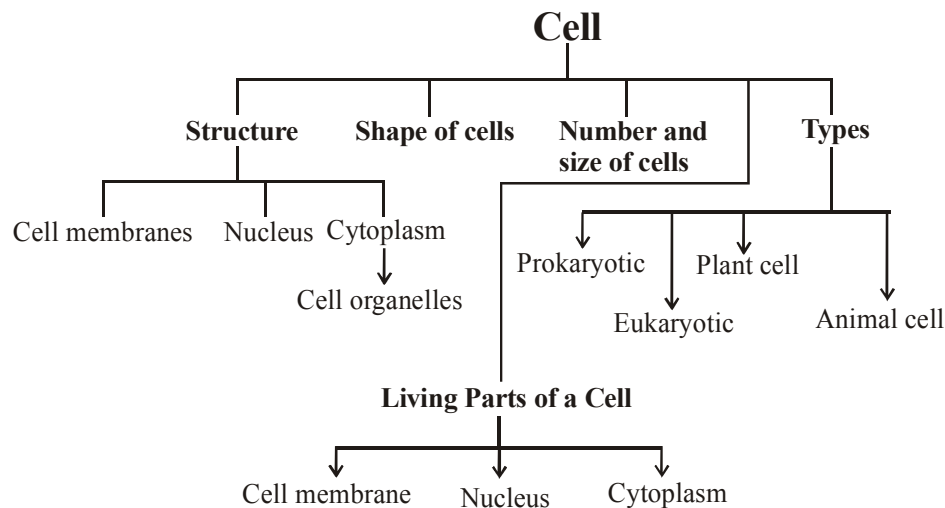


4

CELL STRUCTURE AND FUNCTION



INTRODUCTION

- **Cell is the structural and functional unit of all life forms.** A single cell organism such as **bacteria, Amoeba and Chlamydomonas** are also a type of life forms.
- The simplest organism like amoeba consist of one cell while humans have as many as few trillion cells.
- **The microscopic study of cell is called Cytology. A cell may be defined as a unit of protoplasm surrounded by a membrane.**
- **A.V. Leeuwenhoek (1632 – 1723)**, was first to construct a microscope. He discovered the minute forms of life such as bacteria and single-celled animals like **Infusoria** in a drop of water.
- **Leeuwenhoek (1674)** with the improved microscope, discovered the free cells in the form of bacteria etc. for the first time. The **first compound microscope** was built by **F. Jansen** and **Z. Jansen (1590)**.
- Cells were first discovered by **Robert Hooke (1665)**, in a cork slice. He gave details about cell in his book “**Micrographia**” and describe cell as honey comb lattice.
- It was **Robert Brown** in **1831**, who discovered the **nucleus** in the cell.
- **J.E. Purkinje** in **1839** gave the term ‘**protoplasm**’ for the **living fluid substance of the cell**.
- Cell theory was given by German botanist **M.J. schleiden (1838)** and German zoologist **T. Schwann (1839)**.
 - (i) A cell is the basic unit of life.
 - (ii) Cell does not arise de novo (Denovo–Spontaneous).
- **Modern cell theory or cell principle or cell doctrine states -**
 - (i) All organisms are made up of cells.

- (ii) Cells arise from pre-existing cells. (Omnis cellular cellula) added by **Rudolf Virchow**.
- (iii) All organisms start their life from single cell.
- (iv) Multiplication of cell and their growth leads to the growth of an organisms.

