The Cell

Biological Cell is structural and functional unit in living organisms, all living organisms are composed of one or more cells which multiply by cell division. There are many unicellular organisms, e.g., bacteria and protozoa, in which the single cell performs all life functions. In higher organisms, a division of labor has evolved in which groups of cells have differentiated into specialized tissues, which in turn are grouped into organs and organ systems. Cells of living organisms are classified on base the internal structure into two groups eukaryotic cells has a membrane-enveloped nucleus and prokaryotic cells no have nuclear membrane. The bacteria are prokaryotes which are smaller in size and simpler in internal structure than eukaryotes.

Cell Theory

The cell theory is one of the basic principles of biology. Three German scientists: Theodor Schwann, Matthias Schleiden, and Rudolph Virchow recorded cell theory states

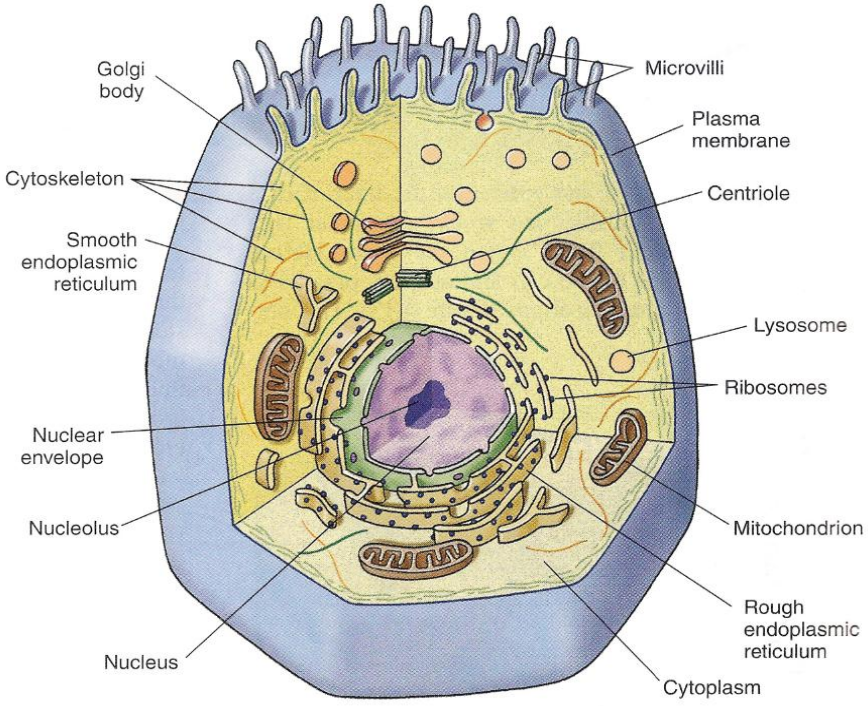
Cell Theory by Theodor Schwann, Matthias Schleiden, and Rudolph Virchow

The basic characteristics of the composition of a living cell

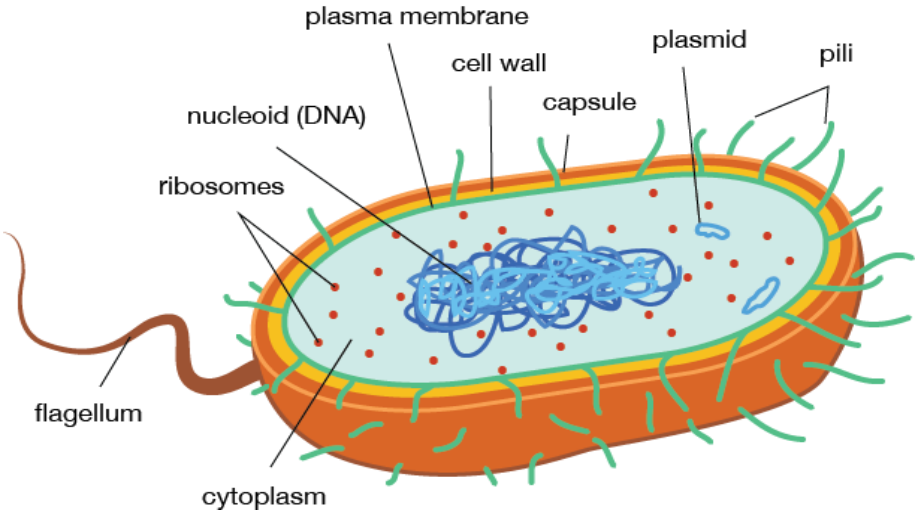
1-Cell membrane and the plasma .

