.

Prokaryotes also lack membrane bound cell organelles. Thus, cell organelles like mitochondria, golgi bodies, ER are lacking in prokaryotes.

Eukaryotes (eu= True, karyon= Nucleus): Organisms whose cells possess a nuclear membrane is known as eukaryotes. Cell organelles like mitochondria, golgi bodies, ER are present in eukaryotes.

Ex. Plants and animals.

Differences between Prokaryotic & Eukaryotic Cells

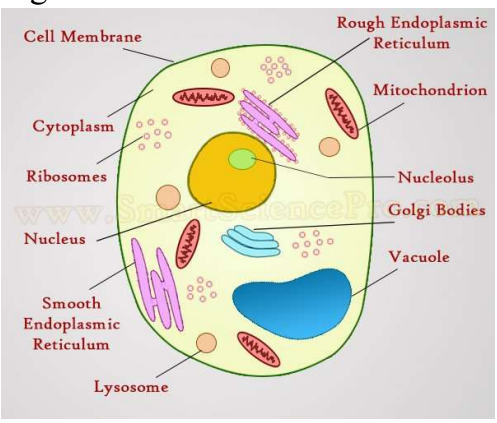
Characters	Prokaryotic Cells	Eukaryotic Cells
Nuclear body	Incipient nucleus, no nuclear membrane, Nucleolus absent, Single closed loop, (histones absent).	True nucleus, nuclear membrane present, Nucleolus present, Multiple chromosomes, (histones present in chromosomes).
Mitosis	No mitosis	Mitosis found
DNA arrangement	Single closed loop, (histones absent).	Multiple chromosomes, (histones present in chromosomes).
Respiratory system	In plasma membrane, (mitochondria absent)	In mitochondria
Photosynthetic apparatus	In internal membranes, (chloroplasts absent)	In chloroplasts
Golgi bodies, Chloroplast, Endoplasmic reticulum. Mitochondria, Lysosomes	Absent	Present

Ribosomes	70 S types	80 S types
Cell wall	Generally present, complex chemical composition. (peptidoglycan)	Present in some types, simple chemical composition. (chitin in fungi)

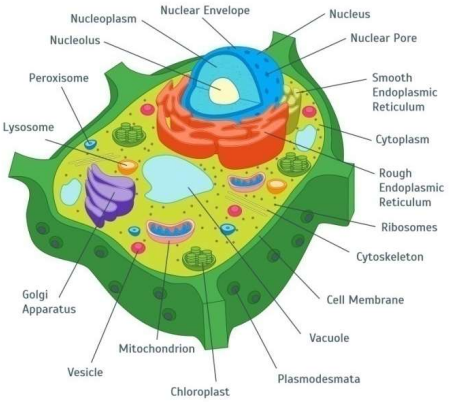
4. TYPES OF CELLS

TYPES OF CELLS:

Although the structure of the cell and its components may vary to a certain extent in plants and animals, the basic structure and functions of specific organelles remain the same.



Animal cell



Plant cell

Generalized ultra structure view of an animal cell and a plant cell

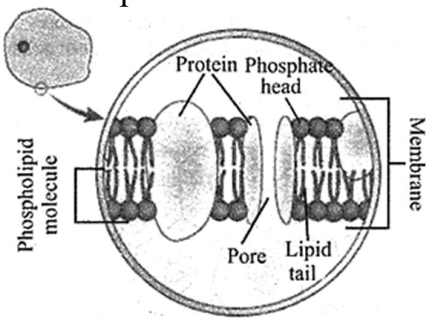
Difference between plant cell & animal cell

Characters	Plant cells	Animal cells
1. Cell wall	Present outside the plasma membrane	Absent
2. Plastids	Present	Absent
3. Vacuole	Single, large central vacuole	Many large and small vacuoles
4. Centriole	Absent	Present
5. Nucleus	Generally eccentric	Generally centric
6. Mitochondria	Less in number	More in number
7. Phagocytosis	Cannot take part	Can take part
8. Glyoxysomes	Present	Absent
9. Reserve food	Starch and fat	Glycogen and fat
10. Cytokinesis	Cell plate method	Cleavage method

5. CELL MEMBRANE

CELL MEMBRANE/PLASMA MEMBRANE

- It is the outermost, extremely delicate elastic membranous covering of each cell. It separates the cytoplasm of the cell from its environment.
- Plasma membrane is a living, selectively permeable membrane.
- It allows some selected materials to move in and out of the cell and prevents the entry and exit of the other substances.
- The plasma membrane is made up of a bilayer of lipids and proteins. Small carbohydrates are attached at places to outer surface of lipids and proteins.

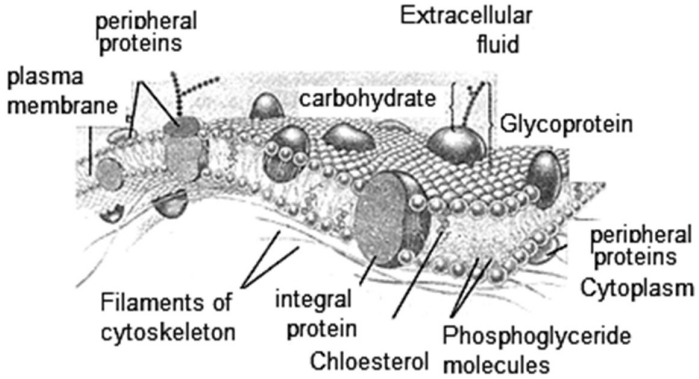


Plasma membrane

Model:

Several models have been proposed regarding the arrangement of proteins and lipids. The Fluid Mosaic Model **Singer and Nicholson** is widely accepted **According to this model:**

- The cell membrane is composed of lipid bilayer of phospholipids molecules into which variety of globular proteins are embedded.
- Each phospholipids molecule has two ends- an outer head hydrophilic (water attracting) and the inner tail hydrophobic (water repelling).
- **Protein molecules are arranged in two ways:** Peripheral proteins or extrinsic proteins are present on the outer and inner surface of lipid bilayer while Integral proteins or intrinsic proteins are, embedded inside lipid bilayer partially or wholly.



