INDEX

CHAPTER 1

The Fundamental Unit of Life

INTRODUCTION

Our Earth is inhabited by millions of different kinds of living organisms. These living organisms are bacteria, fungi, plants and animals. Although the great diversity of organisms look very different from each other but all these organisms exhibit a unique similarity in their organization. Can you guess the structure, which is common to all these organisms? Yes, it is the cell. The bodies of all living organisms are made up of microscopic units called cells. Each of us has about 50 million cells-an enormous number which is difficult to imagine.

Thus, cell is the basic structural and functional unit of living organisms. **Cell Biology** is the study of cells in all aspects of structure and function.

DISCOVERY OF THE CELL

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 "Honey comb" like structures. He named the box-like compartments as **cellulae** or **cells**. The term "cell" is derived from a Latin word *cella* which 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".

In 1838, two biologists, *J.M Schleiden and T.Schwann* proposed the **"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".

Cells 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.

Virus is an exception to cell theory.

CELL SHAPE, SIZE, AND NUMBER

Look at the structure of onion peel cells. *Do all cells look alike in shape and size*? Yes, all cells are of same shape and almost of same size.

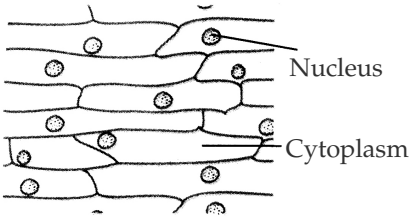


Fig. Onion peel cells

Let's have a look at cells from the different parts of plant body. *Now Are all cells the same*? No, they are not.

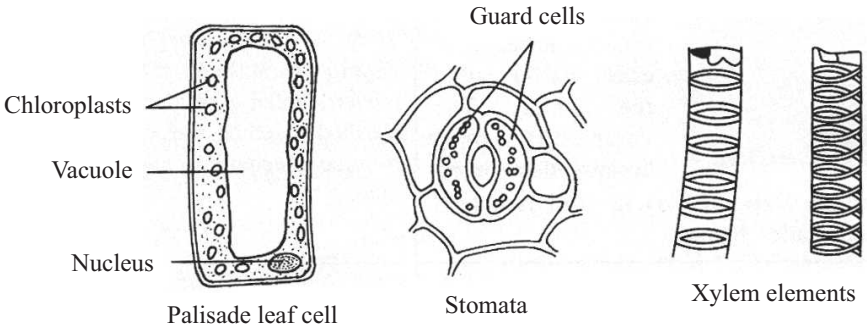


Fig. Different shapes of plant cells

Now if we look at the cells from different parts of human body. They too don't look alike in shape and size. As you can see, the cells are different in shapes and size.

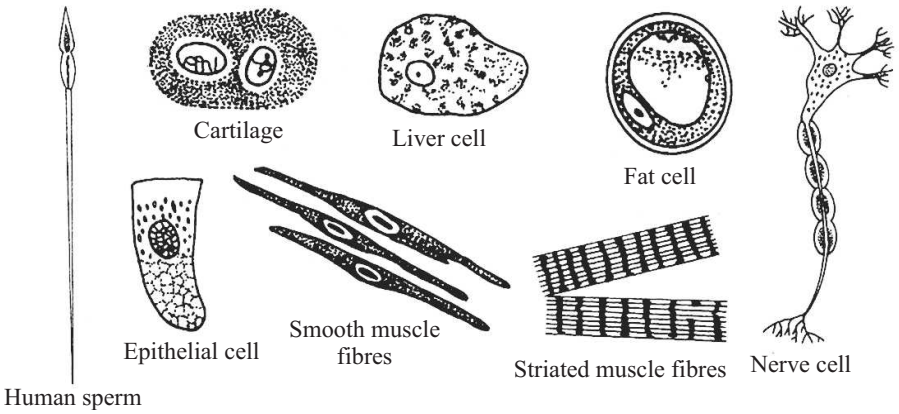


Fig. Different shapes of animals cells

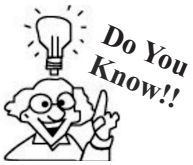
Plant cells are different from animal cells. Plant cells in a root are different to those in the stem or in the leaf. Animal cells, including cells in our bodies are all sorts of different shapes and sizes. It means cells vary in number, shape and size in different organisms and also in different parts of same organism.

Infact, the shape and size of cells are related to the function they perform. For example, in plants, xylem and phloem are elongated in shape and help in conduction of water and food. Similarly, in animals, nerve cells are long and branched that help in conduction of information from one part of body to another.

Cell Size

The size of the cell ranges between broad limits. Some cells are extremely small and can be seen only when magnified and is visible only with a microscope since, they are only a few micrometres in diameter. Cells are limited in size by the ratio between their outer surface area and their volume. Small cells have more surface area for their volume of cytoplasm than large cells. As cell grows, the amount of surface area becomes too small to allow materials to enter and leave the cell quickly enough.

Cell size is also limited by the amount of cytoplasmic activity that the cell's nucleus can control.

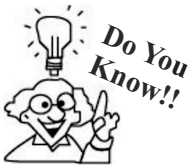


The smallest cell found is a mycoplasma cell, which is about 0.1 micron in diameter.

The longest cells are the nerve cells, measuring about a metre in length.

The largest cells are represented by eggs of Ostrich, which is about 170-135 mm.

Actually the size of the animal is dependent on the number of cells and not the size of the cells. The cell size remains constant for a particular cell and is independent of the size of the organism. The large size of the elephant is due to the larger number of cells present in its body.



Cells are measured in micrometres. A micrometer is one thousandth of a millimetre.

CHECK Point

☛ **Why cells are small in size?**

SOLUTION

Cells are small in size because -

(i) The cells nucleus can only control a certain amount of active cytoplasm.

(ii) Also, the cells are limited in size because of their surface area to volume ratio.

A group of small cells has a relatively larger surface area than a single large cell of same volume. A cell requires nutrients, oxygen and other materials for its survival. So, as cells grow larger at some point, its surface area becomes too small to allow these materials to enter the cell quickly enough to meet the cell's need. Thus, as cell increases in size, its surface to volume ratio decreases that causes the cell to function less efficiently.

Cell Shape

The shape of the cells is more variable than their size. The shape of the cell may be spherical, oval, elliptical, spindle shaped, polygonal or flat-plate like. The shape of the cell is determined by the specific function of the cell.

Some of the cells like *Amoeba* and white blood cells can change their shape while most of the plant cells and animal cells have almost fixed shapes.

Among unicellular organisms, for example, in *Amoeba*, the shape of the cell (body) is irregular, while among multi-cellular organisms like in plants, the xylem and phloem elements are elongated tubular structures so as to help in conduction of water and minerals; the dividing Meristematic cells are isodiametric in shape.

Similarly in animal cells, the nerve cells are elongated thread like which enables an efficient communication system, the muscle cells are elongated and contractile that helps in the movement of bones, while the red blood cells are biconcave shaped. This kind of shape of RBCs helps the RBCs to easily move through capillaries and thus permit gaseous exchange.

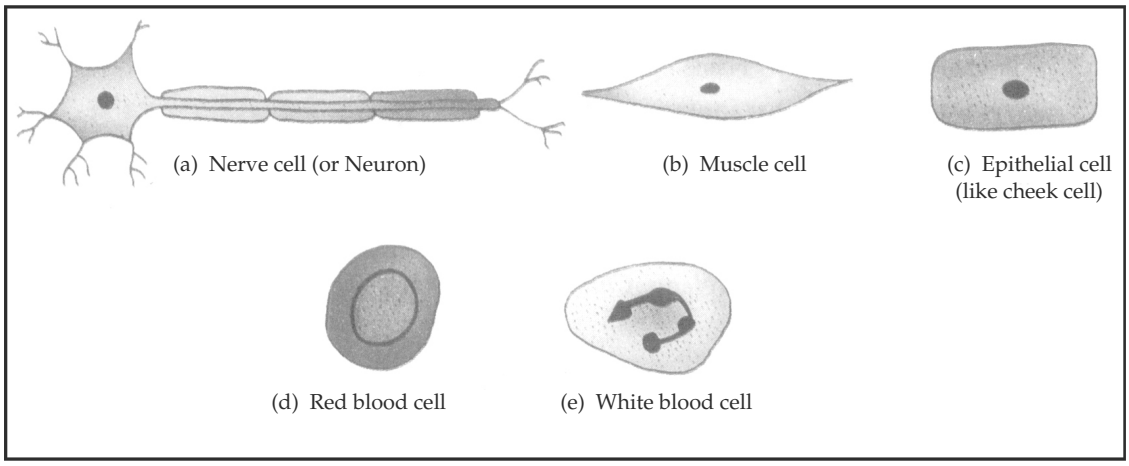


Fig. Some of the examples of animal cells

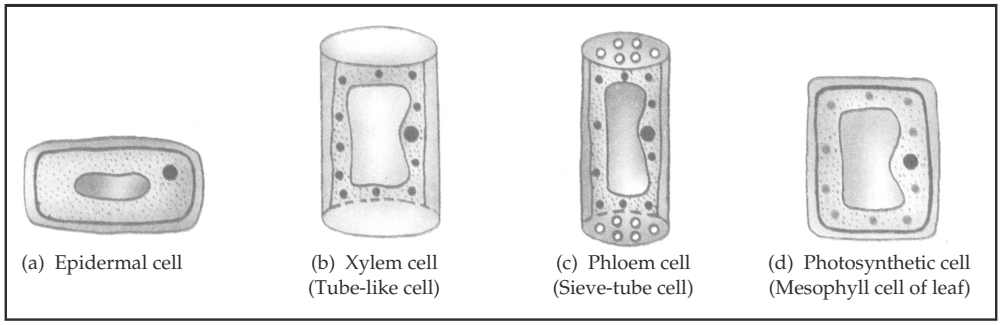


Fig. Some of the examples of plant cells

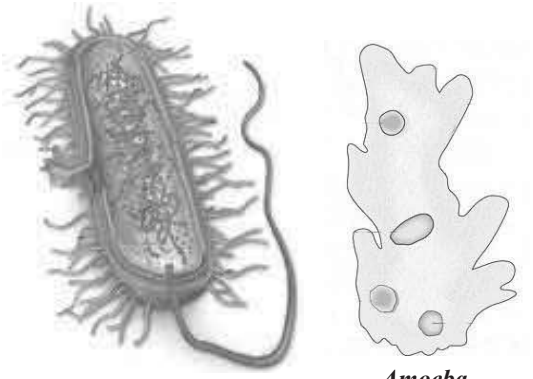
Cell Volume

The volume of a cell is constant for a particular cell type. It is independent of the size of the organism. For example, the kidney or pancreatic cells are about of same size as in dog or cat. The difference in total mass of the organism or organ depends on the number, not on the volume of the cells.

Cell Number

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

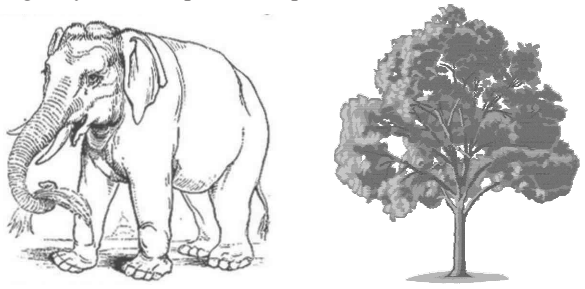
(i) **Unicellular organisms (Single-celled organisms):** The organisms made up of single cells are called unicellular organisms. *Amoeba*, *Paramecium*, bacteria etc are examples of unicellular organisms. The single cells have the ability to perform all the life processes like digestion, respiration, excretion, growth and reproduction. In these cells, there is no division of labour as the single cells have to perform all the activities.



Bacteria ***Amoeba***

Fig. Unicellular organisms

(ii) **Multi-cellular organisms (Multi-celled organisms):** The organisms made up of a number of cells are called multi-cellular organisms. Fungi, plants and animals are example of 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.



Elephant **A Tree**

Fig. Multicellular organisms

The increasing order of complexity in multicellular organisms is:

Cell → Tissue → Organ→ Organ System → organism

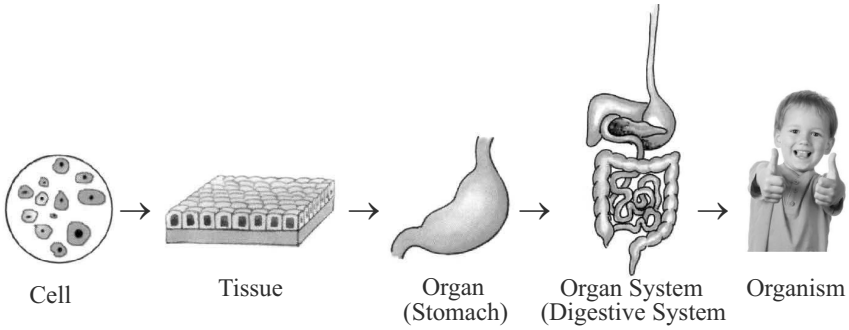
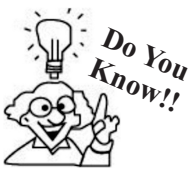


Fig. Levels of organization



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.

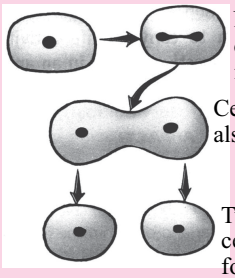
Let us summarize difference between unicellular and multi-cellular organisms.

Sl.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 multi-cellular organism is long.
4.	*Examples* include *Amoeba*, Paramecium, bacteria *etc*.	*Examples* include Fungi, Plants, and Animals.

Knowledge ENHANCER

How cell increases its number? The cells in a living body increase their number by constant cell division. Cell division is a process where cell divides into two new cells. All the living cells grow bigger in size after digesting food. However, it grows upto a certain maximum size. After growing to its maximum size, the 'parent cell' divides to form two similar and smaller cells called "daughter cells". These daughter cells are identical to parent cell, but are smaller in size. Hence, with time, it grows to its maximum size and then divide to produce more and more cells. The main factor that is responsible for the growth of a small plant into a big tree is continuous cell division. For example, a young tree grows into a big tree due to large increase in its number of cells brought about by constant cell division. Similary in humans, a baby grows into an adult man/ woman by continuous cell division.

But, do all cells grow and divide throughout life? No, not all cells in our body grow and divide throughout life. There are some cells that do not grow in number after a certain age. For example, the cells in the skin of our body grow and divide throughout life, but brain cells do not grow in number after a certain age, that is, after 18 years. Then when do cells die? Cells have a fixed lifespan and are replaced automatically as they die off. The more active the cells the shorter the time it will live.



Below is the list of the lifespan of certain cells :

- *Skin cells live for 19 days*
- *Eyelashes live for 3-4 months*
- *Liver cells live for 2-4 years*
- *Sperms live for 2 months*
- *RBCs live for 4 months*
- *Bone cells live for 15-25 years*

Each cell is an amazing world into itself. It can take in nutrients, convert them into energy, carry out specialized function and reproduce as necessary. Even more amazing is that each cell stores its own set of instructions for carrying out each of its activities.

Cells are of two types :

(i) Plant Cell (ii) Animal Cell

Though many things are common between animal and plants cell but they differ in some way.

Animal cell differ from plant cells in terms of structure and types of organelles.

IN THE LAB

Let us perform an experiment to study plant and animal cells with a microscope.

Part A : Plant cells (Onion skin mount)

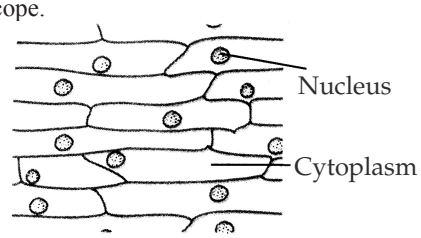
Procedure :

(i) Take an onion piece and peel the delicate transparent tissue from its inner surface using forceps.

(ii) Place this tissue, unwrinkled in a small drop of water on a glass slide.

(iii) Then add a small drop of Safranine stain to the tissue and cover it with a cover slip. While placing the coverslip ensure that there is no air bubbles under the coverslip.

(iv) Now observe the slide under a microscope.