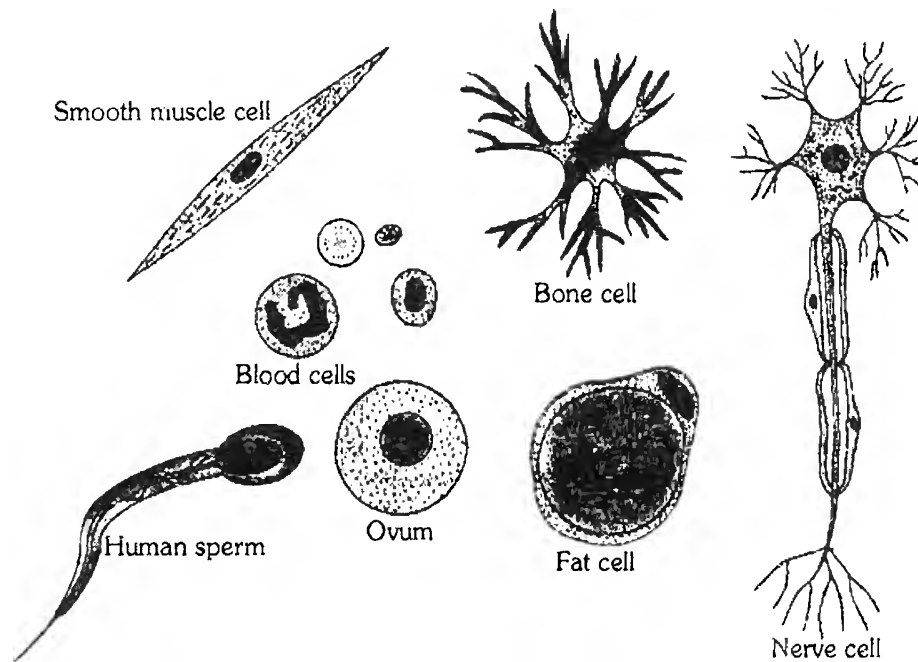
CELL STRUCTURE, SHAPE, SIZE AND NUMBER

1. Structure of Cell

- All cells have three major functional regions, viz. plasma membrane, nucleus and cytoplasm.
- The **cytologists** used to divide the cell into two major components – the nucleus and the cytoplasm.

2. Shape of Cell

There is a great variability in shape of cells. The shape of cell is usually related with its function.



3. Size of Cell

- The smallest cells (0.1 – 0.2 μm) are found in bacteria and some **pleuropneumonia-like organisms (PPLO)**, eg. **Mycoplasma**.
- The largest cell is the egg of an Ostrich which measures 6 inches in diameter with shell and 3 inches, if its shell is removed.
- The largest human cell is the female ovum (0.01 mm in diameter).
- The smallest human cell is the red blood cell (0.0075 mm or 7.5 μm).

4. Number of Cell

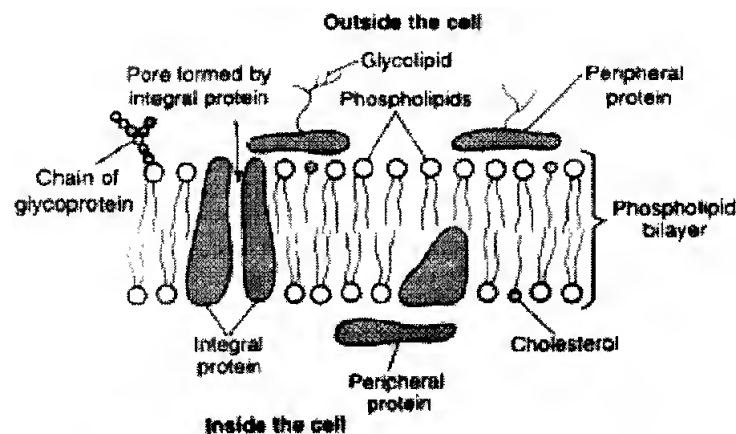
- The number of cells in living organisms also varies greatly.
 - (i) **Unicellular organisms** : In unicellular organisms, a single cell constitutes its body eg. **Amoeba and Paramecium (Protist Organisms) and Chlamydomonas**.
 - (ii) **Multicellular organisms** : are those which are made up of a few to billions of cells. Eg. Most plants and animals.

STRUCTURE OF CELL

- Cell has three main components :
1. Cell membrane 2. Cytoplasm 3. Nucleus

1. CELL MEMBRANE :

- Cell membrane is also called as **Plasma Membrane** or **Plasma lemma**.
- It is the limiting boundary of each cell which separates the cytoplasm from its surroundings.
- It is found in both plant as well as animal cells.
- It is the outer most covering of a cell in case of animals and lies below the cell wall in case of plants.
- It is made up of proteins and lipids where proteins are sandwiched between bilayer of lipids.
- Plasma membrane name was given by **Nageli**.
- Plasma membrane is selectively permeable in nature. It allows or permits the entry and exit of some materials in and out of the cell.
- Singer** and **Nicholson** gave the fluid mosaic model of plasma membrane according to him it consists of a protein layer sandwiched between two layers of lipids. It is in quasifluid state. It is 75Å thick.
- It is flexible and can be folded, broken and reunited.