Cell membrane

Functions of cell membrane:

(i) It provides definite shape to the cell.

(ii) It functions as a mechanical barrier between external and internal environment of the cell.

(iii) It regulates the movement of molecules in and out of cell.

(iv) The flexibility of membrane helps the cell to engulf food and other substances from its external environment by endocytosis.

For example: Amoeba obtains its food by endocytosis. Endocytosis is the ingestion of material by the cells through plasma membrane.

Note: Cell membrane regulates the movement of substance in and out of cell. If the cell membrane fails to function, then the cell dies.

Types of membrane (plasma membrane / cell membrane)

Membrane acts as physical barriers between cell and its surrounding environment.

There are four types of membranes:

Impermeable: Membrane that does not allow substance to pass through it is known as impermeable,

Permeable: The membrane that allows all kinds of materials (both solute and solvent) to pass through it is known as permeable membrane.

Semi -permeable: The membrane that is permeable to solvent but prevents the passage of solutes is known as semipermeable membrane.

Selectively permeable: Membrane that allows the passage of solvent and some selected solutes is known as selectively permeable membrane. Plasma membrane is a selectively permeable membrane.

Transport across The Membrane:

Passive transport: The transport of substances across the plasma membrane without expenditure of energy is known as passive transport.

It is of two types:

(1) Diffusion

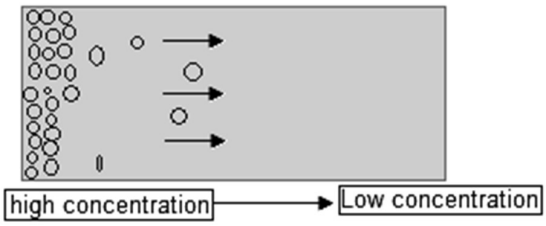
(2) Osmosis

Diffusion: The process of movement of substance from the region of higher water concentration to the region of lower concentration, so as to spread the substance uniformly in the given space is known as diffusion. The process does not require energy.

For example: Transport of CO, and O^{-}, across the membrane. The gases like CO_2 and O^{-}, move across the membrane through diffusion. The process of respiration produces carbon dioxide inside the cell. As the concentrate of CO_2 increases inside the cell as compared to the outside, CO_2 diffuses out of the cell into external medium.

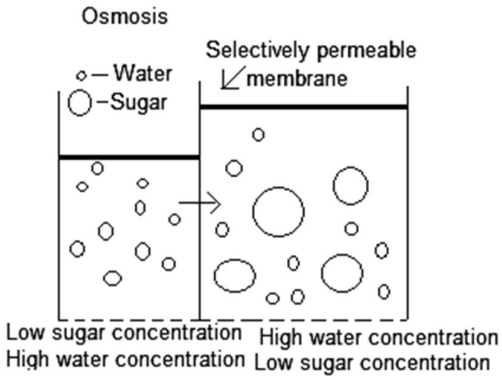
Similarly, the concentration of oxygen is always higher in the external medium (atmosphere) as compared to the cell. Therefore, oxygen diffuses from outside to the inside of cell.

Diffusion



Osmosis: Osmosis is the movement of solvent (always water in biological system) from a dilute solution to a more concentrated through a membrane. A membrane of this type (which allows the passage of some kinds of molecules and not others) is called a semipermeable membrane. Membranes involved in living systems are not perfectly semipermeable. Osmosis between two solutions will continue until they have the same concentration (the state of equilibrium).

For example*:* Movement of water across selectively permeable membrane.



Difference between Diffusion and Osmosis

Diffusion	Osmosis
It is the movement of substance from the region of higher concentration to its lower concentration.	It is the movement of water from the region of higher concentration to its lower concentration through a semi-permeable membrane.
It takes place in all three medium-solid, liquid and gas.	It takes place only in liquid (water) medium.
It does not involve semi-permeable membrane.	It requires semi-permeable membrane.
It is not much influenced by the presence of other substances.	It is influenced by concentration and type of solute particle.

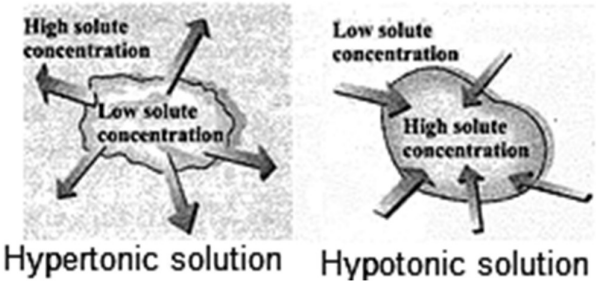
Types of Osmosis:

Endosmosis: Endosmosis is the osmotic entry of water into the cell.

Exosmosis: Exosmosis is the osmotic withdrawal of water from the cell.

There are three types of osmotic solution, which can cause osmosis across semi-permeable membrane.