2-Genetic material .

3-The mechanism Biosynthesis .



Typical Eukaryotic Animal Cell



Typical Prokaryotic bacterial Cell

All cells share a number of common properties are

►They store genetic information in genes made of DNA

►They use proteins as their main structural material

►They synthesize proteins in the cell's ribosomes using the information encoded in the DNA and mobilized by means of RNA

►They use adenosine triphosphate (ATP) as the means of transferring energy for the cell's internal processes

►They are enclosed by a cell membrane, composed of proteins and a double layer of lipid molecules, that controls the flow of materials into and out of the cell.

The prokaryotic Cell Eukaryotic cells

The prokaryotic Cell

The property—the presence or absence of a nucleus—is used as the basis for a simple but fundamental classification of all living things. Organisms whose cells have a nucleus are called eukaryotes (from the Greek words eu, meaning "well" or "truly," and karyon, a "kernel" or "nucleus"). Organisms whose cells do not have a nucleus are called procaryotes (from pro, meaning "before'')

The prokaryotes include bacteria (singular bacterium) and archaea (singular archaeon). Prokaryotes are typically spherical, rod-like, or corkscrew-shaped, and small—just a few micrometers long. They often have a tough protective coat, called a cell wall, surrounding the plasma membrane, which encloses a single compartment containing the cytoplasm and the DNA. The cells reproduce quickly by dividing in two. Under optimum conditions, when food is plentiful, a prokaryotic cell can duplicate itself in as little as 20 minutes. In 11 hours, by repeated divisions, a single prokaryote can give rise to more than 8 billion progeny (which exceeds the total number of humans presently on Earth).

Eukaryotic Cell

Eukaryotic cells, in general, are bigger and more elaborate than bacteria and archaea. Some live independent lives as single-celled organisms, such as amoebae and yeasts; others live in multicellular assemblies. All of the more complex multicellular organisms—including plants, animals, and fungi—are formed from eukaryotic cells. All eukaryotic cells have a nucleus. But possession of a nucleus goes hand-in-hand with possession of a variety of other organelles, subcellular structures that perform specialized functions

Structure of the cell

1- Cell Wall

The cell wall is structural layer, semi-permeable protective layer in some cell types, situated outside the cell membrane. It can be tough, flexible, and sometimes rigid. It provides the cell with both structural support and protection, and also acts as a filtering mechanism. Cell walls are present in most prokaryotes such as bacteria and some archaea, and in plants, fungi and other eukaryotes. Animal cells however, do not have a cell wall

Cell wall composition varies depending on the organism. The composition of cell walls varies between species and may depend on cell type and developmental stage

2- Cell Membrane

Biological membranes surround cells and serve to keep the insides separated from the outsides. They are formed of phospholipid bilayers, which by definition are a double layer of fatty acid molecules (mostly phospholipids, lipids containing lots of phosphorus)

Proteins serve very important functions in cellular membranes. They are active transports in and out of the cell, acting as gatekeepers. They relay signals in and out of the cell. Proteins are the site of many enzymatic reactions in the cell, and play a role in regulation of cellular processes.