Functions :

- It protects the internal components of the cell.
 - It provides shape to the cell.
 - It allows materials to enter and leave the cell through the tiny holes.
- In addition to the cell membrane, plant cells have an outer thick layer called **cell wall**. It is non living and is mainly composed of cellulose. It is protective in function and mainly determines the shape of cell.
 - Transportation of molecules across the plasma membrane:**
 This can be done by following ways:
 - Diffusion:** Movement of solutes or ions from higher concentration to lower concentration is called as diffusion. It does not require energy therefore it is called as passive transport.
 - Osmosis:** The movement of solvent or water from higher concentration (solvent) to lower concentration (solvent) through a semipermeable membrane is called as **osmosis**. The movement of solvent or water from lower concentration to higher concentration of solution through a semipermeable membrane is called as **osmosis**. Osmosis can also be called as “**diffusion of solvents**”.
 - Endosmosis:** Movement of solvent into the cell is called as Endosmosis.
 - Exosmosis:** Movement of solvent outside the cell is called as Exosmosis.

2. CYTOPLASM

- A transparent, jelly like protoplasmic mass of cell inner to plasma membrane and excluding nucleus is called cytoplasm. Cytoplasm was discovered by **Kolliker** in **1862**.
- It can be divided into two parts:
 - (i) **Cytosol:** Aqueous soluble part contains various fibrous proteins forming cytoskeleton.
 - (ii) **Cell organelles:** Living part of the cells having definite shape, structure and function bounded By Plasma membrane.

Cell Organelles and Their Functions

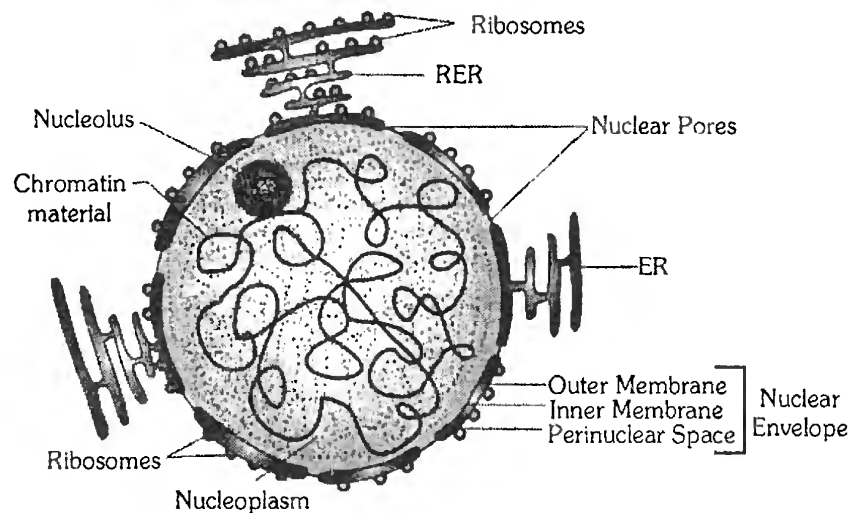
Organelle	Function(s)
Mitochondria (singular mitochondrion) 'Power house of cell'	Perform the function of respiration, provide the cell with energy.
Chloroplast (present only in plant cells)	Contain a green pigment called chlorophyll which helps in food manufacture (photosynthesis); also provides green colour to the leaves.
Endoplasmic reticulum	Being a network of membranes, it provides a large surface area for life functions to take place; synthesis of proteins and lipids.
Golgi complex	It collects and distributes the substances made in the cell (for example, proteins); synthesis and secretion of many materials.
Lysosomes (suicide bags)	Contain enzymes which help in breaking down or destroying the various materials.
Ribosomes	Site of protein synthesis.

- Vacuoles are membrane bound non-cytoplasmic sacs that contain non-living or solid contents. The covering membrane of vacuole is known as tonoplast. Sap vacuole stores salts, sugars, amino acids, organic acids & some proteins. It is also known as **dump** for waste produced in plant cells.
- Vacuoles are either absent or smaller in size in animal cells while they are large in size and single in number in plant cells.
- Plastids are found in plant cells. The plastids are of different colour. The green colour plastids are known as chloroplasts, which provide green colour to the leaves.