Hypotonic solution (Hypo=less than or lower): Hypotonic is the solution which has lower osmotic concentration than the cell.



Hypertonic solution (Hyper=more or higher): Hypertonic is the solution that has higher water concentration than the cell.

Isotonic solution (Iso=same): It is the solution that has same osmotic concentration as inside the cell.

plasmolysis: Plasmolysis is the phenomenon of the loss of water from a plant cell by osmosis when kept in a hypertonic solution, so that the cytoplasm shrinks away from the cell wall.

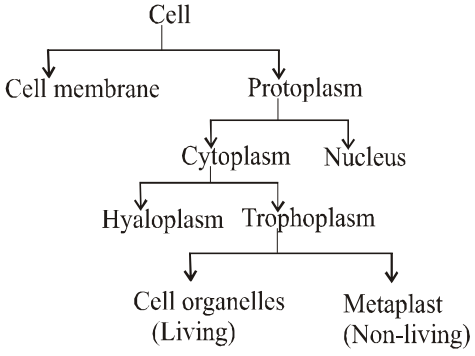
- If a plant cell is kept in a solution more concentrated than the cell sap i.e. in hypertonic solution, water moves out to the outside solution.
- Loss of water causes the vacuole to shrink and pull the plasma membrane with the cell contents away from the cell wall. This phenomenon is known as **plasmolysis**.

Active transport:

- Active transport is the process of transport of molecules across the plasma membrane against the concentration gradient.
- The process requires the use of energy.
- For active transport, the cell membrane possesses ATP mediated carrier protein.
- Glucose, amino acids and ions pass through plasma membrane by active transport.

6. STRUCTURAL ORGANIZATION OF A CELL

CELL STRUCTURE



Cell or Plasma Membrane:

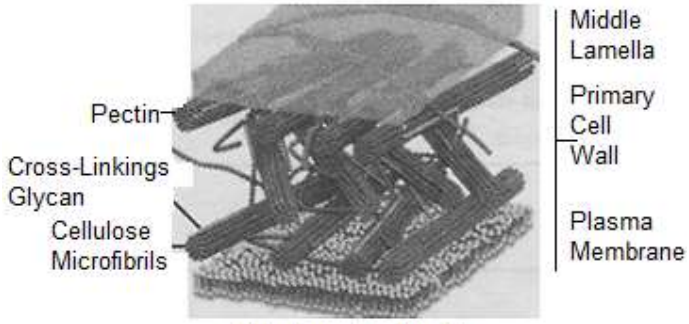
- Cell membrane is the outer covering of each cell, forming a boundary of the cytoplasm. It consists of lipids and proteins.
- The cell membrane encloses the nucleus and cytoplasm of the cell.
- In plant cells, the plasma membrane is present between the cytoplasm and cell wall, whereas in animal cells it forms the boundary of the cytoplasm.
- It is a living delicate semi-permeable (also called selectively permeable) membrane, regulating the movement of molecules inside and outside the cell. It allows the entry and exit of some molecules in and out of the cell. It also prevents the movement of some other molecules.

Structure of Plasma Membrane

- The most acceptable structure of cell membrane was proposed by **Singer** and **Nicolson** in 1972. They named it as fluid mosaic model of cell membrane.
- According to this model, lipids are arranged in two layers called lipid bilayer and proteins are arranged in a mosaic fashion.
- They have described this model as **"Protein icebergs in a sea of lipids".** This model thus explains the dynamic and functional properties of the membrane.

Cell wall:

- Cell wall is a rigid, non-living covering present outside the plasma membrane in plant cells.
- Plant cell is made up of **cellulose**, which is permeable to water, solutes and gases.
- In fungi, the cell wall is made up of **chitin**. A cementing layer called middle lamella is present between the walls of two adjacent cells. Middle lamella is formed of pectin, calcium and magnesium pectate.



Structure of cell wall

Functions of Cell Wall: It gives definite shape to the cells.

- It provides mechanical strength to plants.
- It protects the cell against mechanical injury and pathogens.
- It helps in transport of various substances across it.

Cell wall helps the plant cells to withstand a lot of variations in the surrounding environment. Cell wall prevents the bursting of cell on endosmosis as it is quite thick and rigid.

Protoplasm (Essence of life):

The entire matter found inner to the cell membrane is called as protoplasm. All the living components of a cell lie in the protoplasm and perform their functions.

1. Protoplasm - termed by Purkinje
2. Physical basis of life - Huxley

It can be divided into 2 parts:

(1) Nucleus

(2) Cytoplasm

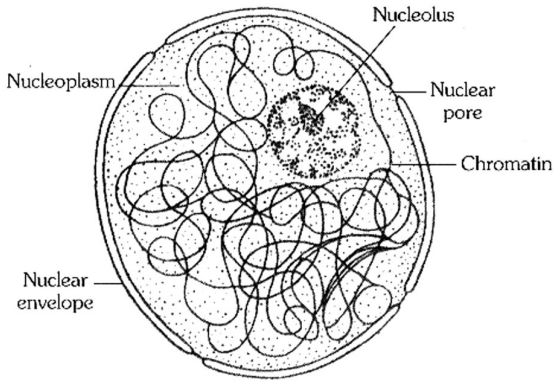
Nucleus: It is a darkly stained structure generally present in the centre of the cell. It was discovered by **Robert Brown** in 1833.

Structure:

It is made up of following four contents:

- Nuclear membrane / Nuclear envelope / Karyotheca
- Nuclear sap / Nucleoplasm / Karyolymph.
- Nucleolus.
- Chromatin threads.

