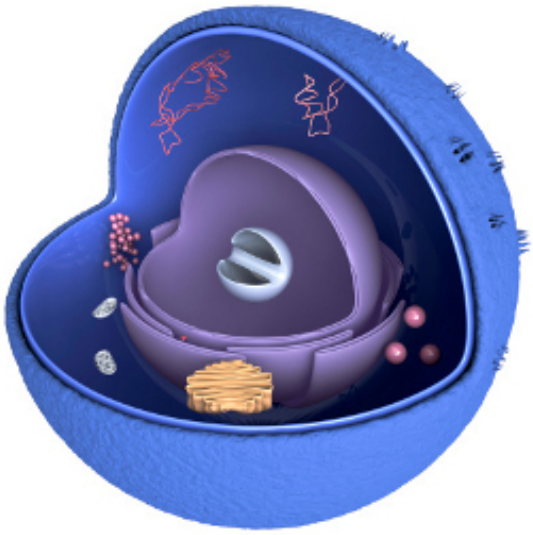
Organelles and Their Functions

The study of cell organelles and their functions is a fascinating part of biology. The current article provides a brief description of the structure of organelles and their functions.

Tagged Under: Cell Biology

Did You Know?

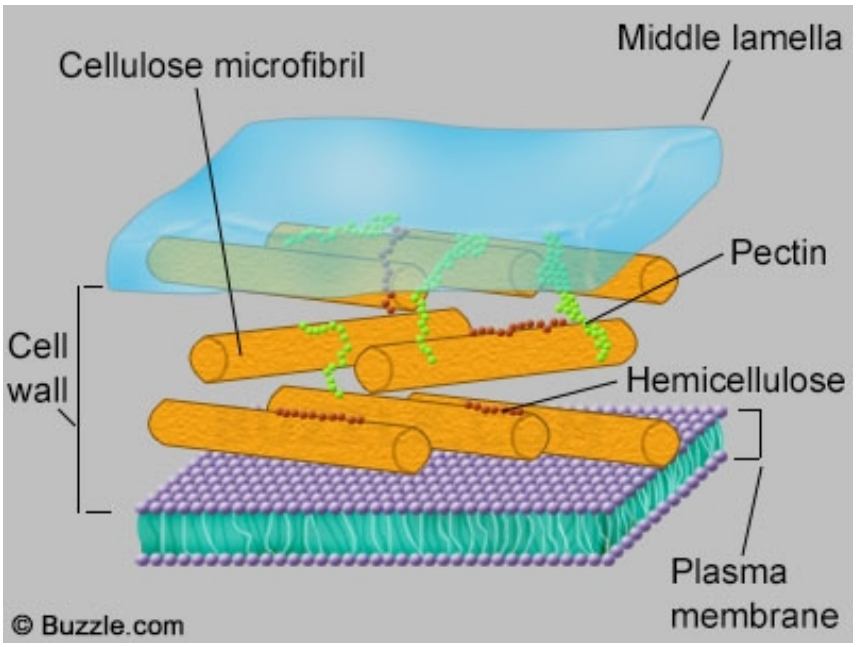


Cells have special **internal highways** and **cargo-carriers** made from proteins, for transporting cellular components within the cell. Even these highways are not devoid of **traffic jams!**

Cells are the basic structural and functional units of an organism. Organelles are specialized membrane-bound structures present inside a eukaryotic cell, and have specific and precise roles in various cellular processes. Prokaryotic organisms like bacteria and archaea lack a nucleus and the genetic matter floats freely within the cells.

Although most organelles are common to both plant and animal cells, certain organelles like cell wall and chloroplast are present only in plant cells; whereas lysosomes and centrioles are predominantly present in animal cells. Given below is a brief description of the structure of different cell organelles and their functions.