Observation : You will see several small rectangular shaped cells. The boundary of each cell is covered by a cell nembrane which in turn is covered by another thick covering called the **cell wall**. In the center of cell, there is a dense round body called the **nucleus**. In between the nucleus and the cell membrane, there is a jelly like substance called **cytoplasm**.

Part B : Animal cells (Cheek cells)

Procedure :

(i) Take a clean glass slide and place a drop of water on it.

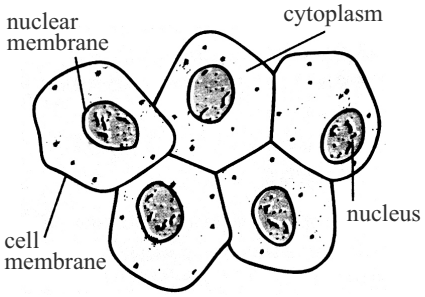
(ii) Gently scrap the inside of your cheek with the blunt end of a clean toothpick.

(iii) Then stir the material on the toothpick in the drop of water on the slide.

(iv) Add a small drop of methylene blue stain on the slide.

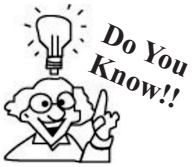
(v) Now carefully place a coverslip over the slide and observe the slide under microscope.

Observation : You can see large number of irregular shaped cells with a thin cell membrane. Cell wall is absent in animal cells. In the center of cell, **nucleus** is present. It is stained dark blue.

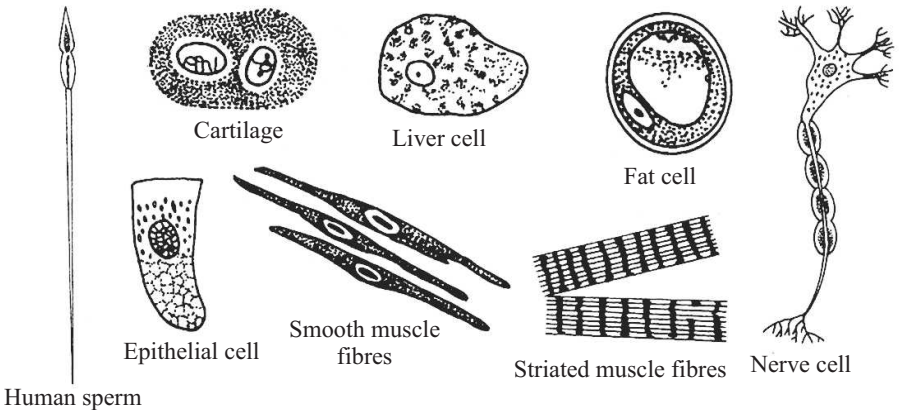


STRUCTURAL ORGANISATION OF A CELL

A cell is the basic unit of life. It performs all basic life functions like intake of food, excretion, metabolism, respiration, growth and reproduction. However, there is no mixing up of different functions. Infact, there is a division of labour. For this, a cell usually possesses a number of components called cell organelles. Each cell organelle performs specific functions. Hence, a cell may be defined as a unit of protoplasm, bounded by a cell membrane or plasma membrane.



Protoplasm is the life giving substance and includes cytoplasm and nucleus. Cytoplasm, on other hand, contains organelles such as mitochondria, endoplasmic reticulum, golgi bodies, lysosomes, vacuoles, plastids and ribosomes.



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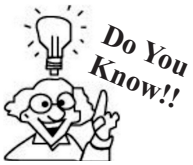

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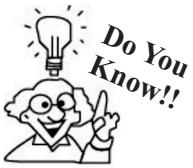

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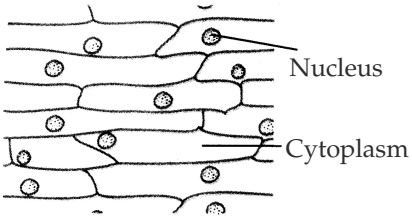

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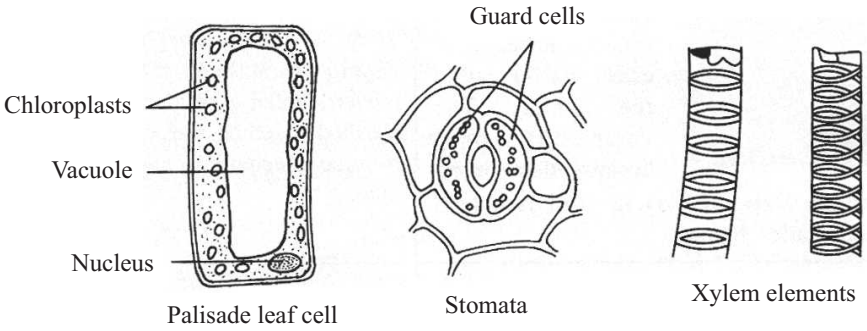


Fig. Different shapes of plant cells

Now if we look at the cells from different parts of human body. They too don't look alike in shape and size. As you can see, the cells are different in shapes and size.

(i) **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_2 and O_2 across the membrane. The gases like CO_2 and O_2 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.

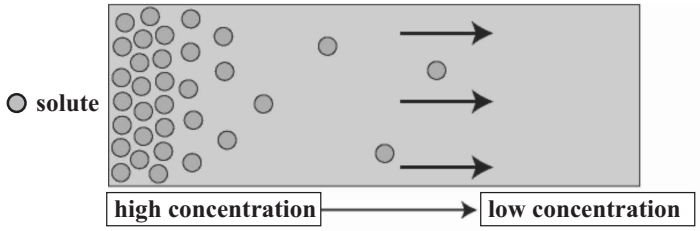


Fig. Diffusion

ACTIVITY !!

Let us perform an activity to understand the process of diffusion.

Take a glass beaker half filled with clean water. Put a few drops of coloured ink, say blue colour, into the beaker. *What did you observe?*

You would find that blue coloured ink slowly diffuses into the water until the ink molecules get uniformly distributed.

This spontaneous movement of a substance from a region of higher concentration to the region of lower concentration is known as **diffusion**.

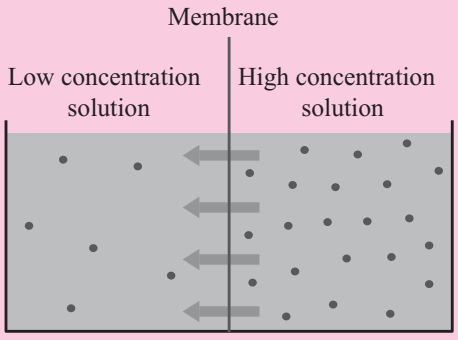


Fig. Diffusion

(ii) **Osmosis :** It is defined as the diffusion of water from region of higher concentration to region of lower concentration across the semi-permeable membrane. This kind of movement is along concentration gradient. There is no expenditure of energy.

For example : Movement of water across selectively permeable membrane.

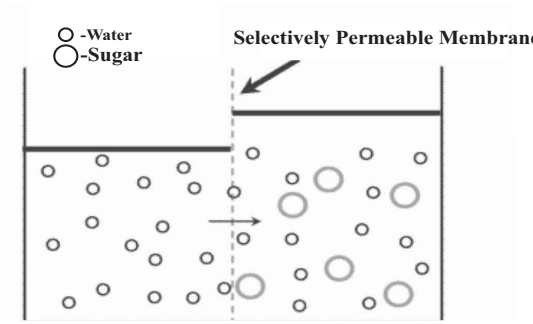


Fig. Osmosis

Table : 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 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:

(i) Endosmosis : Endosmosis is the osmotic entry of water into the cell.

(ii) 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.

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

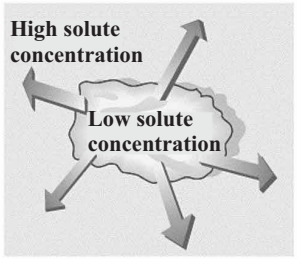


Fig. Hypertonic solution

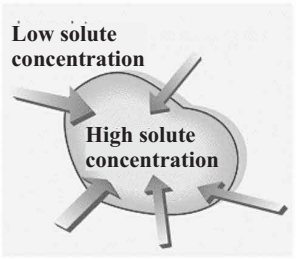


Fig. Hypotonic solution

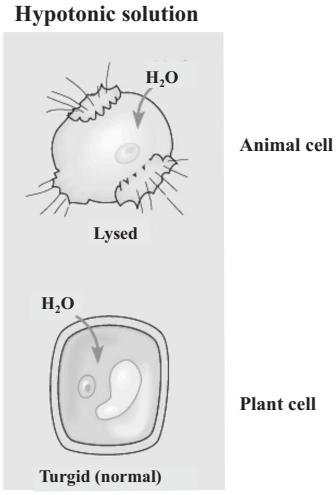
(ii) Hypertonic solution (Hyper=more or higher) : Hypertonic is the solution that has higher water concentration than the cell.

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

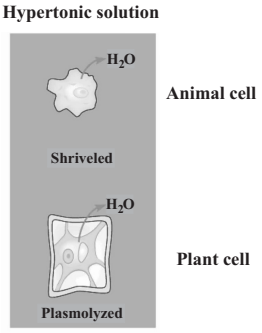
IN THE LAB

Let us perform an activity to understand the three types of solution and the process of osmosis.

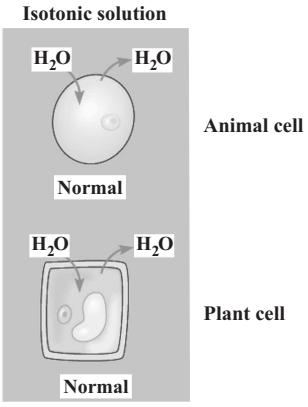
(i) *Take an animal or a plant cell. Place it in a medium that has higher water concentration than the cell. What will happen? The cell will gain water by endosmosis. Such type of solution is known as* **hypotonic solution**. Since, water molecules are free to pass across the cell membrane in both directions, so when cell is placed in a hypotonic solution; more water will come into the cell than it leaves. As a result, the cell is likely to swell up. As water keeps on moving inside cell, the animal cells burst while the plant cells become turgid but do not burst due to the presence of cell wall.



(ii) *Now place the plant and animal cell in a medium that has lower water concentration. What will happen?* The cell will lose water by exosmosis. Such a solution is known as **hypertonic solution**. Since, water molecules are free to pass across the membrane, so when cell is placed in hypertonic solution, the cell will lose water. As a result the cell will shrink. In plant cell, the shrinking protoplasm will contract from cell wall and the process is known as **plasmolysis** while in animal cell; the whole cell shrinks on all sides to give a wrinkled appearance. This process is known as **crenation**.



(iii) *What will happen, if the cell is placed in a medium that has same water concentration as that of cell?* There will be no net movement of water across the membrane. Such a solution is known as **isotonic solution**. In isotonic solution, the amount of water going into and out of cell is same. Hence, there is no movement of water and the size of cell remains the same.



Knowledge ENHANCER

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.

idea box

Take few dry raisins in a Petri dish having plain water. Leave it for 30 minutes and record your observation.

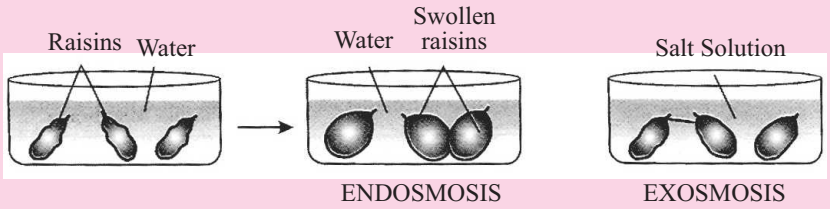


Fig. Dried raisins placed in water

Observation : You would observe that raisins swell up due to endosmosis.

Now place the swollen raisins in concentrated sugar or salt solution and leave it for 30 minutes. Record your observation.

Observation : The raisins shrink in previous form due to exosmosis.

(B) 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.

CHECK Point

☛ **1. Why does the skin of your fingers shrink when you wash clothes for a long time?**

2. Classify the following as osmosis or diffusion.

(i) Swelling up of raisins on keeping in water.

(ii) Spreading of virus on sneezing.

(iii) Fish using oxygen dissolved in water during respiration.

(iv) Absorption of water by the roots from the soil

SOLUTION

1. Clothes are washed with soap or detergent solution. The solution is hypertonic as compared to osmotic concentration of our skin cells. The detergent solution, therefore, causes exosmosis in the skin cells. Hence, the skin over the finger shrinks while washing clothes for a long time.
2. (i) Osmosis, (ii) Diffusion, (iii) Diffusion, (iv) Osmosis

II. Cell Wall

Cell wall is a rigid, non-living covering present outside the plasma membrane in plant cells. Animal cells lack a cell wall.

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.

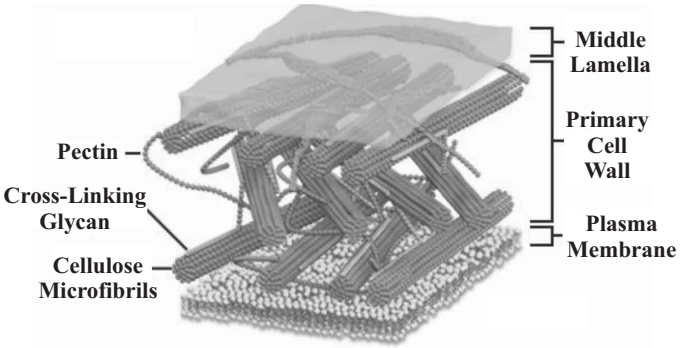


Fig. Structure of Cell Wall

Table : Difference between Cell wall and Cell membrane

Sl. No.	Cell Wall	Cell Membrane
1.	It is found only in plant cells.	It is found in both plant and animal cells.
2.	It is outermost layer of the plant cell.	It lies on the outside of animal cell and inner to the cell wall in plant cell.
3.	It is thick and rigid.	It is thin and flexible
4.	It is permeable.	It is selectively permeable.
5.	It is formed of cellulose and pectin.	It is formed of lipids and proteins.
6.	It provides protection and strength to the cell.	It acts as mechanical barrier and regulates the movement of molecules in and out of cells.

Functions of Cell Wall:

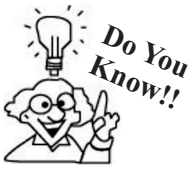
1. It gives definite shape to the cells.
2. It provides mechanical strength to plants.
3. It protects the cell against mechanical injury and pathogens.
4. It helps in transport of various substances across it.
5. Cell wall helps the plant cells to withstand a lot of variations in the surrounding environment.
6. Cell wall prevents the bursting of cell on endosmosis as it is quite thick and rigid.

CHECK Point

☛ **Why cell wall is present only in plant cell?**

SOLUTION

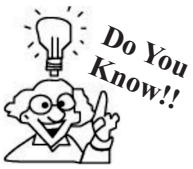
Plants grow tall, towards the sun's light. So, in order to provide strength and necessary support, the plants have cell wall and is present only in plant cell.



If an animal's body were made of plant cells, the animals would be very stiff and unable to move easily.

III. Nucleus

Nucleus is the prominent, spherical structure found at the center of the cell. It is the largest organelle present in cell. Basically, nucleus is the controlling centre of all cell activities and hence, it has been described as the **brain of the cell.**
In *plant cell,* nucleus lies towards the periphery due to the presence of large central vacuole while in *animal cell*, nucleus lies in the central position.



Nucleus was discovered by an English biologist, Robert Brown in 1831.

Structure of Nucleus : It is made up of following parts :

(i) Nuclear envelope: It is the double membranous structure that separates the nucleus from the cytoplasm. It is mainly made up of proteins and lipids. The membrane is perforated by several nuclear pores, which allows exchange of materials between the nucleus and cytoplasm.

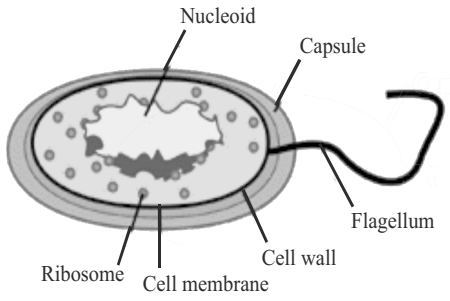
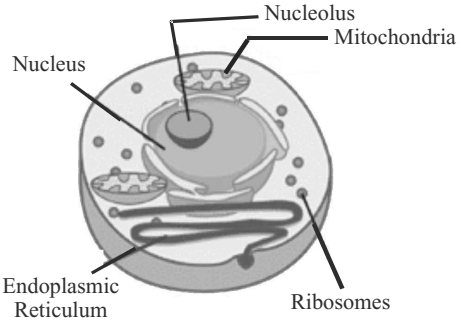
On the basis of presence or absence of nuclear membrane, organisms are divided into two types:

(a) Prokaryotes (Pro = Primitive, karyotes = nucleus) : Organism whose cells do not possess a well formed nucleus are known as prokaryotes. *Examples*, Bacteria, Cyanobacteria, etc. Prokaryotes also lack membrane bound cell organelles. Thus, cell organelles like mitochondria, golgi bodies, ER are absent in prokaryotes.