Nuclear membrane: Nucleus is surrounded by two membranes, that separates nucleoplasm from cytoplasm. The outer membrane is continuous with endoplasmic reticulum. The nuclear membrane has minute pores. These are called nucleopores.



Structure of a nucleus

Nucleoplasm:

- The part of protoplasm which is enclosed by nuclear membrane.
- It contains chromatin threads and nucleolus.

Nucleolus:

- It is spherical or oval body present within the nucleus.
- It is generally bigger in size in those cells which are actively concerned with protein synthesis.
- It is more prominent in non-dividing cells.

- It contains large amount of RNA and proteins and also a small amount of DNA.
- Nucleolus is a site where ribosomes are formed.

Chromatin Threads:

- It is entangled mass of thread like structures.
- During cell division, the chromatin material gets organized into chromosomes. These are rod-shaped structures, Chromosomes are made up of DNA (Deoxyribonucleic acid) and proteins.
- DNA is the master molecule, and it controls all the activities of the cell. Functional segments of DNA are called genes. Genes control the characters.

Functions of Nucleus:

(i) It controls all the metabolic activities of the cell and regulates the cell cycle.
(ii) It helps in transmission of hereditary characters from parent to offspring.
(iii) Nucleus plays a central role in the cellular reproduction (division of single cell to form two cells).

Cytoplasm:

- It is a large region of each cell enclosed by the cell membrane.
- It is a transparent, semi-solid ground substance in which various cell organelles are present.
- Water is the main component of cytoplasm which contains fats, proteins, carbohydrates and various organic substances.

Functions:

1. It helps in exchange of materials between cell organelles.
2. It acts as a site of chemical reactions like glycolysis.

7. CELL ORGANELLES

Large and more highly evolved cells, or cells of the multicellular organisms have a great deal of biochemical activities to support their complicated structure and function. Such cells possess specific membrane bound sub – cellular components within themselves to keep different kinds of cellular activities separate from each other. These membranes within themselves to keep different kinds of cellular activities separate from each other. These membranes bound sub – cellular components are called **organelles** (i.e., small organs). Presence of organelles is one of the important features of the eukaryotic cells which distinguishes them from prokaryotic cells. We have already discussed plasma membrane, cell wall and nucleus.

A. Living Part of a Cell B. Non-Living part of a cell

A. Living Part of a Cell	B. Non-Living part of a cell
1. Plasma Membrane 2. Cytoplasm 3. Endoplasmic reticulum 4. Mitochondria 5. Golgi apparatus 6. Ribosomes 7. Lysosomes 8. Peroxisomes 9. Centrioles (animal cells only) 10. Plastids (Plant cells only)	1. Cell wall (Plant cell only) 2. Vacuoles 3. Granules (Inclusions)

ENDOPLASMIC RETICULUM:

Introduction:

- It is an elaborate network of membrane bound tubules highly concentrated in the endoplasm hence called endoplasmic reticulum.
- The first observed by Porter and Kallman (1952) coined the term 'endoplasmic reticulum'. Garnier had earlier named it ergastoplasm.

Types:

- Depending upon the nature of its membranes, endoplasmic reticulum is of two main types, smooth and rough.
- The two types of ER may be continuous with one another, plasma membrane and nuclear envelope.
- Endoplasmic reticulum may develop from pre-existing E.R., plasmalemma or nuclear envelope.

Differences between SER and RER

SER	RER
SER or smooth endoplasmic reticulum does not bear ribosomes over the surface of its membranes.	RER or rough endoplasmic reticulum possesses ribosomes attached to its membranes.
It is mainly formed of vesicles and tubules.	It is mainly formed of cisternae and a few tubules.
It is engaged in the synthesis of glycogen lipids and steroids.	The reticulum takes part in the synthesis of proteins and enzymes.
SER gives rise to sphaerosomes.	It helps in the formation of lysosomes through the agency of Golgi apparatus.
SER is often peripheral. It may be	It is often internal and connected with

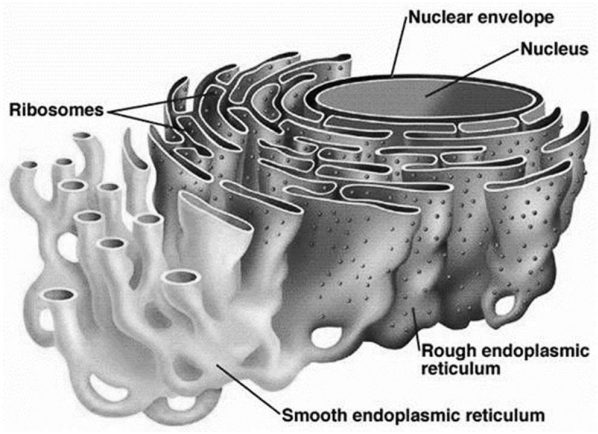
SER	RER
connected with plasmalemma.	nuclear envelope.
Ribophorins are absent.	RER contains ribophorins for providing attachment to ribosomes.
It may develop from RER through loss of ribosomes.	It may develop from outer membrane of nuclear envelope.
It has enzymes for detoxification.	The same are absent.

The term **'endoplasmic reticulum'**. Garnier had earlier named it **ergastoplasm** with same cellular structure.