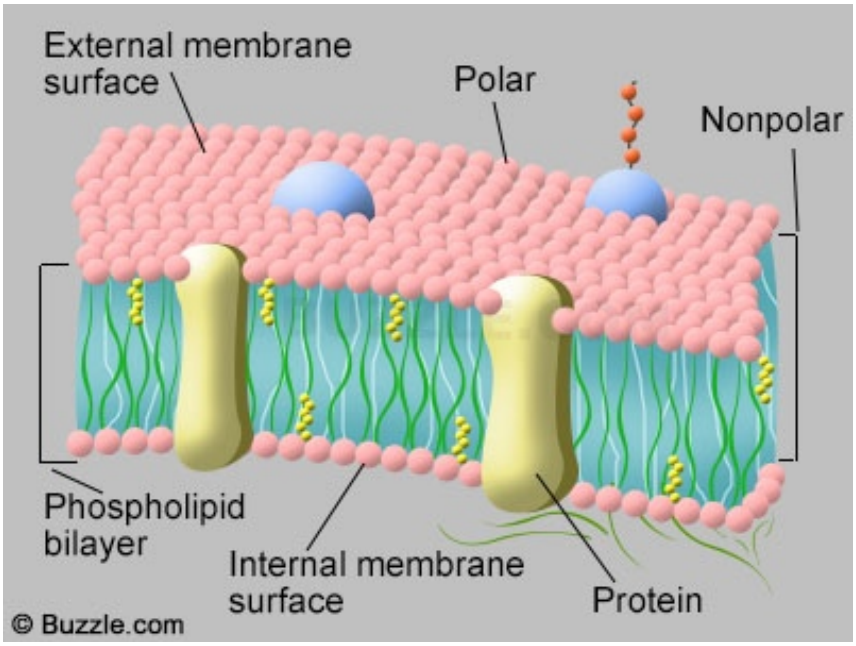
Cell Wall



Structure: This is the outermost covering of a cell, and is present only in plant cells. It is made up of pectin, hemicellulose, cellulose microfibrils, and proteins organized into two layers called primary cell wall and middle lamella. In many plant cells a third layer called secondary cell wall, which is made up of lignin, is present between the primary cell wall and the cell membrane.

Function: The cell wall provides support, protection and rigidity to the plant cells. It is a semi-permeable structure and allows only certain set of molecules to enter and exit the cell. The middle lamella serves as a cementing layer between adjoining cells.

Cell Membrane

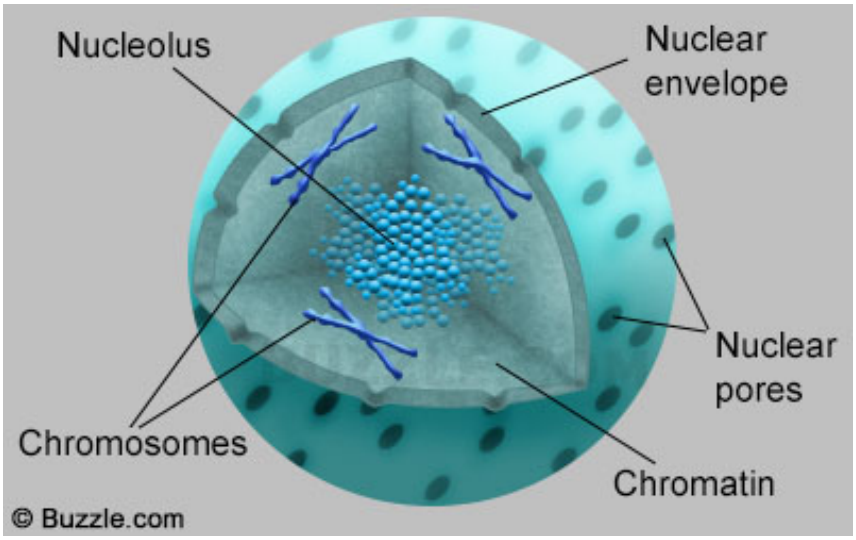


Structure: It is present just below the cell wall in plant cells, and forms the outermost covering of an animal cell. It comprises two layers of phospholipids arranged in such a way that their hydrophobic tails are on the inner side and the hydrophilic heads form the outer side. This arrangement is called a *phospholipid bilayer*.

Function: The cell membrane provides structure and shape to the cell, and is responsible for holding the organelles together. It regulates the entry and exit of molecules and ions from the cell, and plays a vital role in cell eating (phagocytosis) and cell drinking (pinocytosis). It is also involved in the se-

cretion of hormones, enzymes and other molecules outside the cells, as well as in several processes of the immune system.