(b) Eukaryotes (Eu= True, karyotes = nucleus) : Organisms whose cells possess a nuclear membrane are known as eukaryotes. Cell organelles like mitochondria, golgi bodies, ER are present in eukaryotes.

Examples, Plants and animals.

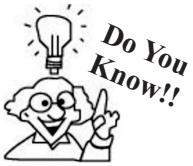
Table : Difference between Prokaryotes and Eukaryotes

Sl. No.	Prokaryotes	Eukaryotes
1.	An organized nucleus is absent. Hereditary material lies free in cytoplasm and is known as nucleoid. Nuclear membrane is absent.	A well organized nucleus is present. It contains hereditary material covered by a nuclear membrane.
2.	A single chromosome is present and is represented by a single circular DNA only.	Numbers of rod-like chromosomes, with two or several DNA molecules are present.
3.	Membrane bound cell organelles are absent.	Membrane bound cell organelles are present.
4.	No compartments are found in prokaryotes.	Distinct compartments in the cell i.e. the cytoplasm and the nucleus is present in eukaryotes.
5.	Example includes Bacteria and Cyanobacteria.	Example includes Plants, Animals, and Fungi
		

Think It Over!! *Compare, which cells are more complex? Circle you answer*
(i) Prokaryotic (ii) Eukaryotic

(ii) Nucleoplasm (Nuclear sap) : It is colourless cytoplasm within nuclear membrane in which chromatin and nucleoli are suspended.

(iii) Nucleolus : It is dense, spherical granular structure found inside the nucleus. Nucleolus is not bounded by a membrane. It is membraneless. It is rich in proteins and RNA. Basically, Nucleolus is the site of ribosome formation. Ribosome, in turn helps in protein synthesis in the cytoplasm.



Nucleolus is known as the factory of ribosomes.

(iv) Chromatin Network : Chromatin is a network of fine thread like coiled filaments uniformly distributed in the nucleoplasm. It is usually made of DNA and protein. During cell division, chromatin become highly condensed, thick and rod like structures known as **chromosomes**.

The chromosome contains genes, which are composed of DNA. A gene is the functional unit of a chromosome. These are arranged in a single linear order along the chromosome. One gene is responsible for single characteristic or a single characteristic may be transmitted by a set of genes. Genes are responsible for storing and transmitting hereditary characteristics from one generation to another.

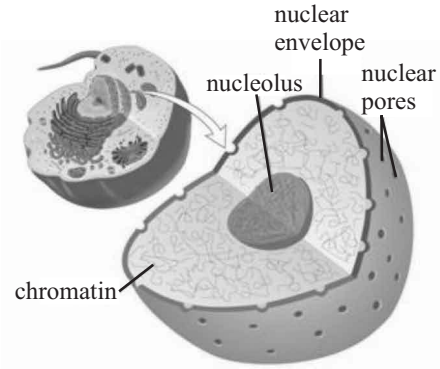


Fig. Structure of Nucleus

Functions of Nucleus:

(i) Nucleus is the chief controlling center of cell. It contains chromosomes which carry genes. Genes are responsible for transmission of hereditary characters from parents to offspring.

(ii) Nucleus controls all metabolic activities taking place in the cell.

(iii) It participates directly in cell division to produce genetically identical daughter cell by a process known as **mitosis**.

CHECK Point

☛ **1. Do all cells contain a well defined nucleus structure?**

2. Give an example of a human cell which lack nucleus?

SOLUTION

1. No. Not all cells contain a well-defined nucleus. The nucleus of bacterial cell is not well organised like the cells of multi-cellular organisms. They do not have nuclear membrane. Such type of cells are known as prokaryotic cells. On the other hand, the cells that have well-organised nucleus with a nuclear membrane are called eukaryotic cell.
2. Red blood cells. The red blood cells of humans lose their nuclei, which enables them to carry more haemoglobin and thereby more oxygen.

Knowledge ENHANCER

CHROMOSOMES

Chromosome is a rod like or thread like structure that are formed by condensation of chromatin fibers during cell division. A chromosome consists of two similar thread called chromatids. The two chromatids are attached to one another at a point called centromere. The two parts on either side of a centromere are known as arms.

Function : Chromosomes carry and help transfer of information for inheritance of characters from parents to offspring.

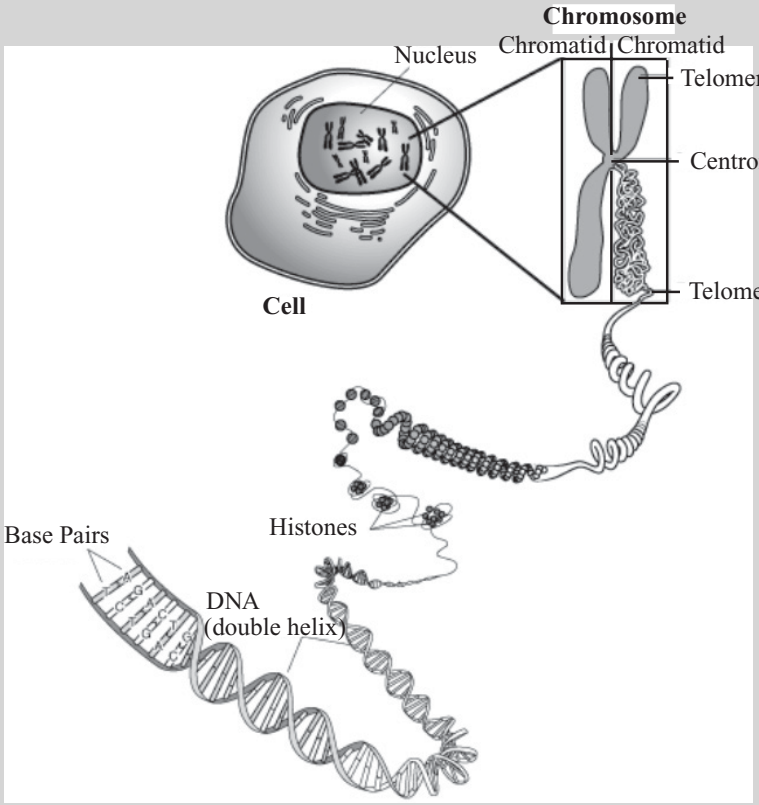


Fig. Structure of Chromosome

*The number of chromosomes is fixed in an organism. In most organisms, chromosome occurs in homologous pairs. In each pair, one chromosome comes from father and other belongs to mother parent. The presence of two sets of chromosomes is called **diploid** or **2N**. For example, Humans have 46 or 23 pairs of chromosomes. Similarly, there are 20 or 10 pairs of chromosomes in Maize.*

*The presence of only a single set of chromosome in gametes of diploid organisms is known as **haploid** or **N**. During cell division, chromosomes divide in a manner that the daughter cells receive identical amount of hereditary material.*

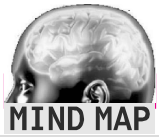
CHECK Point

☛ **1. How are chromatin, chromatid and chromosomes related to each other?**

2. Why DNA is called "the blueprint of life"?

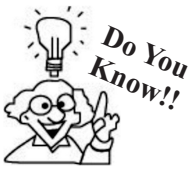
SOLUTION

1. Chromatin is interwined mass of fine thread like structure made of DNA and protein. During the division of a cell, chromatin condenses to form thicker rod like structures called *chromosomes*. Each chromosome consists of two similar halves called *chromatids*. The formation of chromosomes having two chromatids is meant for equal distribution of chromatin, which is a hereditary material.
2. In the center of all plant and animal cell, there is a copy of organism's genetic material, called DNA or deoxyribonucleic acid. This DNA carries a complete blue print of the organism that transfers characteristics from one generation to the next. Our DNA comes from our parents and their DNA comes from their parents too. That is why relatives have similar DNA to each other.



Genes $\xrightarrow{\text{Make}}$ Proteins $\xrightarrow{\text{Make}}$ cells $\xrightarrow{\text{Make}}$ Body

Genes $\xrightarrow{\text{on}}$ DNA $\xrightarrow{\text{in}}$ Chromosomes $\xrightarrow{\text{in}}$ Nucleus $\xrightarrow{\text{in}}$ Cell $\xrightarrow{\text{in}}$ Body



We inherit our genetic material through DNA from our parents-half from our father and half from our mother. That is why, we often look like our parents.
The cells of all living organism contain DNA, which is made up of four chemicals
1. Adenine (A), 2. Guanine (G) 3. Cytosine (C), 4. Thymine (T)

IV. Cytoplasm

Cytoplasm occupies the major part of the cell. It is a living component of cell, consisting of transparent, semi-fluid granular substance. It is limited on the outside by the cell membrane. Water is the main component of the cytoplasm.

Cytoplasm has two major parts:

(i) **Cytosol:** Cytosol is the fluid part of cytoplasm. It is viscous, and contains a number of substances like water, ions, enzymes, vitamins, carbohydrates, lipids and proteins. All major biochemical reactions take place in the cytoplasm.

(ii) **Cell organelles:** Cell organelles are tiny, sub-microscopic structures that are specialized to perform specific functions. These organelles are bounded by a membrane to keep their contents separate from the external environment. These organelles include Mitochondria, Endoplasmic reticulum, Golgi bodies, Plastids, Lysosomes, Peroxisomes, Ribosomes and Centrosomes.

Knowledge ENHANCER

On the basis of membranous covering, cell organelles are divided into three types:

(i) Membrane less organelles- *Example: Ribosomes.*

(ii) Single membrane bound organelles- *Examples: Endoplasmic reticulum, Golgi bodies, Lysosomes, Vacuoles.*

(iii) Double membrane bound organelles- *Examples: Mitochondria and plastids.*

Let's discuss each of these organelles one by one in detail.

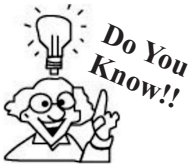
1. Mitochondria (Singular-Mitochondrion):

Mitochondria are rod shaped cell organelles surrounded by a double membrane. The outer membrane is smooth and porous while the inner membrane is folded into large number of finger like structures called cristae. *Cristae* increase the surface area of the inner membrane, which provides more surface area for the metabolic reactions to take place. The fluid inside the mitochondria is called the *matrix*.

Mitochondria are commonly known as *"Powerhouse of the cell"*. They contain enzymes necessary for the total oxidation of food and for the release of large amount of energy in the form of ATP molecules. The energy stored in this ATP is used for synthesis of new products and other metabolic process.

Flow chart that describes the fate of glucose in the release of energy :

In cytoplasm, glucose enters cells (containing 6 atoms of carbon)	Broken into two Pyruvic acid molecules (containing 3 atoms of carbon)	In mitochondria oxidised into CO_2, H_2O and ATP



***ATP** = Adenosine Triphosphate. ATP is known as energy currency of the cell. It is a common cellular fuel that drives many energy-requiring processes of the cell.*

Mitochondria have the ability to make their own protein, as they contain their own DNA and ribosome. That is why; mitochondrion is also known as *semi-autonomous organelle*.

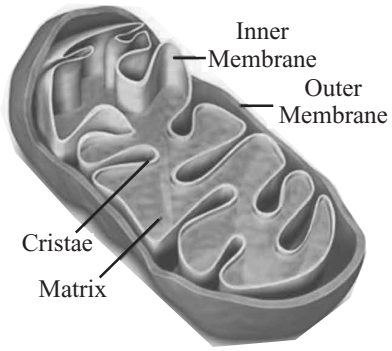


Fig. Structure of Mitochondrion

Functions of Mitochondria:

(i) Mitochondria are the site of cellular respiration. They use molecular oxygen from air to oxidize the carbohydrates and fats present in the cell to carbon dioxide and water vapour.

Glucose + Oxygen → Carbon dioxide + Water + Energy (ATP)

(ii) Mitochondria provide energy in the form of ATP for various metabolic activities of living cells. Since, the mitochondria synthesize ATP, it is also known as power house of cell.

2. Plastids :

Plastids are found only in plant cells. They are absent in animal cells.

On the basis of pigments present in them, plastids are of following three types:

(i) Leucoplasts : Leucoplasts are colourless plastids. They are found in storage cells of roots, seeds and underground stems. They take part in storage of food.

Leucoplasts are of three types depending on the storage products :

Amyloplasts stores starch, *Aleuroplasts* stores protein while *elaioplasts* store oil and fat.

(ii) Chromoplasts : They are coloured plastids. The colour varies from red, orange, yellow etc due to the presence of carotenoids. They are mostly found in flowers and fruits. They provide colouration to organs for attracting pollinators.

(iii) Chloroplasts : Chloroplasts are green colour plastids, found in leaves. The green colour is due to the presence of chlorophyll. Chlorophyll traps the solar energy which is used for manufacturing food. They are the sites of photosynthesis. So, chloroplasts are the "*Kitchen of the cells*".

Structure of chloroplasts: A chloroplast is bounded by two membranes i.e. outer membrane and inner membrane. The inside of chloroplast is clearly marked into a colourless ground matrix called ***stroma***.

(i) **Stroma** is homogenous matrix in which grana is embedded. Stroma contains a variety of photosynthetic enzymes, DNA and ribosomes. It is the site where all chemical reactions occur and starch (sugar) is synthesized.

(ii) **Grana** are stacks of membrane bound, flattened sacs containing the molecules of chlorophyll. One thylakoid stack is known as granum. Each thylakoid have chlorophyll molecules on their surface that trap sunlight and take part in process of photosynthesis.

The stacks of grana are connected by stromal lamellae. The lamellae act like the skeleton of chloroplast, keeping all sacs in safe distance from the other sac. Grana are main functional units of chloroplasts.

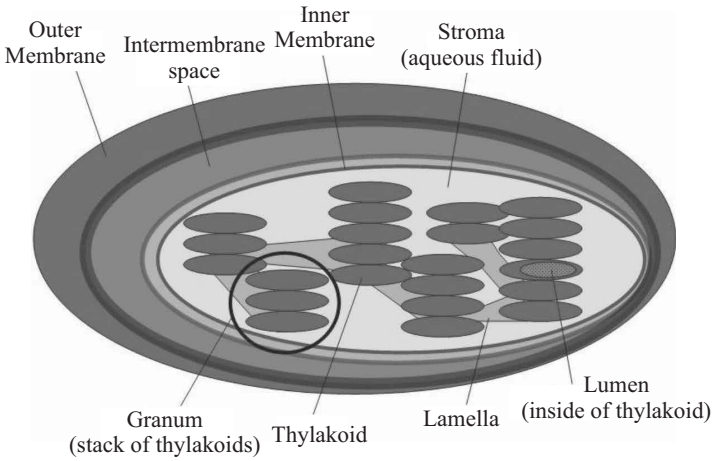
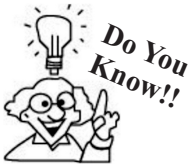


Fig. Structure of chloroplast



During photosynthesis granum is the site of light reaction while stroma is the site of dark reaction.

Functions of Chloroplast:

(i) Chloroplasts trap solar energy, which is used to manufacture food through photosynthesis. Photosynthesis is the process of synthesizing food (sugar) from carbon dioxide and water in the presence of sunlight.

$$CO_2 + H_2O \xrightarrow[\text{Sunlight}]{\text{Chlorophyll}} \text{Glucose} + \text{Oxygen}$$

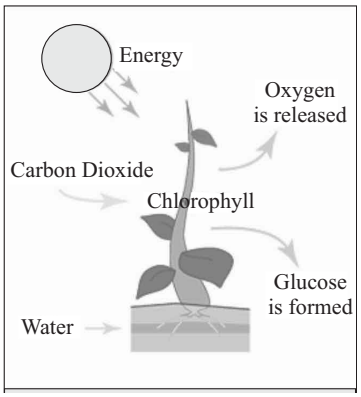


Fig. Process of photosynthesis

(ii) Chromoplasts provide colour to fruits and flowers to attract insects for pollination.