Structure:

- It is a fine branched vacuolar system extending from the nucleus through the cytoplasm to the margins of the cell. In young meristematic cells it forms a continuous system extending from the nuclear envelope to the cell membrane and even to the cell wall. It may even extend to the neighbouring cells. In old cells it may be less prominent and is represented by discontinuous vesicles.
- It occurs in one of the three shapes **cisternae, tubules** and **vesicles**. The morphology of the ER depends upon the physiological and developmental stages of a cell. It is not a stable structure rather capable of being broken down and reconstructed. The cisternae are large flattened parallel sac like structures interconnected to each other. A cisterna is usually 40 to 50 nm in thickness. The tubules are 50 to 100 nm and vesicles 25-500 nm have a diameter.
- The membrane of the ER is thinner 50-60 Å than the plasma membrane. The cavity of the ER is sometimes so small that the two membranes come in intimate contact but usually the space is quite distinct. The plasma cells and the goblet cells with active protein synthesis show a wider space.

Microsomes: These are small spherical vesicles formed from disrupted endoplasmic reticulum when a cell is homogenized and is subjected to differential centrifugation.



Endoplasmic reticulum

Function:

- Storage of glycogen, lipid, calcium.
- Glycosylation or synthesis of glycoprotein, glycolipids etc.
- Detoxification of various toxic, waste materials like drugs, pollutants, bile salts, degraded amino acids and fatty acids.
- Provides skeletal framework to the cell and give rise to membranae organelles like Golgi bodies, spherosomes etc.

Special features

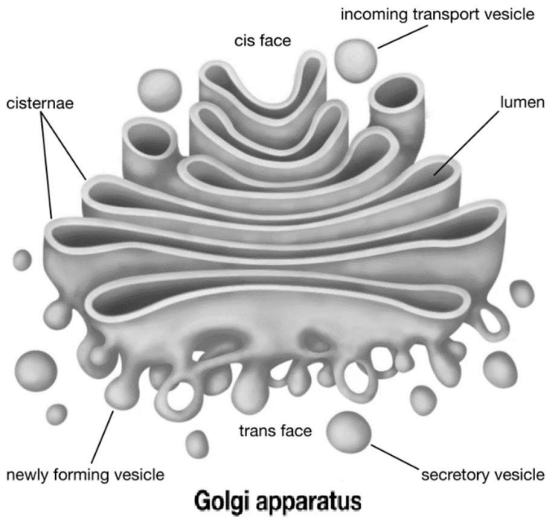
- It provides a large surface inside the cell for various physiological activities.
- It functions as cytoskeleton or intracellular and ultra structural skeletal framework by providing mechanical support to colloidal cytoplasmic matrix.
- Endoplasmic reticulum keeps the various organelles in their position.
- Endoplasmic reticulum (as **desmotubules**) controls movement of materials between two adjacent protoplasts through plasmodesmata (proteins and lipids).
- Endoplasmic reticulum acts as a means of quick intracellular transport.

GOLGI APPARATUS - DICTYOSOMES

Discovered by Camillo Golgi (1898) in nerve cells of owl.

Golgi Apparatus:

- First described by **Camillo Golgi** and also known as Golgi body or Golgi complex, it consists of smooth, flattened, membrane bound (double walled), sac-like structures called **cisternae.**
- The cisternae are usually placed one above the other (stacked together) in parallel rows.
- The Golgi apparatus is frequently surrounded by vesicles which are discharged from the cisternae.
- When present in plants in the form of subunits. Golgi apparatus is called dictyosome.



Golgi apparatus

Functions:

- It is a secretory organelle of the cell.
- It packages materials, synthesized in the cell and transports these out of the cell.
- It is involved in the formation of lysosomes.
- In some cases, complex sugars are made from simple sugars in this organelle.
- Packing protein and other molecules within the cell.

LYSOSOME – SUICIDAL BAG OF THE CELL

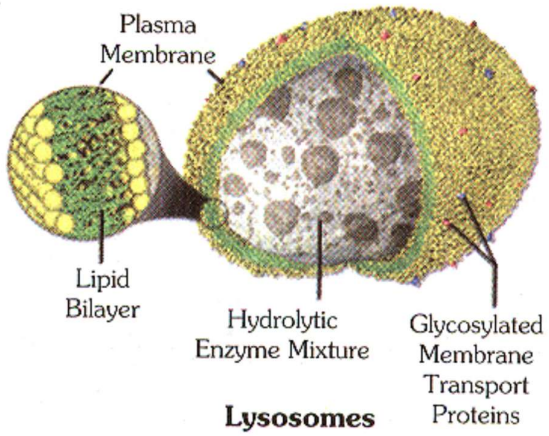
Introduction:

Lysosomes are electron microscope spherical sac like structures found in the cytoplasm of all the eukaryotic animal cells except mammalian RBCs. Lysosomes contain several digestive enzymes. More than 40 enzymes present in lysosomes are synthesized in rough endoplasmic reticulum (RER) and are brought to the lysosome through Golgi complex. These enzymes are capable of breaking down almost all types of organic substances. Lysosomes pass through various stages in the same cell.

- First observed and the term coined by **Christian De Duve** (1955).

Types of Lysosomes

- Primary lysosomes or storage granules
- Digestive vacuoles or Heterophagosomes
- Residual bodies
- Autophagic lysosomes or cytolysosomes or autophagosomes



Functions:

- It involves in digestion of foreign materials received in cell by phagocytosis and pinocytosis.
- Digestion of old or dead cell organelles. Autophagy also takes place during starvation of cell.
- Sometimes all lysosomes of a cell burst to dissolve the cell completely. That's why lysosomes are also known as suicidal bags.