3. NUCLEUS

- It is a part of the cell, also called as **director/ master of the cell**, present in cytoplasm.
- First described by **Robert Brown (1831)**.
- In prokaryotic cells well defined nucleus is absent due to absence of nuclear membrane. Such undefined nuclear region is called a **nucleoid** or **genophore**.
- **Structure of Nucleus:**
It has four parts :

(A) Nuclear Membrane	(B) Nucleoplasm
(C) Nucleolus	(D) Chromosomes



(A) Nuclear Membrane (Karyotheca)

- It is bilayered, also called nuclear envelope.
- Has nuclear pores that allow exchange of substances between nucleus and cytoplasm etc.

(B) Nucleoplasm

- Transparent, homogenous, semifluid substance, having chromatin material and nucleolus.
- Having water, sugar, minerals and various enzymes.

(C) Nucleolus

- It is a spherical body in the nucleus. It is composed of RNA and is ribosome factory.

(D) Chromosome

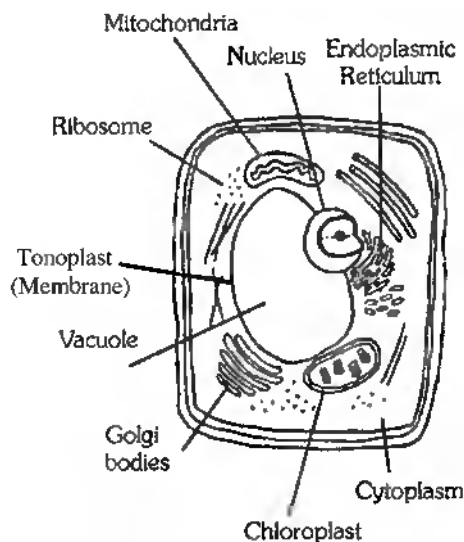
- The hereditary units of chromosomes are the genes. They are responsible for the transmission of characters from parents to the offspring.

Functions of Nucleus

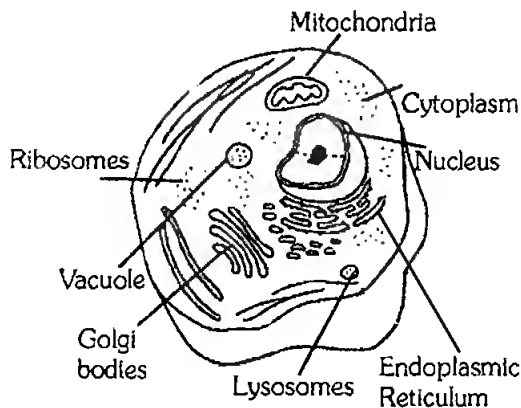
- Controls all cellular activities.
- Chromosome contains hereditary informations of the cell and transfer the genetic information from one generation to another.
- Plays central role in cellular reproduction.

TYPES OF CELL

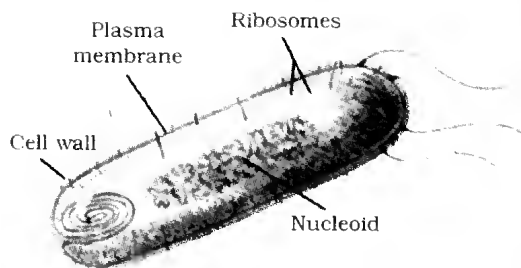
- On the basis of well organised nucleus, cells can be of two types
 - Prokaryotic Cells** : These are cells having primitive nucleus without nuclear membrane. Organism with primitive nucleus are known as prokaryotes.
Eg. Bacteria and Blue green algae etc.
 - Eukaryotic Cells** : These are cells having a well organised nucleus with nuclear membrane. Organisms with true nucleus are known as eukaryotes.
Eg. Man, Elephant, Onion etc.



Plant Cell



Animal Cell



Bacterial cell

Differences between Prokaryotic and Eukaryotic Cells

S.No.	Prokaryotic Cell	Eukaryotic Cell
1	Size is Generally small (1-10 um)	Size is Generally large (1-100 um)
2	Protoplasm is relatively rigid, usually non vacuolate.	Protoplasm is typically more fluid like, generally vacuolate..
3	True nucleus absent, i.e. nuclear membrane and nucleolus absent.They have incipient nucleus or nucleiod or genophore	True nucleus present, i.e. nuclear membrane and nucleolus present.
4	Membrane-bound cell organelles like plastids, mitochondria, Golgi bodies, E.R. absent.	Membrane-bound cell organelles like plastids, mitochondria, Golgi bodies, E.R. present.
5	Ribosomes are of 70S type.	Ribosomes are of 80S type.
6	Examples: Bacteria, blue-green algae, mycoplasma.	Examples: Cell of all higher organisms, including plants and animals

Differences between Plants Cell and Animal Cell

S.No.	Plant Cell	Animal Cell
1	It has a definite cell wall. Cellulose is present in the cell wall.	Cell wall is absent.
2	One or more vacuoles are present.	Vacuoles may or may not be present.
3	Plastids are usually present.	Plastids are absent.
4	Centrosome is absent.	Centrosome is present near the nucleus.