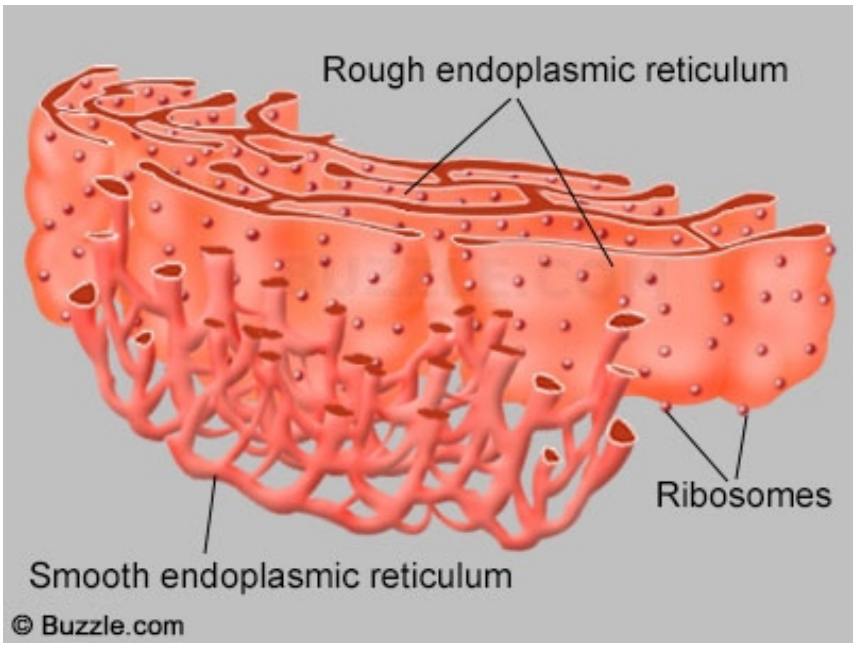
Nucleus



Structure: It is the most important organelle as it contains the genetic material of the cell enclosed inside two concentric phospholipid bilayers collectively called nuclear envelope. Inside the nuclear envelope is present chromatin and nucleolus, which is composed of nucleic acids and certain proteins. The nuclear envelope has tiny pores called nuclear pores which allow the transport of molecules, especially regulatory macromolecules and gene products, from the nucleus to the cytoplasm, and vice versa.

Function: The nucleus is often referred to as the 'brain' of the cell, as it controls all the activities that are carried on within the cell. It carries the information code in the form of DNA, and hence is also known as the information storage organelle. It provides a separation between DNA and the regulatory molecules of the cell, thus facilitating their interaction at the right time and stage.

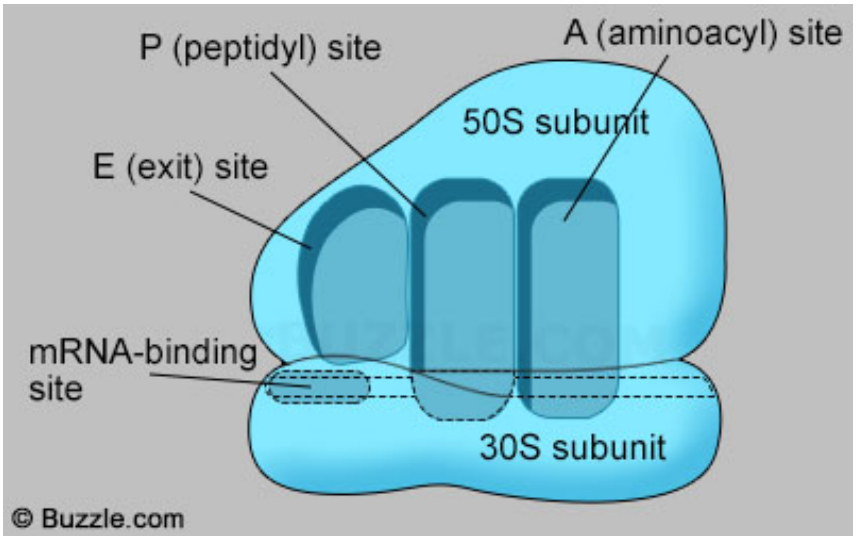
Endoplasmic Reticulum (ER)



Structure: This is an extensive network of membranes which is often seen in continuation with the nuclear membrane. The membranes that are arranged in the form of tubes are collectively termed smooth ER; whereas the ones arranged into flattened disc-like structures with ribosomes attached onto the surface are collectively called rough ER.