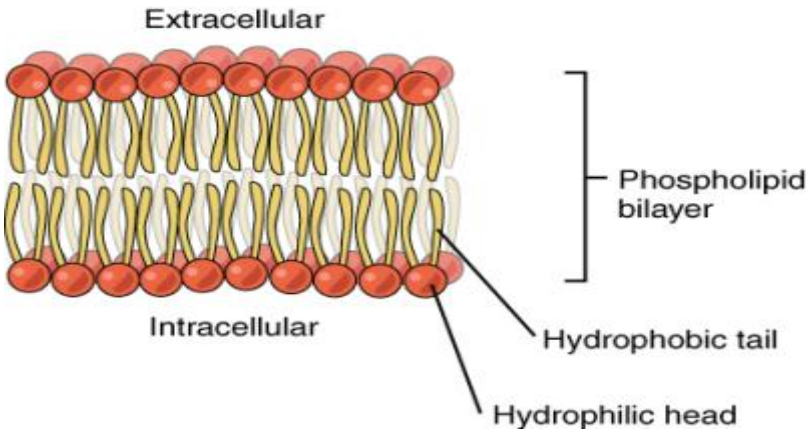


Figure: phospholipid bilayer is composed of two layers of phospholipids

Phospholipid

►Phospholipid bilayer basis of biological membranes and cellular organisms

►contains a charged, hydrophilic (attracted to water) head and two hydrophobic (repelled by water) hydrocarbon tails

►In presence of water, phospholipids form bilayer

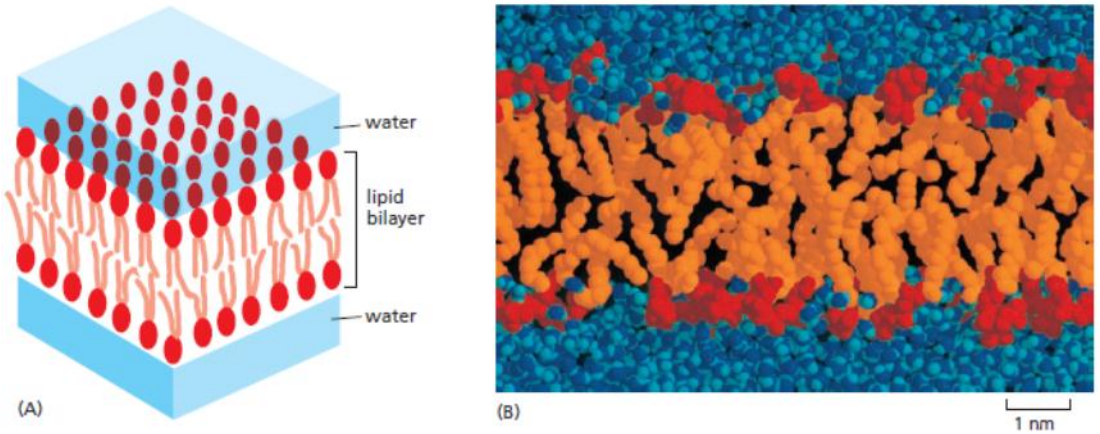


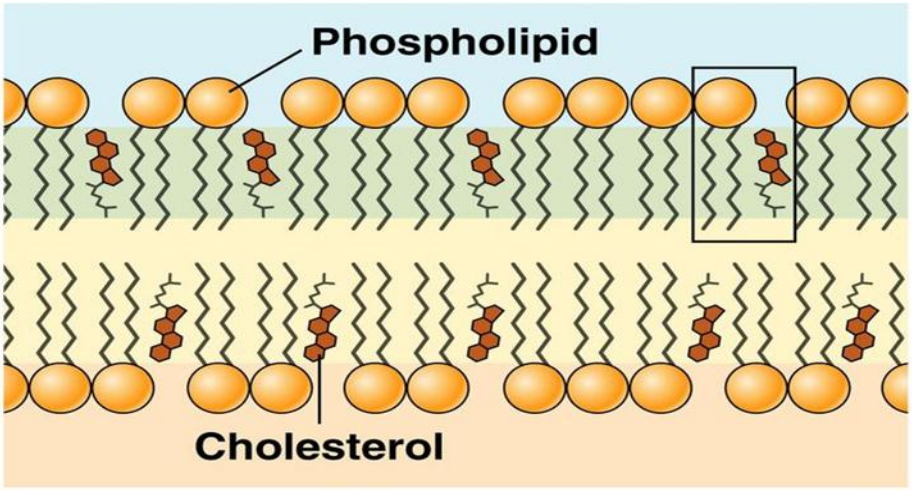
Figure: Amphipathic phospholipids form a bilayer in water. (A) Schematic drawing of a phospholipid bilayer in water (B) Computer simulation showing the phospholipid molecules and the surrounding water molecules in a cross section of a lipid bilayer