MITOCHONDRIA - POWER HOUSE OF THE CELL

Introduction: It is a rod-shaped organelle found in the cytoplasm of eukaryotic cells, except for mammalian red blood cells, and are absent in prokaryotes. They are known as the "powerhouses" of the cell because they produce the energy needed for cellular functions, primarily in the form of ATP.

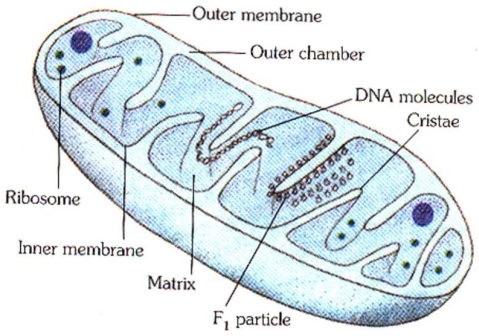
Discovered:

Mitochondria, the powerhouse of the cells as they are involved in ATP generation, storage and supply of ATP according to the need of the cell and they are double-membrane organelles.

- **Kolliker** (1850) first found it in muscle cell and named as ***sarcosomes*.**
- **Altmann** (1886) observed round structures and called them as ***bioblast*.**
- **Flemming** (1897) observed elongated and darkly stain structures and introduced the term ***filia*.**
- **Benda** (1900) coined the term ***mitochondria***

Structure:

- It is double membrane bound cell organelle.
- The outer membrane is smooth and straight. The inner membrane is enfolded into the cavity. These finger-like infoldings are called as cristae.
- Mitochondrial matrix have enzyme for kreb's cycle. Beside these enzymes matrix have a complete protein synthesis apparatus (Ribosome- 70-s, DNA & RNA, enzymes) so mitochondria called as semi-autonomous cell organelle.



A longitudinally cut mitochondrion showing its internal structure

Functions:

- Mitochondria are the sites of cellular respiration, where energy in the form of ATP (Adenosine triphosphate) is formed and they are called as the powerhouses of the cell.

  (i) Mitochondrial matrix- Site of Krebs cycle.

  (ii) Peri- mitochondrial space- Site of link reaction.

  (iii) Oxysomes - Site of ETS.

- Since mitochondria have their own ribosomes and DNA, they can synthesize their own proteins and they are self-duplicating units.
- Mitochondria may store and release calcium when required.

PLASTIDS:

- The term 'plastid' was given by **Haeckel** in 1866.
- They are spherical or discoidal in shape and are enclosed in double membrane.
- They are present only in plant cells. These are absent from the prokaryotes, fungi and animal cells. Plastids are also self – replicating bodies.
- They contain their own DNA, RNA and ribosomes, i.e., they have their own protein synthesizing machinery hence are called semi – autonomous bodies.

Types:

On the basis of the colour, plastid may be of the following types:

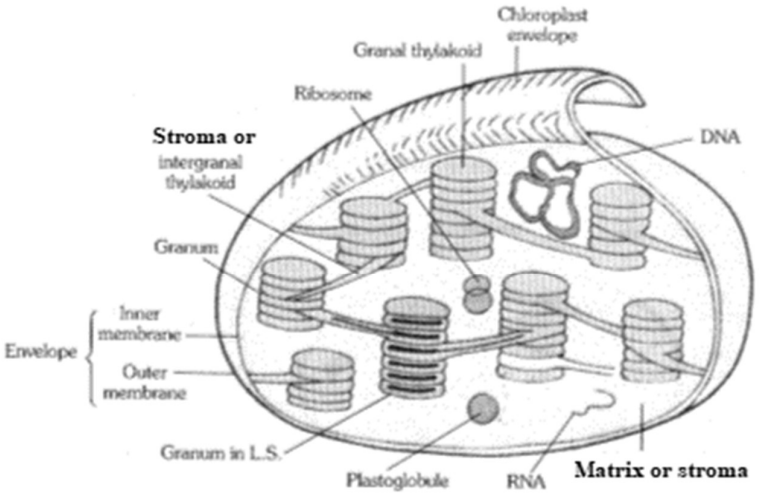
Chloroplasts: Green – coloured, chlorophyll containing plastids.

Leucoplasts: Colourless plastids

Chromoplasts: Contains carotenoids (red, orange and yellow).

CHLOROPLAST – KITCHEN HOUSE OF THE CELL

It is double membrane bound cell organelle and is the largest organelle of the cell.



Schematic 3-dimensional structural diagram of a chloroplast

Grana: It constitutes of the lamellar system.

- These are found in layer on top of each other, these stacks are called as grana.
- Each lamella is made up of unit membrane.
- Each granum of chloroplast is formed by superimposed, closed compartments called thylakoids.
- Different grana are connected with the help of tubular connection, called stroma lamellae or fret channels or inter granum.

  Function: Site of light reaction.

  Stroma: It is a granular transparent substance filled in cavity of chloroplast. It is also called as matrix. Grana are embedded in it.

- It contains enzymes of Calvin cycle or dark reaction. Rubisco is the most abundant enzyme on the earth. It made 16% protein of the chloroplast.

Function: Site of dark reaction.

Functions:

1. Chloroplasts, the green plastids, help in photosynthesis and thus, help in the synthesis of food.
   These are called kitchen rooms of the cell.
2. Chromoplasts are coloured plastids which provide colour to the flowers and the fruits.
3. Leucoplasts help in the storage of food.