Function: The rough ER is the site for protein synthesis from the attached ribosomes, and is responsible for the transport of these proteins and other molecules along with the smooth ER. The smooth ER plays an important role in carbohydrate metabolism, drug detoxification and lipid biosynthesis.

Ribosome

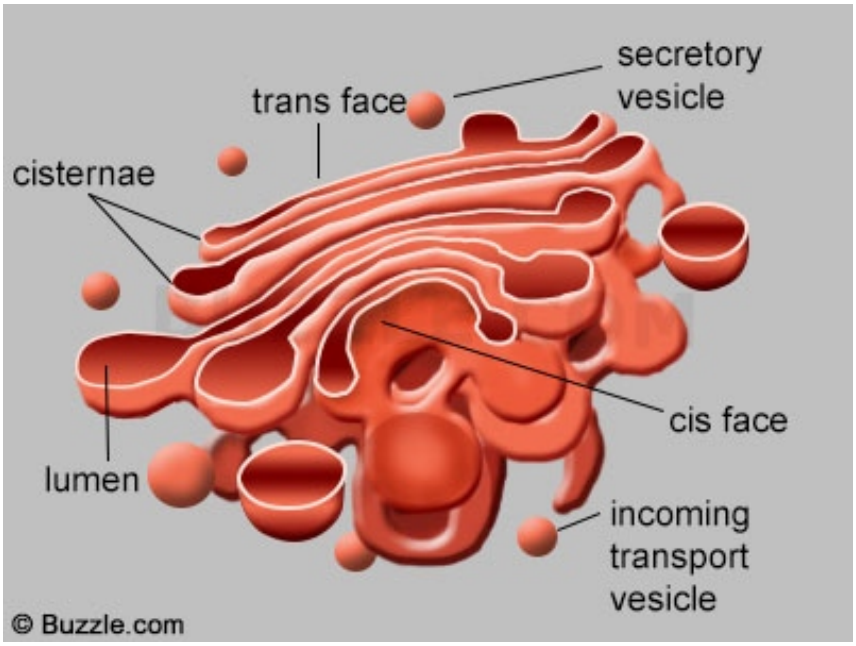


Structure: Ribosomes are thousands of tiny spherical structures that are made of RNA and proteins, and are present in prokaryotes as well as eukaryotes. Although ribosome is not a membrane-bound structure it is considered to be an organelle owing to its size as well as functional importance. It is composed of two subunits which collectively form distinct binding and functional sites for tRNA molecules.

Function: It is the molecular machine that reads information on mRNA obtained from nucleus, and synthesizes polypeptide chains for the cell. This process is called translation, and also involves the participation of tRNA molecules which serve as the carriers for amino acids

that need to be assembled to form a protein. The tRNA attaches at the aminoacyl (A) site, travels through the peptidyl (P) site and exits via the exit (E) site, generating a polypeptide chain in the process.

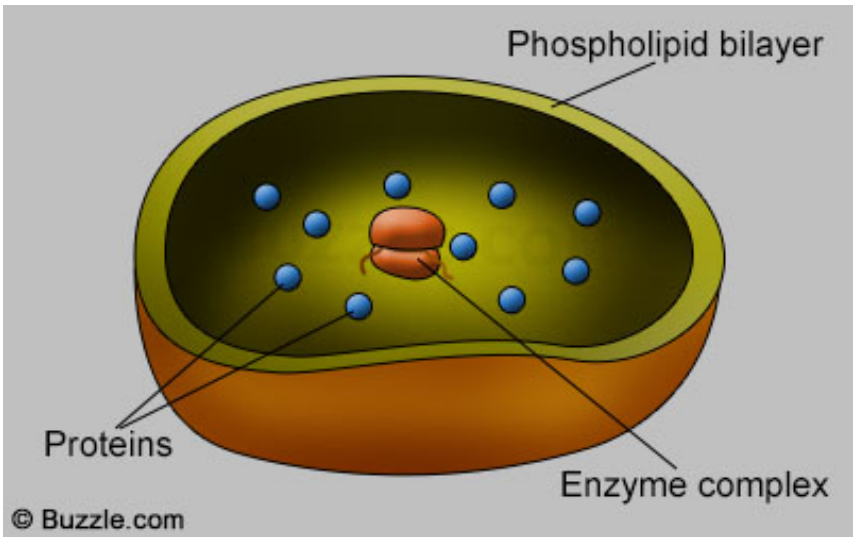
Golgi Apparatus



Structure: The Golgi apparatus is a huge network of membranous stacks called cisternae. These are divided into four structural and functional components called cis-Golgi, medial-Golgi, endo-Golgi and trans-Golgi. Each component carries a specialized set of enzymes and proteins.