Fluid mosaic model

The fluid mosaic model was first proposed by S. J. Singer and G. L. Nicolson in 1972 to describe the structure of cell membranes. This discovery is about cell structure, phospholipid molecules, each with one hydrophobic, and one hydrophilic end, make up most of the membrane.

The lipids in cell membranes combine two very different properties in a single molecule: each lipid has a hydrophilic ("water-loving") head and one or two hydrophobic ("water fearing") hydrocarbon tails. The most abundant lipids in cell membranes are the phospholipids molecules in which the hydrophilic head is linked to the rest of the lipid through a phosphate group. The most common type of phospholipid in most cell membranes is phosphatidylcholine, which has the small molecule choline attached to a phosphate as its hydrophilic head and two long hydrocarbon chains as its hydrophobic tails

Molecules with both hydrophilic and hydrophobic properties are termed amphipathic. This chemical property is also shared by other types of membrane lipids, including the sterols (such as the cholesterol found in animal cell membranes) and the glycolipids, which have sugars as part of their hydrophilic head. Having both hydrophilic and hydrophobic parts plays a crucial part in driving these lipid molecules to assemble into bilayers in an aqueous environment



Cholesterol in plasma membrane

3- Nucleus

The nucleus is the round object in the cell that holds the genetic information (DNA) of the cell. It is surrounded by a nuclear envelope and has a nucleolus inside

Nuclear envelope is a double-layered plasma membrane like the cell membrane, although without membrane proteins. To allow some chemicals to enter the nucleus, the nuclear envelope has structures called nuclear pores. The nuclear envelope is continuous with the endoplasmic reticulum.

The nucleolus appears in a microscope as a small dark area within the nucleus. The nucleolus is the area where there is a high amount of DNA transcription taking place.

The nucleus is the information store of the Cell

The nucleus is usually the most prominent organelle in a eukaryotic cell. It is enclosed within double membranes that form the nuclear envelope, and it contains molecules of DNA—extremely long polymers that encode the genetic information of the organism. In the light microscope, these giant DNA molecules become visible as individual chromosomes when they become more compact as a cell prepares to divide into two daughter cells. DNA also stores the genetic information in

prokaryotic cells; these cells lack a distinct nucleus not because they lack DNA, but because they do not keep their DNA inside a nuclear envelope, segregated from the rest of the cell contents

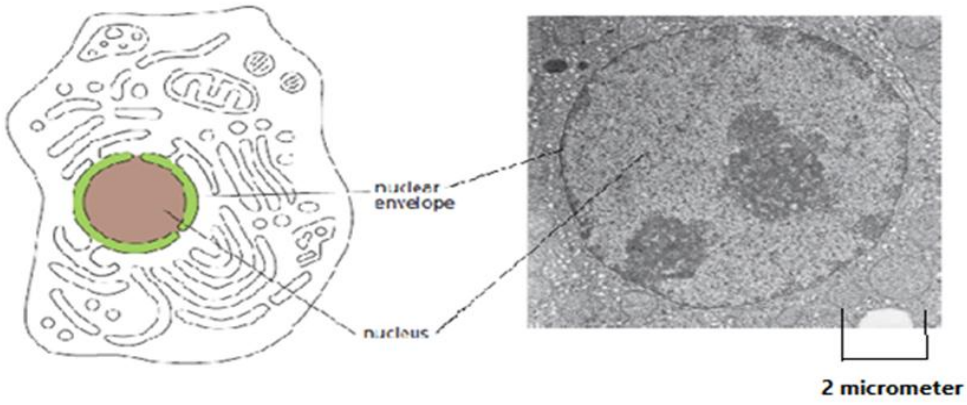


Figure: The nucleus contains most of the DNA in a eukaryotic cell. (a) In this drawing of a typical animal cell—complete with its extensive system of membrane-enclosed organelles—the nucleus - nuclear envelope and the cytoplasm (the interior of the cell outside the nucleus) . (B) an electron micrograph of a nucleus in a mammalian cell.