(iii) Leucoplasts take part in storage of protein, starch and oil.

CHECK Point

☛ **What will happen if chloroplast is taken out of the cell and is illuminated?**

SOLUTION

Chloroplast is a semi-autonomous cell organelle. They have their own DNA and protein. So, if chloroplast is taken out of the cell and illuminated, it can still perform its function of photosynthesis and release oxygen, provided it is kept in isotonic medium and receives raw material of carbon dioxide.

3. Endoplasmic reticulum:

Endoplasmic reticulum is a complex network of membrane bound structure which runs through the cytoplasm. Cisternae are spaces within the folds of the ER membranes. It is connected to both the outer nuclear membrane as well as cell membrane. The membrane has the same structure as the plasma membrane but ribosomes do not have membranes.

Depending on presence or absence of ribosome on the surface of ER, it is divided into two types:

(i) Rough Endoplasmic reticulum (RER): It is lined with ribosomes and is rough in appearance, hence, named as rough endoplasmic reticulum. It is the site of protein synthesis.

(ii) Smooth Endoplasmic reticulum (SER): It contains no ribosomes and hence is smooth in appearance. It helps in lipid and steroid synthesis.

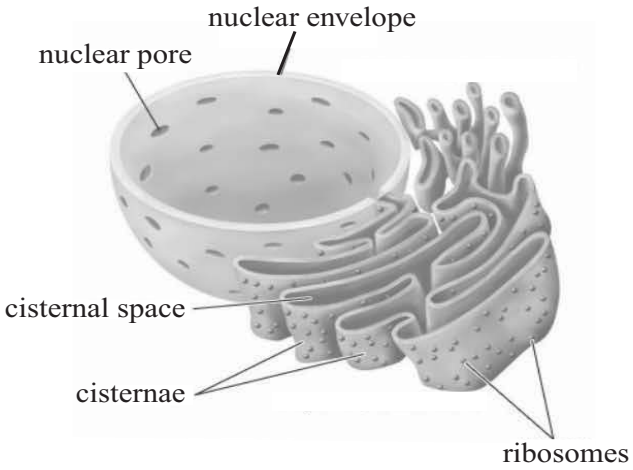


Fig. Structure of ER

Functions of endoplasmic reticulum:

(i) Endoplasmic reticulum helps in intracellular and intercellular transport of materials. It is the "*transport system*" of the cell. It transports chemicals between cells and within cells.

(ii) It provides large surface area for various metabolic reactions.

(iii) RER is the site of protein synthesis.

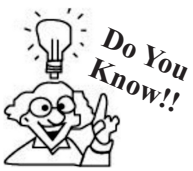
(iv) SER helps in lipid synthesis.

(v) SER in liver cells helps in detoxifying many drugs and poisons.

(vi) Proteins and lipids synthesized on ER are used for making cell membrane. The process is known as membrane biogenesis.

4. Golgi Bodies :

Golgi body consists of smooth, flattened, membrane bound, sac-like structures called cisternae. The cisternae are stacked together; placed one above another in parallel rows. It is frequently surrounded by vesicles, which are discharged from the cisternae.



Golgi body is a single complex in animal cells while in plant cells, it is formed of separate units called dictyosomes

Membranes of Golgi body may develop connections with membranes of ER to form complex called extramembrane system.

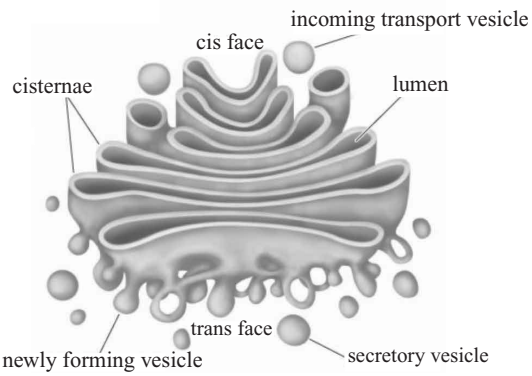


Fig. Structure of Golgi bodies

The Golgi apparatus receives vesicles from ER on its convex or cis face for elaboration of their contents. They are then dispatched to intracellular and extra cellular targets through vesicles that develop on the sides as well as maturing convex or trans face of apparatus.

Know your Scientist

Camillo Golgi

Camillo Golgi is an Italian doctor and neurologist. He is known for discovery of cell organelle, named after him, *i.e.* Golgi apparatus. In 1898, he discovered Golgi apparatus in nerve cells of Barn owl and Cat. He named the organelle **'apparato reticolore interns'**. The name Golgi apparatus was bestowed by Cajal in 1914.

Camillo Golgi shared the Nobel prize of 1906 with *Santiago Ramony Cajal* for their work on the structure of nervous system.

Functions of Golgi bodies:

(i) It is involved in the synthesis and repair of cell membrane.
(ii) It is also involved in formation of lysosomes and peroxisomes.
(iii) Secretion is the major function of Golgi apparatus. All types of substances that are secreted and excreted are packed in vesicles by Golgi bodies for passage to the outside. It is the *secretory organelle* of the cell.
(iv) Golgi apparatus also takes part in storage, modification and packaging of various biochemical products produced by different components of the cell.

5. Lysosomes (Lysis = Breaking down; Soma = Body):

Lysosomes are small, spherical vesicle covered by a single membrane. It is scattered all over the cytoplasm.

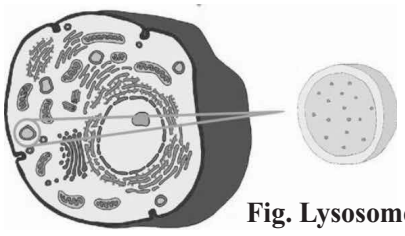


Fig. Lysosome

It contains powerful digestive enzymes (about 40 in number) that are capable of breaking down the organic material. Thus, lysosome serves as an intracellular digestive system, and is called *digestive bags*.

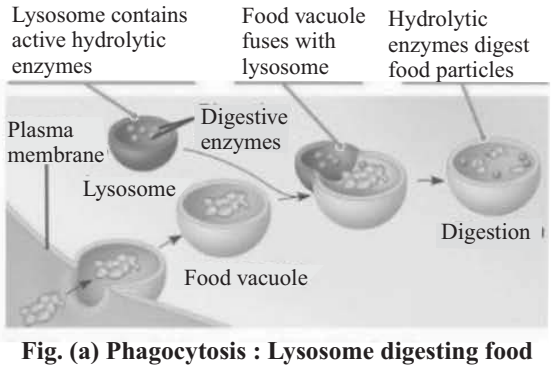


Fig. (a) Phagocytosis : Lysosome digesting food

The digestive enzymes contained in lysosomes are synthesized by RER, and are packed into lysosomes by Golgi bodies.

Lysosomes are also called *suicidal bags* as enzymes contained in them can digest the cell's own material when damaged or dead.

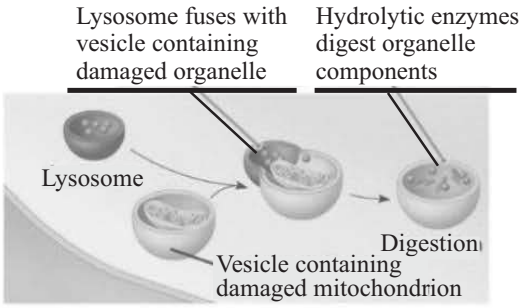


Fig. (b) Autophagy : Lysosome breaking down damaged organelle

Functions of Lysosomes:

(i) Lysosome helps in intracellular digestion of food particles as they are rich in various digestive enzymes.
(ii) They help in destruction of foreign particles, as in white blood cells.
(iii) They help in cleaning up the cell by digesting damaged materials of the cell. Lysosomes are therefore called cellular scavengers.
(iv) Lysosomes digest the cell's own material when damaged or dead. Hence, they provide energy during cell starvation by digesting cell's own parts.

6. Vacuoles:

Vacuoles are membrane bound fluid-filled cavities or sacs present in the cytoplasm. They are surrounded by a membrane called tonoplast. The vacuole is filled with a liquid called "*cell sap*" that contains dissolved salts and sugars.

A single, large vacuole is present in a plant cell. In animal cells, vacuole may or may not be present. If present, they are numerous and smaller in size.

Vacuoles are of three types:

(i) Sap vacuole: Sap vacuole stores salts, sugar, amino acids, salts and some proteins. Sap vacuole helps in maintaining turgidity and rigidity of the cell. It also maintains the osmotic pressure of water.

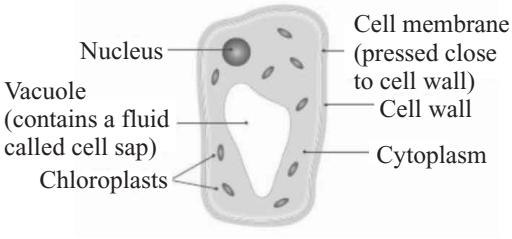


Fig. Sap Vacuole

(ii) Food vacuole: In single-celled organisms, like *Amoeba*, the sacs containing ingested food fuse with lysosomes to form food vacuole. The process of digestion takes place inside the food vacuole.

(iii) Contractile vacuole: Contractile vacuole collects liquid from the cell, swells up and rises to the surface and burst to release their contents. They take part in osmoregulation and excretion.

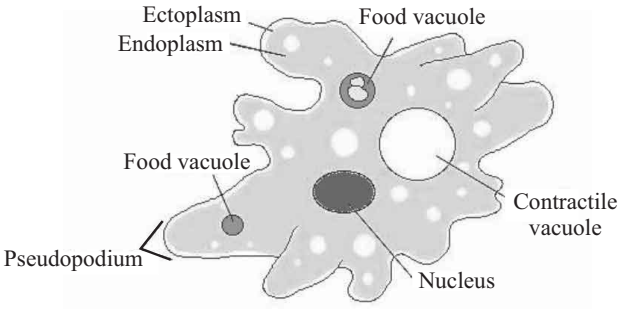


Fig. Food and Contractile Vacuole

Functions of Vacuole:

In plant cells:

(i) Vacuoles help to provide turgidity and rigidity to the cell.

(ii) Vacuole acts as a store house of pigments and waste products. It also stores useful minerals and salts.

(iii) Sap vacuole maintains an osmotic concentration which is required for absorption of water.

In animal cells:

(i) In single celled organisms, like *Amoeba*, food vacuole helps in digestion of food particles.

(ii) Contractile vacuole takes part in osmoregulation and excretion.

(iii) They store materials such as food, water, sugar and waste products.

CONNECTING TOPIC

7. Centrosome:

Centrosome is a small naked organelle found in the cytoplasm near the outer surface of the nucleus. It encloses two microcylinders called centrioles. The two centrioles lie at right angles to each other.

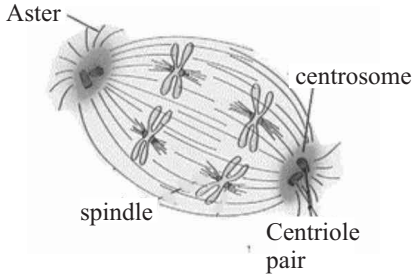


Fig. Centrosome and Centriole

In plant cells, centrosome is absent and polar caps perform the function of centrosome.

Functions of centrosome:

(i) Centrosome and Centriole help in formation of spindle fibres during cell division.

(ii) Centriole also produces basal bodies that form cilia and flagella.

8. Ribosomes:

Ribosomes are tiny, membrane-less organelle present in the cytoplasm. They are found either in Free State in the cytoplasm or attached to the surface of ER. They are rich in RNA and proteins.

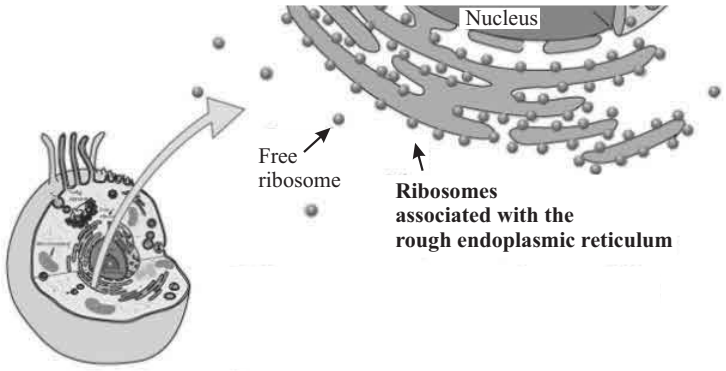


Fig. Ribosomes

Functions of Ribosome : Ribosomes are sites of protein synthesis. Hence, they are known as **protein factories of cell**.

idea box

The following table compares the organelles found in plant, animal and a prokaryotic cell. Tick mark the organelles found only in plant, animal and a bacterial cell.

Cell Organelle	Eukaryotic cell		Prokaryotic cell
	Plant cell	Animal cell	Bacterial cell
Cell wall			
Cell membrane			
Nucleus			
Cytoplasm			
Endoplasmic reticulum			
Ribosome			
Mitochondrion			
Vacuole			
Lysosome			
Chloroplast			
Nucleolus			
Golgi apparatus			
Centrioles			

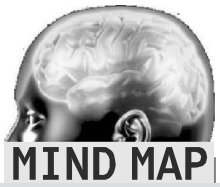
CHECK Point

☛ **Name the organelle which show analogy written as below :**

1.	**Power house of the cell**	_____
2.	**Digestive bag of the cell**	_____
3.	**Storage sac of the cell**	_____
4.	**Kitchen of the cell**	_____
5.	**Control room of the cell**	_____
6.	**Transporting channels of the cell**	_____
7.	**Packaging and dispatching unit of the cell**	_____

SOLUTION

1. Mitochondria; 2. Lysosome; 3. Vacuole; 4. Chloroplast; 5. Nucleus; 6. Endoplasmic reticulum; 7. Golgi apparatus



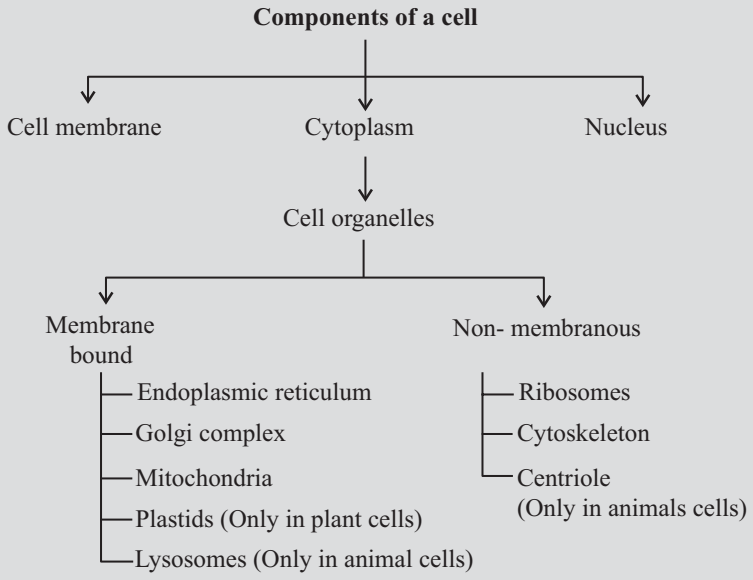
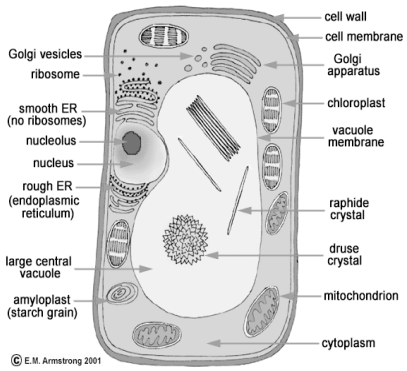
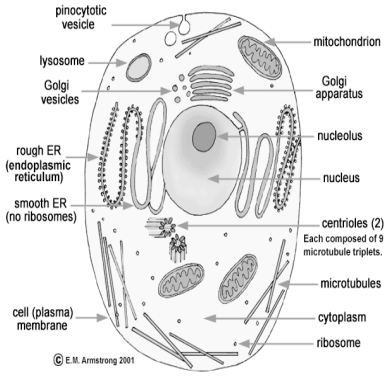


Table : Difference between Plant and Animal Cell

Sl. No	Plant Cell	Animal Cell
1.	Plant cells are larger in size compared to animal cell.	Animal cell is comparatively smaller in size.
2.	Cell wall is present around cell membrane.	Cell wall is absent.
3.	Plastids are present.	Plastids are absent.
4.	A single large central vacuole is present.	Few small vacuoles are present.
5.	Golgi body present in the form of units known as dictyosomes	Golgi body is well developed.
6.	Nucleus lies on one side in the peripheral cytoplasm.	Nucleus lies in the center of the cell.