Function: The Golgi apparatus is responsible for modifying the polypeptide chains synthesized in the ER by ribosomes to get the final, effective protein molecules. These modifications include the addition of sugar molecules, lipid moieties, functional groups etc. It is also the site for breakdown of proteins to get functionally active forms of the protein. Through its ability to form and fuse with membrane-bound vesicles, it serves to package and distribute macromolecules to other parts of the cell, and also facilitates the release of molecules, especially enzymes and hormones outside the cells.

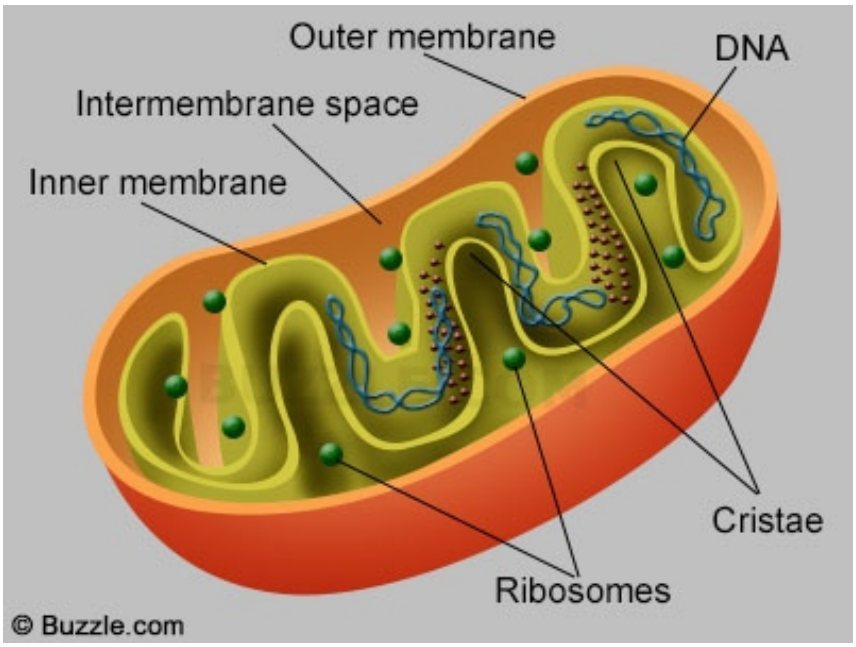
Lysosome



Structure:: These are spherical organelles with a highly acidic interior that contains degradative or lytic enzymes called hydrolases. Lysosomes are polymorphic and exist as primary, secondary, autophagic and secretory lysosomes.

Function: Lysosomes serve as the waste disposal system of the cell, and the lytic enzymes present inside them are capable of digesting any type of macromolecule including proteins, lipids, carbohydrates and nucleic acids. They can digest unwanted molecules, aged or damaged organelles as well as foreign bodies like bacteria, viruses and other pathogens. They play a vital role in processes central to protection against pathogens as well as in cell membrane repair, fertilization and self-destruction.