POINTS TO REMEMBER

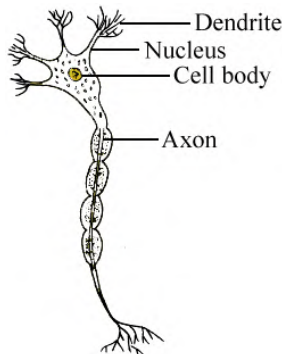
- ◆ *Cell* is the basic unit of life that can carry out all the processes of life.
- ◆ *Robert Hooke* was the first person to observe cells under a microscope.
- ◆ All organisms are made of smaller parts called as an organs. Organs are made of still smaller parts called cell.
- ◆ *Tissue* is a group of cells that are alike and work together to perform a specific function.
- ◆ *Organ* is a relatively independent part of the body. It is a group of tissue that carries out one or more specialised function.
- ◆ *Organisms* made of more than one cell are called multicellular organisms. Examples plants and animals.
- ◆ Organisms made of single-cell are called *unicellular organisms*. Examples, *Amoeba*, *Paramecium*.
- ◆ The single cell of unicellular organism performs all the basic functions performed by a variety of cells in multicellular organisms.
- ◆ A white blood cell (WBC) in human blood is an example of single cell which can change in shape.
- ◆ The cell has three main parts–
 - Cell membrane
 - Cytoplasm
 - Nucleus
- ◆ Cells without well organised nuclei (i.e, lacking nuclear membrane) are called *prokaryotic cells*. For example, bacterial cell.
- ◆ Cells having well organised nuclei with a nuclear membrane are called *eukaryotic cells*. For example, onion cells and cheek cells.
- ◆ *Plasma membrane* is a *selectively permeable* membrane. It regulates the movement of molecules in and out of cell.
- ◆ Plant cells differ from animal cells in having an additional layer around cell membrane called *cell wall*.
- ◆ When a plant cell is put in a hypertonic solution, it losses water due to osmosis (exosmosis) and as a result, protoplast is shrunk away from the cell wall. This is called plasmolysis.
- ◆ Various membrane bound cell organelles present in eukaryotic cell are nucleus, endoplasmic reticulum, golgi apparatus, mitochondria, plastids, lysosomes etc.
- ◆ *Mitochondria* form power house of cell. They use molecular oxygen and generate energy-rich compounds.
- ◆ *Chloroplasts* are chlorophyll containing green plastids. They use water and CO₂ and convert radiant energy of sunlight into chemical energy of carbohydrates.
- ◆ *Ribosomes* are sites of protein synthesis.
- ◆ *Endoplasmic reticulum* are of two types – SER and RER, SER synthesizes lipids and RER synthesises proteins.
- ◆ *Golgi apparatus* is the site for the storage, processing and packaging of various cellular secretions.
- ◆ *Lysosomes* form garbage disposal system of animal cells.
- ◆ *Nucleus* contains thread like structure called chromosomes, which carry genes and helps in transmission of characters.

CONCEPT APPLICATION LEVEL - I [NCERT Questions]

Q.1 Make a sketch of the human nerve cell. What function do nerve cells perform?

Ans. Function of Nerve cells:

The nerve cell receives and transfers messages, thereby helping to control and coordinate the working of different part of the body.