4- Endoplasmic reticulum

The endoplasmic reticulum is a cellular organelle made up of a series of extended folded intracellular membranes. It is continuous with the nuclear membrane. There are two main types of endoplasmic reticulum: rough endoplasmic reticulum (site of protein synthesis) associated with (ribosomes) and smooth endoplasmic reticulum (site of lipid synthesis)

Rough Endoplasmic Reticulum

The rough endoplasmic reticulum is made up of membranes which have ribosomes attached to it. This means that the rough endoplasmic reticulum is responsible for the production of polypeptides that are about to be taken through the membrane to be post-modified. Rough endoplasmic reticulum is an organelle found in eukaryotic cells. Its main function is to produce proteins.

Smooth Endoplasmic Reticulum

Smooth endoplasmic reticulum produces enzymes for lipid and carbohydrate biosynthesis and detoxification rough endoplasmic reticulum.

Sarcoplasmic Reticulum

This is a specialized form of endoplasmic reticulum found in some muscle cell types particularly striated, skeletal muscle. Its main function is different from the other types in that are mainly acts as storage of calcium.

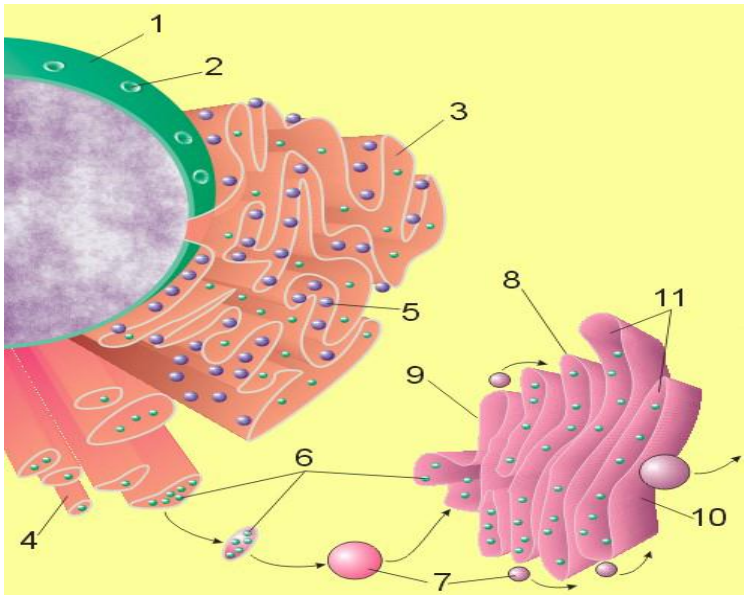


Figure: nucleus, endoplasmic reticulum and Golgi apparatus

1.Nucleus 2.Nuclear pore 3.Rough endoplasmic reticulum (RER)
4.Smooth endoplasmic reticulum (SER) 5.Ribosome on the rough ER
6.Proteins that are transported 7.Transport vesicle 8.Golgi apparatus
9.Cis face of the Golgi apparatus 10.Trans face of the Golgi apparatus
11.Cisternae of the Golgi apparatus

5-The Golgi apparatus

The Golgi apparatus is made up of a series of flattened, stacked pouches called cisternae. The Golgi apparatus is responsible for transporting, modifying, and packaging proteins and lipids into vesicles for delivery to targeted destinations. It is located in the cytoplasm next to the endoplasmic reticulum and near the cell nucleus. While many types of cells contain only one or several Golgi apparatus, plant cells can contain hundreds

6-Peroxisomes are small, membrane-enclosed organelles that contain enzymes involved in a variety of metabolic reactions, including several aspects of energy metabolism.