7.	Centrosomes and centrioles are absent.	Centrosome with centrioles is present.
		

Let us summarise the functions of various parts of a cell

Cell Organelle	Structure	Function
Cell membrane (found in all cells)	1. Composed of lipid and protein. 2. Selectively permeable.	1. Protects and gives definite shape to the cell. 2. Regulates movement of ions across cell.
Cell wall (found only in plant cell)	1. Composed of cellulose and hemi-cellulose 2. Rigid and strong	1. Provides mechanical strength to cell. 2. Makes cell turgid. 3. Protects cell against pathogen and injury.
Nucleus (master control of a cell)	Composed of protein, phosphorus and DNA/ RNA.	1. Controls all the activities of cell. 2. Responsible for transmission of characters.
Cytoplasm	Composed of insoluble wastes and storage products.	1. Storehouse of amino acids 2. Site of metabolic activities
Endoplasmic Reticulum (ER)	Occurs in three form - cisternae, vesicles and tubules. It is of two types : (i) Smooth ER; (ii) Rough ER	1. Provide supporting skeletal framework to the cell. 2. SER - Synthesizes fat 3. RER - Plays role in modification of proteins
Golgi apparatus (In plants, they are called as dictyosomes)	Consists of cisternae stacked together in parallel rows.	1. Packages materials synthesized in cell and dispatches from cell across plasma membrane. 2. Produces lysosomes
Ribosome	Composed of RNA and protein	1. Helps in protein synthesis
Mitochondria (Powerhouse of the cell)	Semi-autonomous organelle	1. Site of cellular respiration - produces ATP - universal currency of energy.
Chloroplast (Kitchen of the cell)	Semi-autonomous organelle	1. Site of photosynthesis 2. Store food in the form of carbohydrate
Lysosome (suicidal bag of the cell)	Tiny sac like structure surrounded by single, thin membrane	Contains digestive enzyme and helps in intracellular digestion.
Vacuole	Fluid filled structure bounded by tonoplast.	1. Provide turgidity and rigidity to the plant cell. 2. Take part is excretion and osmoregulation.

1 EXERCISE

Fill in the Blanks :

DIRECTIONS : *Complete the following statements with an appropriate word / term to be filled in the blank space(s).*

1. Ribosomes are concerned with the synthesis of ..... .
2. Cell wall is found only in ..... cells.
3. DNA is the abbreviated form of ..... .
4. Movement of water across cell membrane takes place by .....
5. Part of cell between plasma membrane and nucleus is .....
6. Genes are functional segments of .....
7. Photosynthesis takes place in .....
8. Vacuoles are surrounded by a single membrane called .....
9. Active transport is the movement of molecules against a diffusion gradient from ..... concentration to ..... concentration.
10. Active transport and facilitated transport are alike in that they require ..... proteins, but they differ in that in active transport ..... is required.
11. The type of endocytosis known as "cell feeding" is called .....
12. The fundamental organisational unit of life is the .....
13. Cells are enclosed by a plasma membrane composed of ..... and .....
14. In plant cells, a cell wall composed mainly of ..... is located outside the cell membrane.
15. The primary function of leucoplasts is .....
16. Cristae create a large surface area for .....generating reactions.
17. Plant cell wall is mainly composed of ..... .
18. Same organelles perform ..... function in all organisms.
19. Cell theory was proposed by ..... and ..... .
20. Cells were discovered by Robert Hooke in ..... .

True / False :

DIRECTIONS : *Read the following statements and write your answer as true or false.*

1. *Amoeba* has an everchanging shape.
2. Central vacuole occupies 10-20% of cell volume.
3. Lysosomes keep the cells clean by digesting foreign materials.
4. A dilute solution is called hypertonic solution.
5. Movement of a substance from the area of low concentration to an area of high concentration is called diffusioin.
6. SER detoxifies many poisions and drugs.
7. Robert Brown discovered protoplasm in 1831.
8. In animal cells, mitochondria is the only cell organelle outside the nucleus that contains DNA.
9. Protoplasm is the part of the cell which surrounds the nucleus.
10. Ribosomes are present in eukaryotic cells only.
11. Photosynthetic prokaryotic bacteria have chlorophyll pigments in membranous vesicles.
12. Presence of cell wall enables bacteria to live in hypotonic medium without bursting.
13. The first cell appeared on earth was probably eukaryotic.
14. In general, eukaryotic cells consist of a nucleus and a cytoplasmic region.
15. Diffusion is the movement of molecules from a place of higher concentration to a place of lower concentration in liquid, solid, or gaseous state.
16. Facilitated transport requires the expenditure of energy.
17. Plants are composed of prokaryotic cells.
18. Nuclei and mitochondria are surrounded by a double membrane.
19. Lipids in a lipid bilayer rotate rapidly around their long axis.
20. Lipids in a lipid bilayer rapidly exchange positions with one another in the plane of the membrane.
21. Some membrane proteins are enzymes.
22. The nucleus in eukaryotes is separated from the cytoplasm by double-layered membrane.
23. The ER functions both as a passageway for intracellular transport and as a manufacturing surface.
24. Prokaryotic cells have no membrane-bound organelles.

Match the Following :

DIRECTIONS : *Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in Column I have to be matched with statements (p, q, r, s) in Column II.*

1.

Column I	Column II
(A) Structures with one unit membrane	(p) Lysosome
(B) Structures with two membrane	(q) Ribosome
(C) Structures without membrane	(r) Plastids

2.

Column I	Column II
(A) Cell wall	(p) External support, protection and made of cellulose
(B) Cell membrane	(q) Osmosis
(C) Nucleus	(r) Location of chromatin
(D) Ribosomes	(s) Workbench for protein synthesis.

3.

Column I	Column II
(A) Endoplasmic reticulum	(p) Organelle of photosynthesis
(B) Chloroplast	(q) Production &segregation of proteins to be secreted.
(C) Golgi body	(r) Digestion of nutrients and worn-out cell parts.
(D) Lysosomes	(s) Sorting, packaging, labeling of cell products

4.

Column I	Column II
(A) Mitochondria	(p) Site of energy production
(B) Vacuoles	(q) Internal fluid of a cell
(C) Cytoplasm	(r) Storage of water cell sap
(D) Microtubules	(s) Filaments that separate chromosomes during cell division.

Very Short Answer Questions :

DIRECTIONS : *Give answer in one word or one sentence.*

1. Write the names of the following organelles –
(A) Power house of the cell
(B) Digestive bag of the cell
(C) Protein factory of cell
(D) Head quarter of cell

2. Define cristae ?

3. Which cell type probably evolved first ?

4. What is the primary function of the plasma membrane ?

5. Why does water diffuse out of a cell if it is placed in a hypertonic solution ?

6. What are the structural differences between a prokaryotic cell and a normal eukaryotic cell ?

7. What will happen if all the mitochondria of a cell are destroyed ?

8. What do you mean by "semi-autonomous genomes system"? In which organelle is it present ?

9. Name process by which a cell engulfs its food ?

10. What is the function of ribosomes ?

11. Which type of microscope would you use to study –
(a) The changes in shape of a living human white blood cel1.
(b) The finest details of surface texture of a human hair.
(c) The detailed structure of an organelle in the cytoplasm of a human liver cell.

12. How is the nucleoid region of a prokaryotic cell unlike the nucleus of a eukaryotic cell ?

13. Why do phospholipids tend to organize into a bilayer in an aqueous environment ?

14. What is the energy source for active transport ?

15. Schleiden, Schwann, and Virchow all contributed to the development of the Cell Theory in the nineteenth century. Formulate two statements that comprise the cell theory of the nineteenth century.

16. What three features of plant cells distinguish them from animal cells?

17. Endoplasmic reticulum helps in membrane biogenesis. Explain how ?

18. Give two examples of prokaryotic cell.

19. What is the main function of each of the following organelles?
(a) Ribosome (b) Cell wall

20. Name the cell organelle in which following structures are present
(a) Cristae (b) Stroma
(c) Centriole (d) Chromosome

21. What is the main function of each of the following organelles?
(a) Golgi bodies (b) Vacuole

22. Name two cells organelles, which contain their own genetic material.

23. Is the plant cell wall living or dead?

24. What is the common name of mitochondria?

25. Name the following :
(a) Suicide bag of the cell.
(b) Kitchen of a cell.

26. Name the scientist who first studied living cell.

27. How many cells are present in human body?

28. Name the book in which Robert Hooke published his work.
29. Name the smallest and the largest cell.
30. Name the structure from which all multicellular organisms develop.
31. Define cell.
32. What is protoplasm?
33. What is semipermeable membrane?
34. Name the biochemicals present in cell membrane.
35. What do you mean by selectively permeable membrane?
36. Define diffusion.
37. What would happen if plasma membrane ruptures?
38. What is osmotic solution?
39. Define endosmosis.
40. What is main function of plasma membrane?
41. What is exosmosis?
42. Define : (i) Hypertonic solution (ii) Hypotonic solution (iii) Isotonic solution.
43. What is the energy currency in mitochondria?
44. Name the cell-organelle that helps in packaging?
45. Name the cell-organelle which helps in the transportating of material.
46. Why does mitochondria have largely folded inner membrane?
47. What are cisterns?

Short Answer Questions :

DIRECTIONS : *Give answer in 2-3 sentences.*

1. Explain why it is not enough just to say that a solution is "hypertonic."
2. As a cell increases in size, its surface-to-volume ratio decreases which causes the cell to function less efficiently. Discuss ways in which variations in cell structure can help overcome this problem.
3. Why is the presence of organelles within eukaryotes significant? In other words, why are eukaryotes so complex and diverse as compared with prokaryotes?
4. Distinguish between rough endoplasmic reticulum and smooth endoplasmic reticulum, both structurally and functionally.
5. How is osmosis a special type of diffusion ?
6. What are the functions of vacuoles in plant cells and unicellular organisms ?
7. Proteins embedded in the plasma membrane have several important functions in the life of the cell. Describe two of these functions. Explain why they are important to the cell?
8. Organelles are the functional subunits of the cell. Each organelle has a specific function which makes it easier to master the names, structure, and function of each component. In the following table, indicate the functions associated with each structure.

   Organelles :

   (a) Nucleus

   (b) Rough Endoplasmic Reticulum

   (c) Smooth Endoplasmic Reticulum

   (d) Golgi body (e) Lysosomes

   (f) Mitochondrion (g) Chloroplast

   (h) Peroxisomes
9. Why do plant cells have more in number and big sized vacuoles as compared to the animal cell?
10. We eat food composed of all the nutrients like carbohydrates, proteins, fats, vitamins, minerals and water. After digestion, these are absorbed in the form of glucose aminoacids, fatty acids, glycerol *etc*. What mechanisms are involved in absorption of digested food and water?
11. Write the name of different plant parts in which chromoplast, chloroplast and leucoplast are present.
12. Give two major differences between prokaryotes and eukaryotes.
13. What is the main function of each of the following cell organelle?

    (a) Ribosome (b) Cell wall
14. State two types of plastids. Write one function of each.
15. What are chromosomes? List their two functions.
16. Name the nucleic acids that are present in an animal cell.
17. Cell wall is composed of which chief material. How many molecules of glucose contributes o prepare cellulose?
18. (a) Is the cell wall in a plant cell living or non-living?

    (b) Is the cell wall in a plant cell permeable or selectively permeable?

    (c) What is its chemical composition?
19. (a) Who coined the term 'cell'?

    (b) Name three major differences between light microscope and electron microscope.

    (c) Give important points of modern cell theory.

20. (i) Name any two cell organelles which are bounded by double membranes.

(ii) Why are mitochondria called semiautonomous organelles?

(iii) Where one would find green chlorophyll pigment in a plant cell?

21. (a) List various components of the nucleus.

(b) What are chromosomes? Give their chemical composition.

(c) List the type of chromosome if it has the following position of centromere.

(i) in the middle. (ii) at the tip of chromosome.

22. What is nucleoid?

Long Answer Questions :

DIRECTIONS : *Give answer in four to five sentences.*

1. How is the structure of a plasma membrane related to its function?

2. What are the principles of cell theory? Describe it.

3. Draw a neat labelled diagram of plant cell and label its parts.

4. Draw a neat labelled diagram of animal cell.

5. Briefly explain the structure of chromosomes.

6. Describe various components of a nucleus in a eukaryotic cell.

7. Explain structure and functions of plastids.

8. (a) What is endoplasmic reticulum?

(b) Describe its structure.

(c) Name the two types of endoplasmic reticulum.

(d) What crucial role does it play in the liver cells of vertebrates?

(e) What is membrane biogenesis?

9. Explain the following : (i) Active transport (ii) Exocytosis (iii) Phagocytosis.

2 EXERCISE

Text - Book Questions :

1. Who discovered cells and how ?
2. Why is the cell called the structural and functional unit of life?
3. How do substances like CO_2 and water move in and out of the cell? Discuss.
4. Why is the plasma membrane called a selectively permeable membrane?
5. Fill in the gaps in the following table illustrating differences between prokaryotic and eukaryotic cells.

Prokaryotic Cell	Eukaryotic Cell
1. Size : generally small (1-10 λm) 1 λm = 10^{-6}m	1. Size : generally large (5-100 λm)
2. Nuclear region : _____ _____ and known as—	2. Nuclear region : well defined and surrounded by a nuclear membrane
3. Chromosome : single	3. More than one chromosome
4. Membrance-bound cell organelles are absent.	4. _____ _____ _____

6. Can you name the two organelles we have studied that contain their own genetic material?
7. If the organisation of a cell is destroyed due to some physical or chemical influence, what will happen?
8. Why are lysosomes known as suicide bags?
9. Where are proteins synthesised inside the cell?

Text - Book Exercise :

1. Make a comparison and write down ways in which plant cells are different from animal cells.
2. How is a prokaryotic cell different from an eukaryotic cell?
3. What would happen if the plasma membrane ruptures or breaks down?
4. What would happen to the life of a cell if there was no golgi apparatus?
5. Which organelle is known as the power house of the cell? Why?
6. Where do the lipids and proteins constituting the cell membrane get synthesised?
7. How does an *Amoeba* obtain its food?
8. What is osmosis?
9. Carry out the following osmosis experiment.
   Take four peeled potato halves and scoos each one out to make potato cups. One of these potato cups should be made from a boiled potato. Put each potato cup in a trough containing water. Now,
   (a) Keep cup A empty
   (b) Put one teaspoon sugar in cup B
   (c) Put one teaspoon salt in cup C
   (d) Put one teaspoon sugar in the boiled potato cup D.
   Keep these for two hours. Then observe the four potato cups and answer the following :
   (i) Explain why water gathers in the hollowed portion of B and C.
   (ii) Why is potato A necessary for this experiment?
   (iii) Explain why water does not gather in the hollowed out portions of A and D.

Exemplar Questions :

1. How is a bacterial cell different from an onion peel cell ?
2. How does *Amoeba* obtain its food ?
3. Which cell organelle controls most of the activities of the cell ?
4. Do you agree that "A cell is a building unit of an organism". If yes, explain why?

HOTS Questions :

1. (a) Why does the plant cell, placed in a hypotonic solution, not burst?
   (b) What happens when a fully turgid plant cell is placed in a hypertonic solution? Name the phenomenon.
2. Give reasons why mitochondria are called 'power houses' and ATP as 'energy currency' of the cell.
3. Why are lysosomes commonly called 'natural scavengers and cellular housekeepers'?
4. (a) Name the pheonomenon which helps fresh water unicellular organisms (*e.g.*, *Amoeba*) to continuously gain water in their bodies. Also name the mechanism by which these organisms throw out excess of water from their bodies.
   (b) Give at least two examples in plants where similar phenomenon is used to gain of water.