Mitochondria

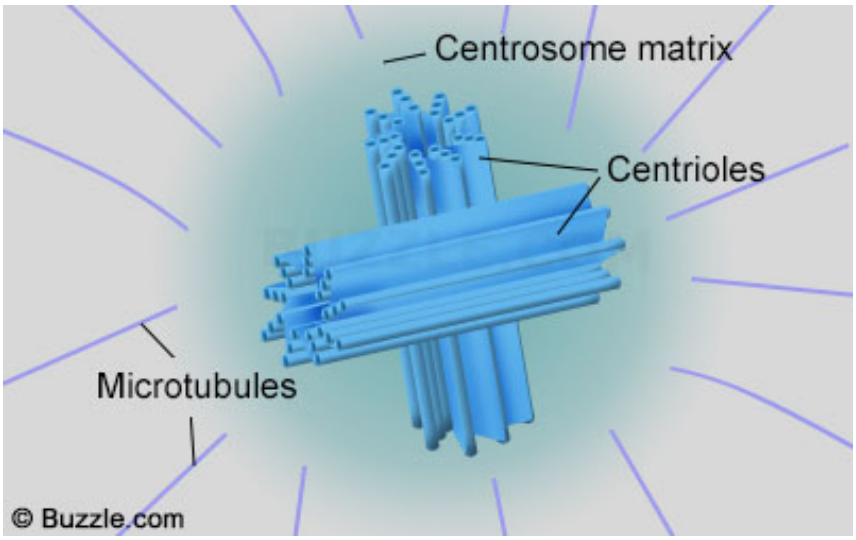


Structure: This essential organelle consists of two phospholipid bilayers that form an outer membrane which encloses all the contents of the organelle; and an inner membrane which folds to form several compartments called cristae. The space between the two membranes is termed as the intermembrane space.

Function: Mitochondria are the powerhouses of a cell, and are responsible for the breakdown of sugar molecules to release ATP (adenosine triphosphate), which is used to transport energy within the cell for metabolism. The outer membrane contains specialized proteins that allow molecular transport across mitochondria. The inner membrane contains numerous enzymes, and is the site

for electron transport chain and ATP synthesis. These organelles are also known to harbor a set of proteins which when released into the cytoplasm lead to activation of the self-destructive processes of a cell. Hence the survival of a cell depends on the integrity of its mitochondria.

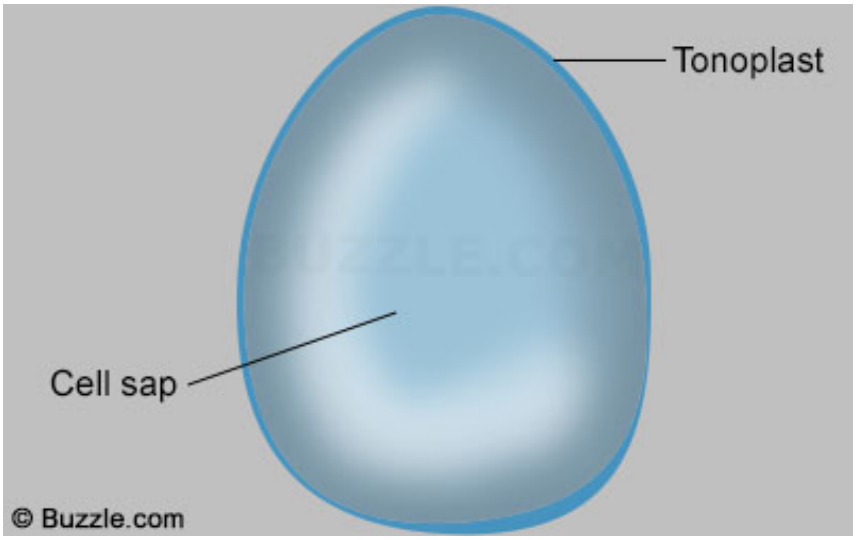
Centrosome



Structure: Located just outside the nucleus, this organelle consists of a pair of centrioles surrounded by a protein network called pericentriolar material (PCM). Centrioles are cylinder-shaped structures made up of microtubules, and are arranged orthogonal to each other. They are absent in fungi and most higher plants.

Function: Centrioles are the centers for microtubule nucleation during cell division, and form an important structural component of the mitotic spindle. These, along with the attached microtubules, are involved in assorting the chromosomes into the resultant daughter cells.