Q.2 Write short notes on the following :

- (a) **Cytoplasm**
 (b) **Nucleus of a cell**

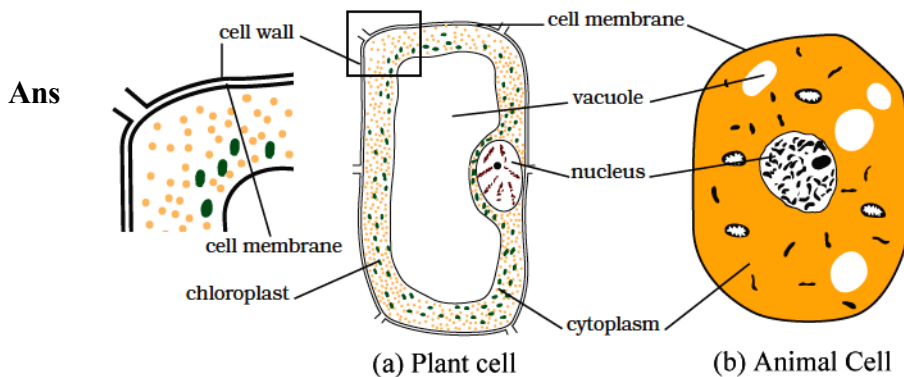
Ans. (a) **Cytoplasm:** This is jelly like substance found between the nucleus and the cell membrane. Various other components or organelles of cells are present in the cytoplasm. It is made up of basic elements like C, H, O and N. These are found in the form of substances like carbohydrates, proteins and water. These substances are present in all the cells of every organism irrespective of size, shape and whether they are unicellular or multicellular.

(b) **Nucleus of a Cell:** It is an important component of the living cell. It is generally spherical and located in the centre of the cell. It can be stained and seen easily with the help of a microscope. Nucleus is separated from the cytoplasm by a membrane called the **nuclear membrane**. This membrane is also porous and allows the movement of materials between the cytoplasm and the inside of the nucleus.

With a microscope of higher magnification, we can see a smaller spherical, dense body in the nucleus. It is called the **nucleolus**. In addition, nucleus contains thread-like structures called **chromosomes**. These carry genes and help in inheritance or transfer of characters from the parents to the next generation. The chromosomes can be seen only when the cell divides.

Nucleus, in addition to its role in inheritance, acts as control centre of the activities of the cell.

Q.3 Make sketches of animal and plant cells. State *three* differences between them.



Plant cells	Animal cells
1. The outermost covering is cell wall which is made of cellulose.	1. The outermost covering is the plasma membrane which is living material.
2. Plastids (e.g., chloroplasts) present.	2. Plastids absent.
3. Large vacuoles present.	3. No or small vacuoles are present.

Q.4 State the difference between *eukaryotes* and *prokaryotes*.

Eukaryotes	Prokaryotes
1. Nucleus of the cell has nuclear membrane.	1. Nucleus is not bound by membrane.
2. Possess membrane bound organelles.	2. Membrane bound organelles are absent.
3. Examples include all higher plants and animals.	3. Examples are bacteria and blue green algae.

Q.5 Where are chromosomes found in a cell? State their functions.

Ans. Chromosomes found in nucleus. Functions of chromosomes carry genes on them and help the transfer of character from parents to the next generation.

Q.6 Cells are the basic structural units of living organisms. Explain.

Ans. Cells in the living organism are basic structural units. They have different designs, shape and sizes in the living organism. In living world, organism differ from one another cell but all are made up of cells. Cells in the living organism are complex living structure.

Q.7 Explain why chloroplasts are found only in plant cells?

Ans. These coloured bodies are scattered in the cytoplasm of the leaf cells. These are called plastids. They are of different colours. Some of them contain green pigment called chlorophyll. Green coloured plastids are called chloroplasts. They provide green colour to the leaves. Chlorophyll mostly found in plant cell. Therefore chloroplast found in plant cells.

Q.8 Distinguish between plasma membrane and cell wall.

Plasma membrane	Cell wall
1. It consist of lipids and protein and it is living.	1. It is made up of complex carbohydrate called cellulose and it is dead or non-living.
2. It is found in both plant and animal cells.	2. It is found in plant cells only.
3. It is semi permeable.	3. It is permeable.
4. It is soft and elastic.	4. It is hard and rigid.

Q.9 What is the significance of cell wall in a plant cell?

Ans. It performs the following functions in the plant cell:

- (i) It gives a definite shape to the cell.
- (ii) It provides rigidity and strength to the cell.
- (iii) It protects the inner cell organelles bounding the cell.
- (iv) It also withstand the osmotic pressure which is developed by cell contents.

Q.10 How do you differentiate *protoplasm* from *cytoplasm*?

Ans. Protoplasm is the liquid substance enclosed by cell membrane while cytoplasm is the liquid between the nucleus and plasma membrane.