5. What wil happen if nucleus is removed from the cell?

6. In what way are chloroplast and mitochondria similar?

7. What is a satellite DNA? Explain.

8. What is C-value paradox? Explain.

9. What is centrosome? Enumerate its function.

10. What would happen to the life of a cell if there was no Golgi apparatus?

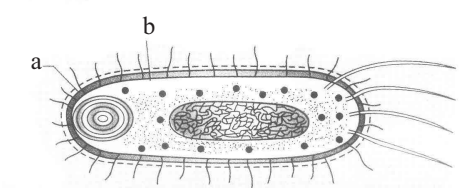
11. What is a SAT-chromosome?

12. Distinguish between diploid and haploid.

13. What do you mean by polytene chromosome? Where are such chromosomes found?

14. What is cyclosis?

15. Given below is a diagram of the cell. Study it carefully and then answer the following questions.



1. Give suitable title to the given figure.
2. What is the term used for the genetic material which lies in the cytoplasm and not covered by any envelope?
3. Name the only cell organelle present in this cell which is not membrane bound.
4. Label the following :
   (i) Outermost covering labelled as (a)
   (ii) Inner covering labelled as (b)

16. Vacuoles can have a wider variety of functions in plant cells than do lysosomes in animal cells. Describe one function that vacuoles perform in plant cells that lysosomes do not in animal cells.

17. Once regarded as depositories for waste products in plant cells, vacuoles now are known to play many different roles. What are some of those roles?

3 EXERCISE

Multiple Choice Questions :

DIRECTIONS : *This section contains multiple choice questions. Each question has 4 choices (a), (b), (c) and (d) out of which ONLY ONE is correct.*

1. Which of these is the smallest in size ?
(a) ribosome (b) lysosome
(c) mitochondria (d) chloroplast

2. The scientist who saw the living cell for the first time was
(a) Leeuwenhoek (b) M.J. Schleiden
(c) Kolliker (d) Palade

3. Who proposed the cell theory ?
(a) Schleiden and Schwann
(b) Watson and Crick
(c) Darwin and Wallace
(d) Mendel and Morgan

4. According to widely accepted "Fluid mosaic model" cell membranes are semi-fluid, where lipids and integral proteins can diffuse randomly. In recent years, this model has been modified in several represents. In this regard, which of the following statements is incorrect
(a) Proteins in cell membranes can travel with in the lipid bilayer
(b) Proteins can also undergo flip-flop movements in the lipid bilayer
(c) Proteins can remain confined within certain domains of the membrane
(d) Many proteins remain completely embedded within the bilayer.

5. Which of the following organelles does not have membrane ?
(a) Ribosome (b) Nucleus
(c) Chloroplast (d) Mitochondria

6. Which of the following organelles would not be found in a plant cell ?
(a) Chloroplast (b) DNA
(c) Food vacuole (d) Cell membrane

7. Plastid that are white in colour (pigment free)
(a) Chloroplast (b) lysosome
(c) leucoplast (d) Chromoplast

8. Which of the following is called 'suicidal bags'
(a) Centrosomes (b) Lysosomes
(c) Microsomes (d) Mesosomes

9. Plant cell wall is mainly composed of
(a) sugars (b) cellulose
(c) proteins (d) lipids

10. Nucleus was discovered by
(a) Robert Brown (b) Robert Hooke
(c) A.V. leeuwenhock (d) Schwaan

11. In the mitochondrion energy is stored in the form of
(a) adenosine triphosphate (ATP)
(b) adenosine monophosphate (AMP)
(c) citric acid
(d) adenosine diphosphate (ADP)

12. The site of protein synthesis in plants is the
(a) chloroplast (b) ribosomes
(c) lysosome (d) mitochondria

13. The plasma membrane is
(a) permeable
(b) semipermeable
(c) differentially permeable
(d) impermeable

14. The infoldings of the inner membrane of mitochondria is referred to as
(a) grana (b) stroma
(c) oxysome (d) cristae

15. When a plant cell is treated by cellulose and pectinate enzymes, which of the following is formed ?
(a) Chloroplast (b) Leucoplast
(c) Protoplast (d) One of these

16. The golgi bodies are related to
(a) respiration (b) excretion
(c) secretion (d) circulation

17. Rough endoplasmic reticulum is concerned with
(a) Protein synthesis (b) Fat synthesis
(c) Respiration (d) Photosynthesis

18. Which animal cell structure is characterized by selective permeability ?
(a) Chromosome (b) Cell membrane
(c) Cell wall (d) Ribosomes

19. The most abundant compound in cytoplasm is
(a) fat (b) water
(c) protein (d) carbohydrates

20. Which organelle is usually found associated with the nucleus of the cell in animals ?
(a) Centrosome (b) Vacuole
(c) Chromosome (d) Mitochondrion

21. The smallest organelle in the cell is
(a) lysosome (b) ribosome
(c) mitochondria (d) peroxisome

22. The dictum - "*Omnis cellula a cellula*" was proposed by :
(a) Schwann (b) Virchow
(c) Schleiden (d) Robert brown

23. Cynobacteria have
(a) A well-defined nucleus and chloroplast
(b) A well-defined nucleus but no chloroplast
(c) Incipient nucleus and vesicles containing chlorophyll.
(d) Incipient nucleus but no chloroplast or pigment.

24. Which of the following statements about the plasma membrane is true ?
(a) It is a solid layer of protein that protects the contents of the cell.
(b) The plasma membrane of a bacterium has none of the same components as the plasma membrane of an animal cell.
(c) It is a rigid and unmoving layer of phospholipids and proteins.
(d) It allows selected molecules to pass into and out of the cell.

25. One key function of nuclear pores is to
(a) allow cells to communicate with one another.
(b) aid in the production of new nuclei.
(c) allow molecules such as proteins to move into and out of the nucleus.
(d) form connections between different organelles.

26. Vesicles are essential for the normal functioning of the Golgi apparatus because
(a) they provide energy for chemical reactions.
(b) they move proteins and lipids between different parts of the organelle.
(c) they contribute to the structural integrity of the organelle.
(d) they produce the sugars that are added to proteins.

27. Which of the following statements is not true –
(a) Both mitochondria and chloroplasts provide energy to cells in the same way.
(b) Both mitochondria and chloroplasts have more than one membrane.
(c) Only chloroplasts contain the pigment chlorophyll.
(d) Both animal and plant cells contain mitochondria.

28. Thickness of plasma membrane (unit membrane) is –
(a) 75 Å (b) 100 Å
(c) 125 Å (d) 150 Å

29. Cellular respiration is related to ..... as ..... is to chloroplasts.
(a) nucleus; cytoplasm
(b) mitochondria; photosynthesis
(c) ATP; light
(d) grana; cristae

30. Which of the followings does best describe the structure of the plasma membrane?
(a) proteins sandwiched between two layers of phospholipid
(b) proteins embedded in two layers of phospholipid
(c) a layer of protein coating a layer of phospholipid
(d) phospholipids embedded in two layers of protein

31. The total solute concentration in a red blood cell is about 2%. Sucrose cannot pass through the membrane, but water and urea can. Osmosis would cause such a cell to shrink the most when the cell is immersed in which of the following –
(a) a hypertonic sucrose solution
(b) a hypotonic sucrose solution
(c) a hypertonic urea solution
(d) a hypotonic urea solution

32. What process does link reception of cell signals to responses within the cell ?
(a) a signal transduction pathway
(b) protein synthesis by ribosomes
(c) budding of transport vesicles from the Golgi
(d) active transport of the signal into the cell

33. If an animal cell is placed into a solution whose concentration of dissolved substances is higher than that inside the cell –
(a) the cell will swell
(b) the cell will shrivel
(c) the solution is described as hypertonic
(d) both (b) and (c) are correct

34. Which of the following processes does cause substances to move across membranes without the expenditure of cellular energy ?
(a) Endocytosis (b) Exocytosis
(c) Active transport (d) Diffusion

35. The outermost boundary of an animal cell is the –
(a) plasma membrane (b) nucleus
(c) cytoplasm (d) cytoskeleton

36. A series of membrane-enclosed channels studded with ribosomes are called –
(a) lysosomes
(b) Golgi complex
(c) rough endoplasmic reticulum
(d) mitochondria

37. Temporary mount of a tissue is made in
(a) wax (b) alcohol
(c) glycerine (d) xylene

38. The rough endoplasmic reticulum owes its rough surface to
(a) mitochondria (b) proteins
(c) ribosomes (d) DNA particles

39. The energy necessary for active transport across cytoplasmic membranes is believed to come from
(a) ATP (b) diffusion
(c) osmosis (d) kinetic energy

40. Transport proteins are required for –
(a) diffusion
(b) osmosis
(c) facilitated transport
(d) facilitated transport and active transport

41. Cells were determined to be the basic structural units of plants and animals in which century
(a) 1600's (b) 1700's
(c) 1800's (d) 1900's

42. Which organelle is made up of flat, membrane-enclosed sacs and functions as a processing center?
(a) Chloroplast
(b) Smooth endoplasmic reticulum
(c) Rough endoplasmic reticulum
(d) Golgi body

43. The cell's "garbage disposals" are the
(a) lysosomes (b) peroxisomes
(a) mitochondria (d) vacuoles

44. The organelles that help the cell use oxygen, and also contain a variety of enzymes that help the cell degrade rare biochemicals, among other things, are the –
(a) lysosomes (b) peroxisomes
(c) mitochondria (d) vacuoles

45. Choose the best definition of 'diffusion'.
(a) Passive movement from an area of greater concentration to one of lesser concentration.
(b) Active movement from an area of greater concentration to one of lesser concentration.
(c) Passive movement from an area of lesser concentration to one of greater concentration.
(d) Active movement from an are of lesser concentration to one of greater concentration.

46. If a red blood cell (interior concentration of 0.9% salt) was placed into a test tube of 10% salt, what would happen to the red blood cell ?
(a) It would fill with water and burst.
(b) Nothing - the solution is isotonic to the interior of the red blood cell.
(c) The red blood cell would shrink as it loses water to the salt solution in the test tube.
(d) None of these

47. Cell to cell contact in plant cells is maintained through
(a) tight junctions (b) desmosomes
(c) interdigitations (d) plasmodesmata

48. What part of the cell does serves as the intracellular highway?
(a) Endoplasmic reticulum
(b) Golgi apparatus
(c) Cell membrane
(d) Mitochondria

49. Which of the following is found in plant cells, but not animal cells?
(a) Cell wall
(b) Nucleus
(c) Endoplasmic reticulum
(d) Mitochondria

50. The diffusion of water from external solution into dry raisins is called
(a) exosmosis (b) endosmosis
(c) imbibition (d) plasmolysis

51. Where are ribosomes usually located in animal and plant cells ?
(a) inside the nucleus
(b) near the cell membrane
(c) on the endoplasmic reticulum
(d) inside the vacuole

52. What part of the cell does serve to process, package and export proteins ?
(a) Mitochondria (b) Endoplasmic reticulum
(c) Nucleolus (d) Golgi apparatus

53. Which of the following could be found in BOTH the nucleus and the cytoplasm?
(a) Nucleolus (b) Ribosomes
(c) RNA (d) Both RNA & ribosomes

54. Which of the following structures has a 9 + 2 arrangement?
(a) Flagella (b) Ribosome
(c) Mitochondria (d) Golgi apparatus

55. In the eukaryotic cell which one of the following is not a membranous compartment ?
(a) Nucleus (b) Ribosome
(c) Vacuole (d) Lysosome

56. The cell nucleus was discovered by
(a) Robert Hooke (b) Robert Brown
(c) de Duve (d) Virchow

57. Which of the following help in cell wall formation?
(a) Nucleus (b) Golgi complex
(c) Nucleolus (d) Endoplasmic reticulum

58. Mitochondria are not found in
(a) human RBC (b) human liver cell
(c) human nerve cell (d) frog liver cell

59. Chromosomes contain hereditary units called
(a) genes (b) ribosomes
(c) DNA (d) RNA

60. Protoplasm is
(a) true solution (b) suspension
(c) colloidal solution (d) none of the above

61. The physical basis of life is
(a) ectoplasm (b) protoplasm
(c) nucleoplasm (d) endoplasm

62. Cell vacuole contains
(a) water
(b) cytoplasm
(c) dissolved substances
(d) water and metabolic wastes

63. Which of the cell organelle takes part in the formation of acrosome?
(a) Nucleus (b) Chromosome
(c) Golgi complex (d) Mitochondria

64. Lipid molecules in the cell are synthesised by
(a) smooth endoplasmic reticulum
(b) rough endoplasmic reticulum
(c) Golgi apparatus
(d) plastids

65. Which out of the following is not a function of vacuole?
(a) Storage
(b) Providing turgidity and rigidity to the cell
(c) Waste excretion
(d) Locomotion

66. 1 μm is
(a) 10^{-6} m (b) 10^{-9} m
(c) 10^{-10} m (d) 10^{-3} m

67. Which cell organelle plays a crucial role in detoxifying many poisons and drugs in a cell?
(a) Golgi apparatus
(b) Lysosomes
(c) Smooth endoplasmic reticulum
(d) Vacuoles

68. Which of the following can be made into crystal?
(a) A bacteium (b) An amoeba
(c) A virus (d) A sperm

69. Silver nitrate solution is used to study
(a) endoplasmic reticulum
(b) Golgi apparatus
(c) nucleus
(d) mitochondria

70. The cell organelle involved in forming complex sugar from simple sugars are
(a) endoplasmic reticulum
(b) ribosomes
(c) plastids
(d) Golgi apparatus

71. Human cheek cells are commonly stained with
(a) methylene blue (b) safranin
(c) acetocarmine (d) eosine

72. Name the stain which is commonly used to study plant cells
(a) Methylene blue (b) Cotton blue
(c) Safranin (d) Acetocarmine

73. Cells are first focussed in microscope under
(a) 40 X (b) 10 X
(c) 100 X (d) any of these

74. Coverslip is put on the mounted material on a slide very gently to
(a) avoid the crushing of mounted material
(b) avoid the entry of air bubbles
(c) avoid oozing of stain
(d) avoid oozing of glycerine

75. Raisins are soaked in water for determining the percentage of water absorbed by raisins. The formula, used by a student, for calculating the percentage of water absorbed, is
(a) $\frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$
(b) $\frac{\text{Final weight} - \text{Initial weight}}{\text{Initial weight}} \times 100$
(c) $\frac{\text{Final weight} - \text{Initial weight}}{\text{Final weight}} \times 100$
(d) $\frac{\text{Initial weight} - \text{Final weight}}{\text{Final weight}} \times 100$

76. Iodine gives blue-black colour with
(a) protein (b) oil
(c) starch (d) sucrose

77. Root hairs absorb water from soil through
(a) diffusion (b) imbibition
(c) osmosis (d) All the above

78. Mitochondria are the seat of
(a) Kreb's cycle (b) Calvin cycle
(c) anaerobic respiration (d) trapping of sun light

79. Which of the following is incorrect pair?
(a) Nucleus-Brain of the cell
(b) Mitochondria-Power house of the cell
(c) Chloroplast-Kitchen of the cell
(d) Lysosome-Secretory granules

80. *Amoeba* acquires its food through a process, termed
(a) exocytosis
(b) endocytosis
(c) plasmolysis
(d) exocytosis and endocytosis both

81. Which one of the followings cell-wall is not made up of cellulose?
(a) Bacteria (b) Hydrilla
(c) Mango tree (d) Cactus

Assertion & Reason :

DIRECTIONS : *Each of these questions contains an Assertion followed by reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.*

(a) Assertion is True, Reason is True; Reason is a correct explanation for Assertion.
(b) Assertion is True, Reason is True; Reason is NOT a correct explanation for Assertion.
(c) Assertion is True, Reason is False.
(d) Assertion is False, Reason is True.

1. **Assertion :** Larger cells are less efficient.
Reason : Surface volume ratio is more in large cells.

2. **Assertion :** Schleiden and Schwann were the first to put forward cell theory.
Reason : The cells are always living unit.

3. **Assertion :** Lysosomes help in photorespiration.
Reason : Lysosome have hydrolytic enzyme.

4. **Assertion :** Cell wall is not found in animal cell.
Reason : Animal cells are covered by cell membrane.

5. **Assertion :** Cell is a structural and functional unit of an organism.
Reason : A cell keeps its chemical composition steady within its boundary.