Peroxisomes contain at least 50 different enzymes, which are involved in a variety of biochemical pathways in different types of cells. Peroxisomes originally were defined as organelles that carry out oxidation reactions leading to the production of hydrogen peroxide. Because hydrogen peroxide is harmful to the cell, peroxisomes also contain the enzyme catalase, which decomposes hydrogen peroxide either by converting it to water or by using it to oxidize another organic compound

They replicate by division

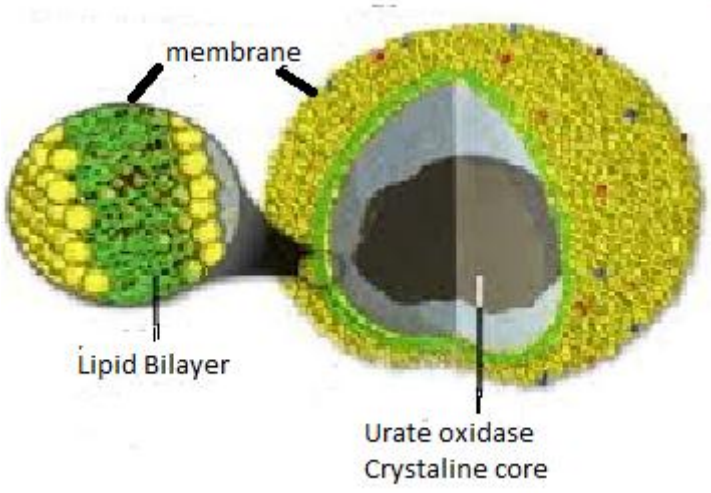


Figure: Anatomy of Peroxisome

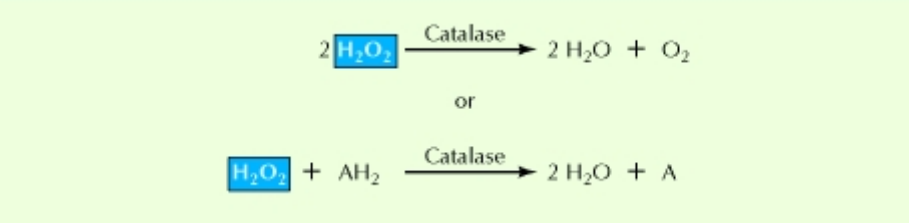


Figure: Fatty acid oxidation in peroxisomes

The oxidation of a fatty acid is accompanied by the production of hydrogen peroxide (H_2O_2) from oxygen. The hydrogen peroxide is decomposed by catalase, either by conversion to water or by oxidation of another organic compound (designated $AH_{2)}$

7-Ribosomes

Ribosomes are the site of protein synthesis. Ribosomes themselves are synthesized in the cell nucleoli and are structured as two subunits, the large and the small. These parts are composed of RNA and protein Prokaryotic and eukaryotic ribosomes are different, the eukaryotic ones being larger and more complicated.

8-DNA-containing organelles

Although the vast majority of DNA in most eukaryotes is found in the nucleus, some DNA is present within the **mitochondria** of animals, plants, and fungi and within the chloroplasts of plants. These organelles are the main cellular sites for ATP formation, during oxidative phosphorylation in mitochondria and photosynthesis in chloroplasts. Many lines of evidence indicate that mitochondria and chloroplasts evolved from bacteria that were endocytosed into ancestral cells containing a eukaryotic nucleus, forming endosymbionts. The mitochondria and chloroplasts in today's eukaryotes retain circular DNAs encoding proteins essential for organelle function as well as the ribosomal and transfer RNAs required for their translation. Thus eukaryotic cells have multiple genetic systems: a predominant nuclear system and

secondary systems with their own DNA in the mitochondria and chloroplasts.