RIBOSOMES: UNIVERSAL CELL ORGANELLES

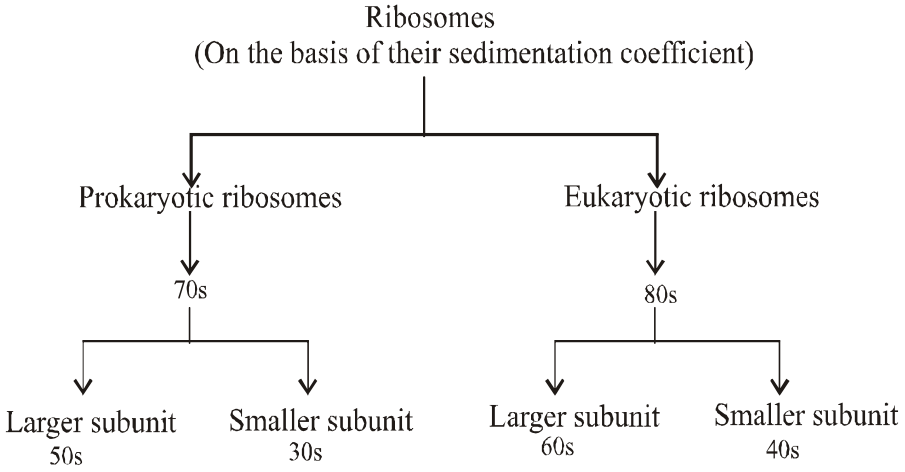
Ribosome (Engine of cell)

Albert Claude (1941) first observed them and called microsome.

Plade (1955) coined the term Ribosome.

- Except mammalian RBC all living cells have Ribosomes. (Both prokaryotes& Eukaryotes).
- These are the smallest and membrane less cell organelles.

Types:

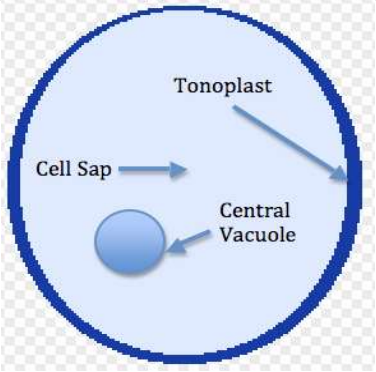


Functions:

- Site of protein synthesis, so these are also called protein factories.
- At the time of protein synthesis, several ribosomes become attached to m-RNA with the help of smaller subunits. This structure is called polyribosome or polysome or ergosome.

VACUOLES: – STORE HOUSE OF THE CELL

- Discovered by **Spallanzani (plants)**
- Vacuoles of animal cells arise from Golgi-complex. It is surrounded by **tonoplast**.
- In animals the vacuoles are smaller in size and larger in number while in plants it is larger in size and fewer in number.
- Vacuoles are **storage sacs for liquid** or **solid contents**.



Vacuoles

Functions:

- These serve for storage.
- Transport of dissolved, secretory or excretory substances.
- Vacuoles help the plant cells to remain turgid.
- They play an important role in growth by helping in the elongation of cells.

PEROXISOMES:

- Discovered by **Rhodin & Tolbert**.
- Peroxisome term was first used by **De Duve**.

In plants peroxisomes occur in cells of green tissues and concerned with photorespiration. (Glycolate pathway). It contains per-oxide forming enzymes.

Functions: -

- β-oxidation of fatty acids.
- Concerned with photorespiration.
- In animal cells peroxisomes concerned with peroxide (H_2O_2) metabolism.

CENTROSOME:

- Discovered by Theodor Boveri named as centrosome.
- Centrosomes are primarily found in animal cells and are typically absent in plant cells. While some specialized plant cells or algae may exhibit structures resembling centrosomes,
- It is situated near the nucleus of the cell and shaped like star. Each centrosome has two centrioles. The two centrioles are placed perpendicular to each other. Centriole consists of 9 triple fibres of tubulin. (9 + 0 arrangement).

Functions:

- In animal cells centrioles play important role in initiation of cell division by arranging spindle fibres between two poles of cell.
- The location of centrioles during cell division decides the plane of division.
- It form the basal granule of cilia and flagella in micro-organisms, zoo-spores& motile gametes.
- The centrosome is also involved in forming the tail of sperm.

THE FUNDAMENTAL UNIT OF LIFE

WORK SHEET LEVEL–I

SINGLE CORRECT ANSWER TYPE QUESTIONS

CELL

1. A cell placed in a hypotonic will
   1) Shrink 2) Show plasmolysis
   3) Swell up 4) No change in shape or size
2. Cell theory was proposed by
   1) Robert Hooke 2) Beadle and Tatum
   3) Schleiden and Schwann 4) Hargobind Khorana
3. The animal cell which does not possess nucleus is
   1) Egg of hen 2) White blood cell
   3) Red blood cell 4) Nerve cell
4. The plant cells are more rigid than the animal cell due to
   1) Cell wall 2) Vacuoles 3) Plastids 4) Both (1) & (2)
5. Centrosome is found in
   1) Cytoplasm 2) Nucleus 3) Chromosomes 4) Nucleolus
6. Human cheek cells are commonly stained with
   1) Methylene blue 2) Safranin 3) Acetocarmine 4) Eosin
7. Root hair absorb water from soil through
   1) Osmosis 2) Active transport 3) Diffusion 4) Endocytosis
8. Most cell membranes are composed principally of
   1) DNA and ATP 2) Protein and lipids
   3) Chitin and starch 4) Nucleotides and amino acids