6. **Assertion :** Mitochondria and chloroplasts are semiautonomous organelles.
Reason : They are formed by division of pre-existing organelles as well as contain DNA but lack protein synthesizing machinery.

7. **Assertion :** Chloroplast is a cell organelle.
Reason : An organelle is a distinct part of a cell which has a particular structure and function.

8. **Assertion :** Cell wall is present in plant.
Reason : Animal cells lack cell wall.

9. **Assertion :** Fluid mosaic model was proposed by Singer and Nicolson.
Reason : The 'mosaic' is the intricate composite of protein and lipids of the membrane.

10. **Assertion :** Diffusion is a passive process of membrane transport.
Reason : Osmosis is an active process of membrane transport.

SOLUTIONS

Brief Explanations of Selected Questions

1 EXERCISE

Fill in the Blanks :

1. protein
2. prokaryotic
3. deoxyribo nucleic acid
4. osmosis
5. cytoplasm
6. DNA
7. chloroplasts
8. tonoplast
9. lower, higher
10. carrier, energy
11. phagocytosis
12. cell
13. lipids, proteins
14. cellulose
15. storage
16. ATP
17. cellulose
18. similar
19. Schleiden, Schwann
20. 1665

True/False :

1. True
2. False
3. True
4. False
5. False
6. True
7. False
8. False
9. True
10. False
11. True
12. True
13. False
14. True
15. True
16. False
17. False
18. True
19. True
20. True
21. True
22. True
23. True
24. True

Match the Following :

1. (A) → p, (B) → r, (C) → q
2. (A) → p, (B) → q, (C) → r, (D) → s
3. (A) → q, (B) → p, (C) → s, (D) → r
4. (A) → p, (B) → r, (C) → q, (D) → s

Very Short Answer Questions :

1. (A) Mitochondria (B) Lysosome
   (C) Ribosome (D) Nucleus
2. Cristae are the infoldings of inner mitochondrial membrane which contains oxysomes. They are the sites containing respiratory enzymes.
3. Prokaryotic cell.
4. It regulates the movement of ions and molecules into and out of the cell.
5. The water concentration is more inside the cell than outside the cell hence, and water diffuses down a concentration gradient.
6. Eukaryotic cell contains a true nucleus and various types of membrane-bound organelles whereas prokaryotic cells do not contain these structures.
7. The cell will die because mitochondria are the sites of respiration and contain various respiratory enzymes.
8. The system where there is a presence of replicable DNA molecule constitutes semiautonomous cell system as they themselves can divide and form a new individual of similar type.
9. Cell engulfs its food by endocytosis.
10. Ribosomes help in protein synthesis in the cell.
11. (a) Light microscope; (b) Scanning electron microscope
    (c) Transmission electron microscope
12. There is no membrane enclosing the DNA of the nucleoid region.
13. This structure shields the hydrophobic tails of the phospholipids from water while exposing the hydrophilic heads to water
14. ATP
15. (a) Cells are the structural and functional units of organisms.
    (b) All cells come from pre-existing cells.
16. In contrast to animal cells, plant cells have vacuoles, cell walls, and plastids.
17. SER helps in synthesis of phospholipids and RER synthesises proteins both of these are membrane forming materials but they are packed inside the golgi body.
18. Bacteria and blue green algae.
19. (a) Ribosome is the site of protein synthesis.
    (b) Cell wall provides shape, rigidity and protection to the cell.
20. (a) Mitochondria (b) Plastid (chloroplast)
    (c) Centrosome (d) Nucleus.
21. (a) Golgi bodies help in the formation of cell plate (during cell division) and synthesis of lysomes.
    (b) Vacuoles are involved in the maintenance of water balance.
22. Mitochondria and plastids.
23. Cell wall is dead.
24. Mitochondria are commonly known as power house of the cellls.
25. (a) Lysosome (b) Chloroplast.
26. Living cells were first studied by A.V. Leeuwenhoek (1674).
27. 100 trillion cells.
28. Robert Hooke published his work in 'Micrographia' (1665).
29. The smallest cell is Mycoplasma (PPLO) and the largest cell is Ostrich egg.
30. Zygote.
31. Cell is the structural and functional unit of life.
32. Protoplasm or living matter is a complex semifluid mass of various biochemicals that are often compartmentalised to perform different functions of life.

33. Semipermeable membrane is a membrane which is permeable to solvent but prevents the passage of all solutes through it, but selectively permit.

34. Lipid (phospholipids), proteins and small quantity of carbohydrates.

35. Selectively permeable membrane is the one which allows entry of certain substances, exit of some substances but prevents the passage of other substances.

36. The process of movement of a substance (solid, liquid or gas) from the region of higher concentration to the region of lower concentration so as to spread uniformly is called diffusion.

37. It generally heals within time but if rupturing does not heal, the cell contents will spill over and the cell is killed.

38. Osmotic solution is the one which can cause osmosis if separated from its solvent by a semipermeable membrane.

39. Endosmosis is the osmotic entry of water into a cell or system due to presence of hypotonic solution of the outside.

40. The main function of plasma membrane is to insulate the internal environment of the cell from external environment.

41. Exosmosis is the osmotic exit of water from a cell or system due to presence of hypertonic solution on the outside.

42. (i) Hypertonic solution is the one which has higher solute osmotic concentration and less solvent concentration as compared to another solution.

(ii) Hypotonic solution is the solution that possesses lower (osmotic) concentration and higher solvent concentration as compared to another solution.

(iii) Isotonic solution is the solution that has the same concentration, solute (osmotic) as well as solvent, as that of another solution.

43. ATP-Adenosine Triphosphate.

44. Golgi apparatus.

45. Endoplasmic reticulum.

46. Mitochandria are the sites for cellular respiration and provides energy to the cell. The largely folded inner membrane provides the increase in surface area for ATP-to generate chemical reactions.

47. The golgi bodies consist of a system of membrane-bound vesicles arranged in stacks called cisterns.

Short Answer Questions :

1. Hypertonic and hypotonic are relative terms: A solution that is hypertonic to tap water could be hypotonic to seawater. In using these terms, you must provide a comparison, as in "The solution is hypertonic to the cell.

2. Cells with spines or extensions help to overcome the surface area-to-volume ratio problem by increasing their surface area. Elongated or non-spherical cells also have a more favourable ratio.

3. Eukaryotes have organelles that each contain different enzymes, so the enzymes do not mix and interact within the cytoplasm of the cell. This arrangement allows for greater diversity in types of enzymes and reactions and greater diversity in eukaryotes. Prokaryotes do not have such organelles.

4. Rough ER consists of cisternae with numerous polysomes on their outer surface, whereas smooth ER lacks ribosomes and is mostly tubular. Rough ER is involved in protein synthesis, but smooth ER is involved in the synthesis of lipids.

5. Osmosis is a special type of diffusion because both involve movement of molecules of substance from the region of its higher concentration to the region of its lower concentration. In osmosis water moves across a semi-permeable membrane.

6. In plant cells vacuoles :

(a) Provide rigidity to the cell.

(b) Store waste products, and useful substances like amino acids, sugars, organic acids, proteins, minerals and pigments. In unicellular organisms like *Amoeba* :

(a) Food material is enclosed in vacuoles, called the food vacuole.

(b) Contractile vacuoles expel water and waste products from the cell.

7. One function of proteins embedded in the plasma membrane is to form gateways that allow selective passage of ions and molecules in and out of the cell. This allows wastes to be removed and needed substances to enter. Another function is to recognize changes in the outside environment and to communicate with other cells for the quick response to change occurred.

8. (a) control centre of cell ; houses DNA

(b) site of protein synthesis.

(c) lipid synthesis

(d) center for packaging and secretion

(e) degrade debris, recycle cell contents

(f) organelle in which energy transformation occur.

(g) site of photosynthesis

(h) contain enzymes that help the cell use oxygen.

9. Plant cells attain turgidity and rigidity due to the more number of vacoules as well as large sized vacuoles help the plant cells to withstand the wear and tear, external environment conditions. They also help in the storage of essential material required by plants for their growth like amino acids, sugar and various organic substances.

10. Water is absorbed by osmosis; fatty acids and glycerol are absorbed by diffusion (passive transport) and glucose, amino acids and some ions are absorbed by active transport.

11. Chromoplasts - Flowers and fruits.
Chloroplasts - Green leaves and green parts of young stems.
Leucoplasts - Root and underground stem.

12.

Prokaryotes	Eukaryotes
1. Nuclear material not bounded by nuclear envelope and lies directly in the cytoplasm.	1. Nuclear material is present in nucleus bounded by well developed double-membrane nuclear envelope
2. Membrane-bounded cell organelles absent.	2. Membrane-bounded cell organelles are present.

13. (a) Ribosomes are the sites of protein synthesis.
(b) Cell wall provides shape, rigidity and protection to the cell.

14. Two types of plastids in plant cells are-
(i) Leucoplasts (colourless plastids). These store carbohydrates, proteins and lipids in the cells.
(ii) Chromoplasts (coloured plastids). Green plastids *e.g.* chloroplasts synthesize food in the presence of sunlight by the process called photosynthesis.

15. Chromosomes are thread-like structures usually present in the nucleus and become visible only during cell division. They are composed of DNA and proteins.
(i) Chromosomes contain hereditary information of the cell.
(ii) DNA of chromosomes also controls all the activities of the cell.

16. Deoxyribonucleic acid (DNA).
Ribonucleic acid (RNA)

17. Cellulose (carbohydrate). A cellulose molecule is a long, unbranched chain of about 6000 glucose molecules.

18. (a) Plant cell wall is non-living.
(b) It is permeable.
(c) Plant cell wall is chiefly composed of insoluble firbous polysaccharide, cellulose (carbohydrate). Certain other compounds (hemicellulose, pectins and proteins) also occur in the cell wall.

19. (a) Robert Hooke coined the term cell.

(b) Light Microscope	Electron Microscope
1. Internal vacuum is not present.	1. Internal vacuum is essential.
2. It uses glass lenses	2. It uses electromagnets.
3. It uses beam of light to illuminate the object.	3. It uses beam of electrons instead of light.

20. (i) Mitochondria and chloroplast.
(ii) Mitochondria are capable of self duplication. They are also able to synthesize some of their own proteins. Hence, they are regarded as semiautonomous organelles.
(iii) Chlorophyll pigments are found in thylakoids of chloroplasts in a plant cell.

21. (a) Nuclear envelope, nuclear sap, chromatin material, nucleolus and nuclear matrix.
(b) Chromosomes are thread-like structures usually present in the nucleus and become visible only during cell division. Each chromosome is made up of DNA and proteins.
(c) (i) Metacentric chromosome
(ii) Telocentric chromosome.

22. The nuclear region in some cells are poorly defined due to the absence of a nuclear membrane, it contains only nucleic acid. This undefined nuclear region with nucleic acid in it is called nucleoid.

Long Answer Questions :

1. The plasma membrane has three major functions:
(1) It selectively isolates the cytoplasm from the external environment,
(2) It regulates the flow of materials into and out of the cell, and
(3) it communicates with other cells.
The membrane consists of a bilayer of phospholipids in which a variety of proteins are embedded. There are three major categories of membrane proteins:
(1) Transport proteins, which regulate the movement of most water-soluble substances through the membrane;
(2) Receptor proteins, which bind molecules in the external environment, triggering changes in the metabolism of the cell; and
(3) Recognition proteins, which serve as identification tags and attachment sites.

2. The principles of the cell theory are:
1. Every living organism is made up of one or more cells and products of cells.
2. The smallest living organisms are single cells, and cells are the functional units of multicellular organisms.
3. All cells arise from preexisting cells.

Cells are limited in size because they must exchange materials with their surroundings by diffusion. Because diffusion is relatively slow, the interior of the cell must never be too far from the plasma membrane, and the plasma membrane must have a large surface area through which materials can diffuse relative to the volume of its cytoplasm.
All cells are either prokaryotic or eukaryotic. Prokaryotic cells, or bacteria, are small and relatively simple in structure. More complex eukaryotic cells make up all other forms of life like protists, fungi, plants and animals.

3.

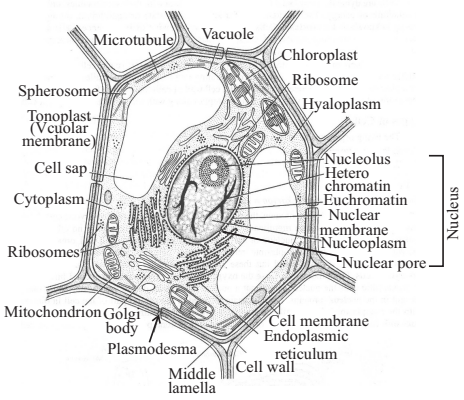


Fig. A plant cell (Electron microscopic structure)

4.

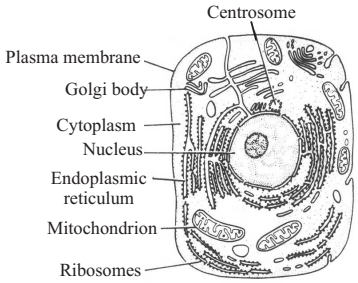


Fig. An animal cell

5. Chromosomes are thread-like structures usually present in the nucleus and become visible only during cell division. These contain hereditary information of the cell. DNA (deoxyribonucleic acid), and Proteins.

DNA is the most important component of a chromosome. These look like rods during the metaphase stage of the cell division. Each chromosome consists of two arms called chromatids which lie side-by-side along their length. The two chromatids of a chromosome are attached at a point called primary constriction of centromere.

One or both the arms of a chromosome may have secondary constrictions. The smaller part of chromosome separated by secondary constriction is called satellite. Chromosomes in which satellite is present are called SAT-chromosomes.

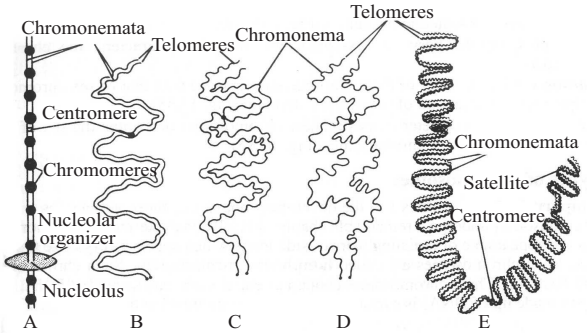


Fig. Chromosomes : A. Diagrammatic, B-E. Different parts of chromosomes

6. The nucleus typically consists of following components :

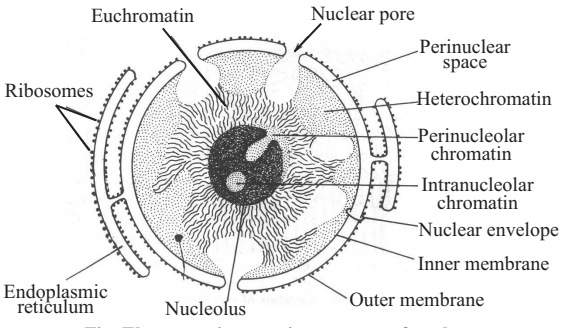


Fig. Electron microscopic structure of nucleus

(i) **Nucleus envelope :** It is bounded by two nuclear membranes, together referred to as nuclear envelope. The two nuclear membranes are designated as outer membrane and inner membrane.

(ii) **Nuclear Sap :** It is a clear, non-staining, fluid material present in the nucleus, also termed nucleoplasm. It contains raw materials, enzymes, proteins and metal ions for the synthesis of nucleic acids (DNA and RNAs) and ribosomal sub-units.

(iii) **Chromatin material :** It occurs in a non-dividing nucleus as fine filaments termed as chromatin fibres. These fibres lie criss cross and give the appearance of a diffuse network. Chromatin fibres help in cell division due to condensation of chromatin material. These are made up of DNA and proteins. The DNA possesses all the necessary information for the cell to function, grow and divide properly. The specific segments of DNA are termed genes. These are the hereditary units.

(iv) **Nucleus :** There is/are one or more rounded bodies called nucleoli (singular : nucleolus) are present in the nucleoplasm.

(v) **Nuclear Matrix :** It is a network of fine, criss crossing, protein-containing fibrils which are joined to the nuclear envelope by their ends. These maintain the shape of nucleus.