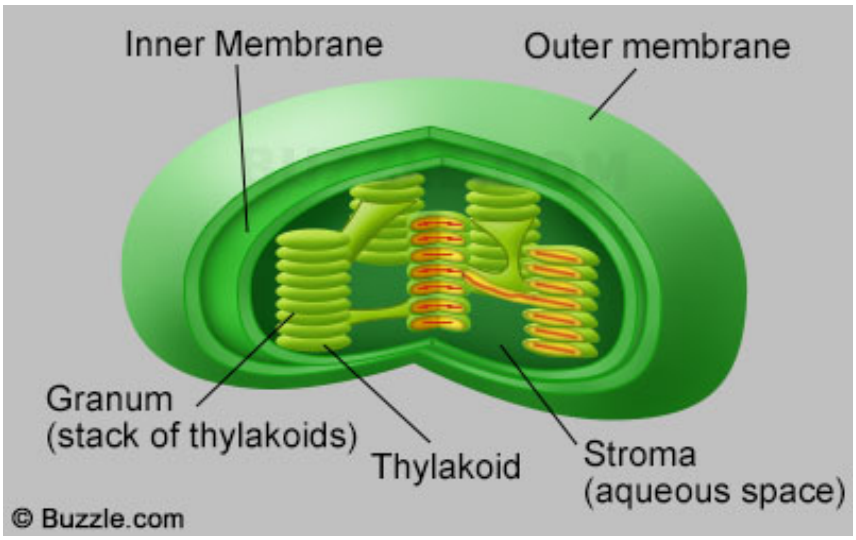
Vacuole



Structure: Present in all plant cells and only a few animal cells, these organelles consist of a membrane called tonoplast, within which water and other molecules including organic molecules are stored. It has no particular shape or size, and reduces or enlarges according to its contents and cellular needs.

Function: Vacuoles function as the storehouse of a cell and store food and water, as well as waste material before it is transported outside the cell. They also provide the necessary turgor pressure against cell walls in plant cells.

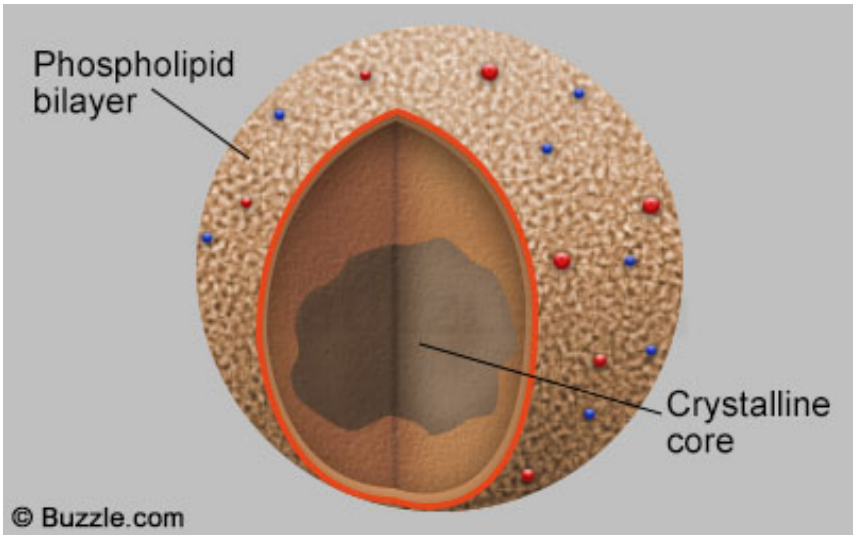
Chloroplast



Structure: A type of plant plastid, chloroplast is made up of a liquid matrix called stroma that is enclosed within two membranes termed outer and inner membranes. Dispersed into the stroma, a specialized network of membranes called thylakoids are organized into stacks called grana. These membranes contain chlorophyll and other photosynthetic pigments.

Function: Plants differ integrally from animals in their ability to prepare food within their cells through the process of photosynthesis. Here solar energy is harnessed by converting it into chemical energy in the form of ATP, which is then used for starch synthesis. This process of photosynthesis occurs through a set of light-dependent reactions that take place in the grana, and a set of dark (light-independent) reactions that occur in the stroma. In addition, chloroplasts are also the site of photorespiration, that involves light-dependent oxygen fixation.

Peroxisome



Structure: These are small spherical organelles morphologically similar to lysosomes. They consist of a central crystalloid core that is enclosed within a phospholipid bilayer. The central crystalline core consists of a variety of enzymes that are essential for several metabolic activities of the cell.

Function: Peroxisomes are the site for breakdown/oxidation of fatty acids to hydrogen peroxide, which is then decomposed by catalase. They also play an important role in seed germination by helping carbohydrate formation from the lipid stores of cells. They are also a site for some of the reactions of photorespiration.

A cell of a higher organism contains a thousand different substances, arranged in a complex system. This great organized system was not discovered by chemical or physical methods; they are inadequate to its refinement and delicacy and complexity. - **Herbert Spencer Jennings**

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