STRUCTURAL ORGANISATION

9. The bacterial cell wall is composed of
   1) A phospholipid matrix 2) Peptidoglycan
   3) Chitin 4) A polymer of sugars
10. Cell wall is present in
    1) Plant cell 2) Prokaryotic cell 3) Algal cell 4) All of these
11. The cell wall of most fungi is made of
    1) Lignin 2) Suberin 3) Chitin 4) Pectin
12. The undefined nuclear region of prokaryotes is also known as
    1) Nucleus 2) Nucleolus 3) Nucleic acid 4) Nucleoid

CELL ORGANELLES

13. Kitchen of the cell is
    1) Mitochondria 2) Endoplasmic reticulum
    3) Chloroplast 4) Golgi apparatus

14. Which cell organelle plays a crucial role in detoxifying many poisons and drugs in a cell?
1) Golgi apparatus 2) Lysosomes
3) Smooth endoplasmic reticulum 4) Vacuoles

15. Which of the following are functions of ribosome?
(i) It helps in manufacture of protein molecules.
(ii) It helps in manufacture of enzymes.
(iii) It helps in manufacture of lipids.
(iv) It helps in manufacture of starch molecules.
(1) (i) and (ii) 2) (ii) and (iii) 3) (iii) and (iv) 4) (i) and (iv)

16. The rough ER is no named because it has an abundance of
1) Mitochondria 2) Lysosomes 3) Golgi bodies 4) Ribosomes

17. Mitochondria was first seen by
1) Benda 2) Kolliker 3) Schwann 4) R.G. Harrison

18. Aerobic respiration is performed by
1) Glyoxysomes 2) Mitochondria 3) Lysosomes 4) Chloroplasts

19. Besides nucleus, DNA is also present in
1) Ribosomes 2) Mitochondria 3) Lysosomes 4) Golgi complex

20. If the ribosomes of a cell are destroyed then
1) Respiration will not take place 2) Fats will not be stored
3) Carbon assimilation will not occur 4) Proteins will not be formed

21. The inner membrane of mitochondria is folded because
1) It has no space inside. 2) It helps in transportation of material.
3) It increases the surface area. 4) It stores more food.

LEVEL–II

CELL

22. Animal cells do not show plasmolysis because
1) They do not exhibit osmosis. 2) They do not possess cell wall.
3) They are living cells. 4) They have intercellular spaces.

23. Main difference between animal cell and plant cell is
1) Nutrition 2) Growth 3) Movement 4) Respiration

24. Cells are first focused in microscope under
1) 40 X 2) 10 X 3) 100 X 4) Any of these

25. A mature plant cell has
1) Protoplasm and vacuole 2) Vacuole and cell wall
3) Cell wall and protoplasm 4) Protoplasm, cell wall and vacuole

26. The part of the cell responsible for maintaining cell shape, internal organization and cell movement is the
1) Vesicle 2) Nucleus
3) Endoplasmic reticulum 4) Cytoskeleton

27. The largest cell in the human body is
1) Nerve cell 2) Muscle cell 3) Liver cell 4) Kidney cell

STRUCTURAL ORGANISATION

28. The structure of the nuclear membrane facilitates
1) Organization of spindle
2) Nucleo – cytoplasmic exchange of materials
3) Anaphasic separation of daughter chromosomes
4) Synapsis of chromosomes

29. Find out the incorrect statement.
1) The movement of water across a semi-permeable membrane is affected by the amount of substances dissolved in it.
2) Membranes are made of organic molecules like proteins and lipids.
3) Molecules soluble in organic solvents can easily pass through the membrane.
4) Plasma membranes contain chitin sugar in plants.

30. A student put five raisins each in two beakers A and B. Beaker A contained 50 mL of distilled water and beaker B had 50 mL of saturated sugar solution. After some time, the student would observe that
1) Raisins in beaker A were more swollen than those in beaker B.
2) Raisins in beaker B were more swollen than those in beaker A.
3) Raisins in both beakers A and B were equally swollen.
4) Raisins in beaker A did not swell up at all.

31. Find out the correct sentence.
1) Enzymes packed in lysosomes are made through RER (rough endoplasmic reticulum).
2) Rough endoplasmic reticulum and smooth endoplasmic reticulum produce lipid and protein respectively.
3) Endoplasmic reticulum is related with the destruction of plasma membrane.
4) Nucleoid is present inside the nucleoplasm of eukaryotic nucleus.

32. Cell wall of which one of these is not made up of cellulose.
1) Bacteria 2) Hydrilla 3) Mango tree 4) Cactus

33. Which of the following statements regarding viruses is incorrect?
1) They are non – cellular structures.
2) They do not show characteristics of life until they enter a living body.
3) They cannot be crystallized.
4) All of the above

CELL ORGANELLES

34. Within chloroplasts, light is captured by
    1) Thylakoids within grana 2) Grana within cisternae
    3) Cisternae within grana 4) Grana within thylakoids
35. Find out the false statement.
    1) Nucleus, plastids and mitochondria contain DNA and hence are able to make their own structural proteins.
    2) Mitochondria are said to be the 'powerhouse' of the cell.
    3) Lysosomes are chlorophyll containing bags surrounded by a single unit membrane.
    4) Ribosomes are also called Palade particles and are the 'protein factories' of the cell.
36. The transportation of materials in the cell is by
    1) Golgi complex 2) lysosomes
    3) Mitochondria 4) Endoplasmic reticulum
37. Ribosomes are found
    1) Only in the nucleus 2) In the cytoplasm
    3) Only in eukaryotic cells 4) Both (2) and (3)