7. The chloroplasts of higher plants are usually spherical, ovoid, discoidal or lens shaped. Each chloroplast is a vesicle bounded by double membrane envelope and filled with a fluid matrix like the mitochondrion. The outer membrane is smooth and freely permeable to small molecules. Inner membrane is, however, selectively permeable. It has carrier proteins that control the passage of molecules. It is greatly infolded but the infolds become free in the mature chloroplast to lie as lamellae in the matrix.

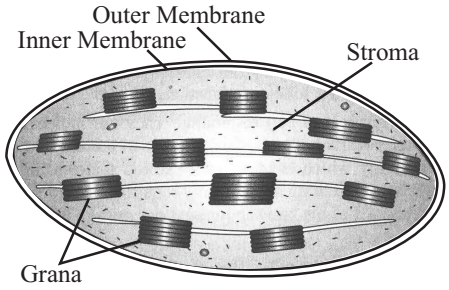


Fig. Diagrammatic representation o sectional view of chloroplast

Plastids perform many important functions :

1. The chloroplasts trap the radiant energy of sunlight and transform it into the chemical energy of carbohydrates using water and CO_2 (carbon dioxide). The process is called photosynthesis.
2. The chromoplasts impart various colours to flowers to attract insects for pollination and to the fruits for alluring certain animals for seed dispersal.
3. Leucoplasts store food in the form of starch (carbohydrates), fats and proteins.

8. (a) The ER is an extensive network of intracellular membrane-bound tubes and vesicles that occupies most of the cytoplasm in almost all eukaryotic cells.

(b) The membranes of endoplasmic reticulum system are lipoproteinic in nature similar in structure to the plasma membrane. The ER is more prominent in young and dividing cells as compared to older cells. It is absent in prokaryotic cells.

(c) The ER is of two types.

1. Rough endoplasmic reticulum (RER)
2. Smooth endoplasmic reticulum (SER)

(d) The SER brings about detoxification in the liver, *i.e.*, it converts harmful materials (drugs, insecticides, pollutants and poisons) into harmless substances for excretion by the cell.

(e) The endoplasmic reticulum helps in the manufacture of fat molecules or lipids, which are important for the cell function. These proteins and lipids helps in the building of the cell-membrane. This process is known as membrane biogenesis.

9. (i) This type of transport across plasma membrane is rapid and requires the use of energy in the form of ATP. It usually occurs against the concentration gradient and involves the use of carrier proteins. Glucose, amino acids and some ions (*e.g.*, Na^+ and K^+) pass through the plasma membrane by active transport or contransport.

(ii) Exocytosis is the process that involves fusion of membrane of the exocytotic vesicle with the plasma membrane to extrude its contents to the surrounding medium.

(iii) Phagocytosis is the intake of solid particles by a cell through cell membrane. It is also called cell eating. Phagocytosis is the major feeding method in many unicellular organisms (*e.g.*, *Amoeba*) and simple metazoa (*e.g.*, sponges). It is also the means by which leucocytes of blood engulf uninvited microbes (*e.g.*, viruses, bacteria), cellular debris etc. in the blood. Such cells are called phagocytes.

2 EXERCISE

Text - Book Questions :

1. Robert Hooke discovered cells. In 1665 under a self-designed microscope, he examined a thin slice of cork. The cork resembled the structure of a honey comb consisting of many little boxes. These little boxes were termed cells by Hooke.

2. All living organisms are composed of cells. Each cell has several cell organelles which perform a specific function for the cell. It is an example of division of labour within the cell. Thus cell has a basic structural organisation and is the basic functional unit.

3. **Movement of CO_2 :** Substances like CO_2 and oxygen move in and out of the cell through plasma membrane by diffusion. When concentration of CO2 is low outside the cell, CO2 moves out of the cell by diffusion and vice versa.

Movement of water :

Movement of water is affected by amount of substance dissolved in water. Water moves from a region of high water concentration to a region of low water concentration by osmosis.

4. Plasma membrane permits the entry and exit of some materials in and out of the cell. It also prevents movement of some other materials. Therefore, the plasma membrane is called selectively permeable membrane.

5.

Prokaryotic Cell	Eukaryotic Cell
1. Size : generally small (1-10 λm) 1 λm = 10^{-6}m	1. Size : generally large (5-100 λm)
2. Nuclear region : Poorly defined without nuclear membrane and known as nucleoid	2. Nuclear region : well defined and surrounded by a nuclear membrane
3. Chromosome : single	3. More than one chromosome
4. Membrance-bound cell organelles are	4. Membrane bound cell organelles are

6. Mitochondria and plastids have their own genetic material and ribosomes.

7. In case of any physical or chemical injury to the cell, lysosomes become active. They burst and their digestive enzymes digest the whole cell. Ultimately the cell will die.

8. Lysosomes are cell organelles which contain digestive enzymes capable of breaking down all organic materials. In case of any damage to the cell, lysosomes burst releasing the enzymes which digest the other cell organelles and finally the whole cell. So, they are called "suicide bags".

9. In a cell, ribosomes are the site of protein synthesis. Rough endoplasmic reticulum has ribosome particles attached to its surface. Ribosomes are also present in Mitochondria and Plastids, so these organelles also have their own protein synthesis machinery . Thus site of protein synthesis in a cell are — RER, mitochondria, plastids and nucleus.

Text - Book Exercise :

1. All living organisms are composed of cells which are the structural and functional units of life. Although the cells are similar in structure and function in all living organisms, plant cells are different from animals cells in some respects.

A comparative study of plant and animal cell shows the presence of plasma membrane, cytoplasm with cell organelles like endoplasmic reticulum, golgi apparatus, lysosomes, vacuoles, mitochondria etc. Nucleus with nuclear membrane and chromatin material is also seen.

Major points of differences between plant and animal cells are following :

	Plant cell	**Animal cell**
(i)	A rigid and protective cell wall of cellulose present outside the plasma membrane. Cell wall provides a definite shape to the plant cell.	Cell wall is absent.
(ii)	Cytoplasm has plastids which contain green coloured pigment called chlorophyll.	Animal cell lack plastids.
(iii)	Large sized vacuoles are present which provide rigidity and turgidity to the cell.	Small vacuoles are present.
(iv)	Centriole is absent.	Centriole is present.

2. On the basis of presence or absence of a well organised nucleus, cells are of two types– Prokaryotic and Eukaryotic.

Differences between prokaryotic and eukaryotic cell are as follows :

	Prokaryotic cell	**Eukaryotic cell**
(i)	Lacks well organised nucleus surrounded by nuclear membrane. Such a nucleus is called nucleoid.	Well organised nucleus surrounded by nuclear membrane is present.
(ii)	Membrane-bound cell organelles is absent.	Membrane-bound cell organelles is present.
(iii)	Single chromosome present.	More than one chromosome present.
(iv)	Small in size.	Large in size.

3. Presence of plasma membrane is so crucial for a cell that we can't even imagine the existence a cell without it. In case of any damage to the plasma membrane, the cellular metabolism get disturbed. Lysosomes become active and they burst. Their digestive enzymes digest the other cell organelles and finally the whole cell *i.e.*, the cell suicides.

4. In the absence of golgi apparatus the transport of proteins and lipids synthesized near rough and smooth endoplasmic reticulum inside and outside the cell will stop. The essential materials synthesized inside the cell will not reach to the target where they are required. So the various activities carried out by different parts of the cell will be affected. Other functions of the cell like storage and packaging of products by vesicles and formation of complex sugars will also affected. Lysosomes would not be produced and bacteria could attack and destroy the cell as there will be no digestive enzymes of lysosomes to break them.

5. Mitochondria are also known as the power houses of the cell because here energy rich compound ATP or adenosine triphosphate is produced which is required by body to carry out various metabolic activities.

6. The lipids and proteins constituting the cell membrane get synthesised in endoplasmic reticulum present in cytoplasm. Rough endoplasmic reticulum containing ribosomes synthesise proteins while smooth endoplasmic reticulum synthesise lipids. The process of building cell membrane with those lipids and proteins is called 'Membrane Biogenesis.

7. The flexible nature of cell membrane helps unicellular *Amoeba* to engulf food by the process called endocytosis. Whenever, *Amoeba* comes in contact with a food particle, its cell membrane along with cytoplasm grows in that direction. Finally it surrounds the food and make it a part of its cytoplasm.

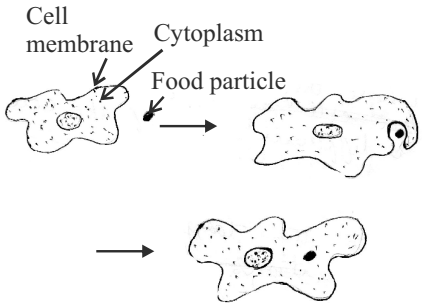


Fig.-Intake of food by *Amoeba* (Endocytosis)

8. The movement of water through a selectively permeable membrane from a region of high water concentration to a region of low water concentration is called osmosis. It is a kind of diffusion. *E.g.* unicellular fresh water organisms and plant roots absorb water by osmosis. Entry of water in a cell is called endosmosis, movement of water outside the cell is called exosmosis.

9. (i) In cups B and C the concentration of solution becomes more (due to sugar and salt) than that of the outer portion which remains in contact with water. So, there is endosmosis *i.e.*, the water will move inside the hollow portion.

(ii) To show that when the concentration is same on both sides, there is no movement of water.

(iii) The water does not gather in cup A due to the same concentration of solution.

The water does not gather in cup D because boiling kills the cells and dead cells are unable to absorb water by osmosis.

Exemplar Questions :

1. **Hint :** Bacterial cell is a prokaryote

Onion peel cell is a plant cell – an eukaryote

2. **Hint :** Endocytosis

3. **Hint :** Nucleus

4. Yes; cell is a building unit of an organism as every living organism is made up one or more cells. In unicellular organisms, single cell performs all the functions of life. However, in multicellular organisms, cells become specialized to form tissues; tissues form organs and various organs are grouped into organ-systems, each with a specific function. However, in all these hierarchial units, cell remains the basic building unit of the organism.

HOTS Questions :

1. (a) A plant cell, when placed in a hypotonic solution, receives water by osmosis. It does not burst because it is surrounded by a rigid cell wall which can withstand the turgor pressure of the turgid cell contents.

(b) When a fully turgid plant cell is placed in a hypertonic solution, the cytoplasm along with plasma membrane shrinks and separates from the cell wall as water flows out from the vacuole of the cell. This pheonomenon is called plasmolysis.

2. Mitochondria use molecular oxygen and bring about stepwise oxidation of food stuffs (carbohydrates, fats, proteins) present in the cells to produce carbon dioxide and water. Oxidation of food releases energy which is temporarily stored to form high-energy ATP molecules. ATP is used to bring about energy-requiring activities of the cell. On this account, mitochondria are called 'power houses' of the cell and ATP as the 'energy currency' of the cell.

3. Lysosomes remove the dead cells and debris that accumulate at the sites of injury by digesting them and thus make a way for their replacements. Thus, they are also called 'natural scavengers' and 'cellular housekeepers'.

4. (a) Fresh water unicellular organisms (*e.g. Amoeba*) continuously gain water in their bodies due to osmosis. These organisms have contractile vacuoles to throw out excess of water from their bodies.

(b) (i) Absorption of water by the plant roots from the soil through root hairs occurs due to osmosis.

(ii) In plants, cells, tissues and soft organs (leaves, young shoots, flowers) maintain turgidity due to osmotic absorption of water.

5. Nucleus contains chromosomes on which genes are present. Genes are responsible for all metabolic and developmental activities of an organism, as they produce specific proteins and enzymes by sending messages through RNA into cytoplasm. If nucleus is removed, all metabolic activities of the cell will cease to occur.

6. Both chloroplast and mitochondria are semiautonomous organelles having their own DNA and specific protein synthesising mechanism. Both of them help in cytoplasmic inheritance of certain specific character and both depend on nuclear genes for biosynthetic activities.

7. A DNA having short regions consisting of highly repetitive specific sequence of nucleotide pairs is called a satellite DNA. Satellite DNA are found only in heterochromatin region of the chromosome, which is genetically inert region.

8. Each species of organism has a characteristic content of DNA, which is constant in all the individuals of that species and has thus been called C-value. The amount or content of DNA of a species is not indicative of the number of genes it possesses, hence is called C-value paradox.

9. Centrosome is a cell organelle found in animal cells only. It remains present in the form of a small clear area of cytoplasm near the nucleus. It contains two granule-like centrioles. During cell division, centrioles are involved in the formation of spindle fibres.

10. In the absence of Golgi apparatus, the following probelems will arise:

(a) The secretory activities of the cell will cease to occur.

(b) The broken membranes like those of lysosomes, cell wall, plasma membrane, *etc.* will not get repaired

(c) Acrosome formation in sperm will not take place, causing inability of sperms to enter the egg.

11. The terminal part of a chromosome may bear a round structure called satellite, which remains separated from the rest of the chromosomes by a constriction. Such a chromosome is called SAT-chromosome. Human chromosome numbers 21 and 22 are examples of SAT-chromosomes.

12. An organism or cell with two sets of chromosomes (2n) or two genomes is called diploid. The somatic cells of higher plants and animals are ordinarily diploid. For example, the somatic cells of human beings contain 46 chromosomes (23 pairs) and are diploid.

An organism or cell having only one complete set (n) of chromosomes or one genome is called haploid. For example, the human sperm or ovum contains only 23 chromosomes and, hence, is haploid.

13. Polytene chromosome means many threaded chromosomes. In the salivary glands, malphighian tubules and gut epithelial cells of certain insect larvae (*e.g.*, Drosophila, Chironomus), the cell division is arrested by chromosomes go on dividing. Hence, a single chromosome contains thousands of repeated chromatids. These chromosomes are much larger in size (more than 200 times) as compared to the normal chromosome, and are called polytene chromosomes (giant chromosomes).

14. Streaming movement of cytoplasm inside a cell is called cyclosis. It helps in the movement of substances inside the cell. In lower organisms (*e.g.*, *Paramecium*), food vacuoles move through cyclosis in a definite path.

15. 1. A prokaryotic cell
2. Nucleoid
3. Ribosomes
4. (i) Cell wall (ii) Plasma membrane

16. Unlike lysosomes in animals cells, large vacuoles in plant cells can fill with water and push against the cell wall, giving it rigidity.

17. Vacuoles store primary metabolites, reserve proteins, and anthocyanins. In addition, vacuoles are involved in the breakdown of organelles and macromolecules, thus facilitating the recycling of chemical elements within the cell.

3 EXERCISE

Multiple Choice questions :

1.	(b)	**2.**	(a)	**3.**	(a)	**4.**	(b)
5.	(a)	**6.**	(c)	**7.**	(c)	**8.**	(b)
9.	(b)	**10.**	(a)	**11.**	(a)	**12.**	(b)
13.	(c)	**14.**	(d)	**15.**	(c)	**16.**	(c)
17.	(a)	**18.**	(b)	**19.**	(b)	**20.**	(a)
21.	(a)	**22.**	(b)	**23.**	(c)	**24.**	(d)
25.	(c)	**26.**	(b)	**27.**	(a)	**28.**	(a)
29.	(d)	**30.**	(b)	**31.**	(a)	**32.**	(a)
33.	(d)	**34.**	(d)	**35.**	(a)	**36.**	(c)
37.	(c)	**38.**	(c)	**39.**	(a)	**40.**	(d)
41.	(c)	**42.**	(d)	**43.**	(a)	**44.**	(b)
45.	(a)	**46.**	(c)	**47.**	(d)	**48.**	(a)
49.	(a)	**50.**	(b)	**51.**	(c)	**52.**	(d)
53.	(d)	**54.**	(a)	**55.**	(b)	**56.**	(b)
57.	(b)	**58.**	(a)	**59.**	(a)	**60.**	(c)
61.	(b)	**62.**	(d)	**63.**	(c)	**64.**	(a)
65.	(d)	**66.**	(a)	**67.**	(c)	**68.**	(c)
69.	(b)	**70.**	(d)	**71.**	(a)	**72.**	(c)
73.	(b)	**74.**	(b)	**75.**	(b)	**76.**	(c)
77.	(c)	**78.**	(a)	**79.**	(d)	**80.**	(b)
81.	(a)						

Assertion & Reason :

1.	(c)	**2.**	(c)	**3.**	(d)	**4.**	(a)
5.	(b)	**6.**	(c)	**7.**	(a)	**8.**	(b)
9.	(b)	**10.**	(c)				