A Study on Animal Cellular Organization

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Abstract
Cells are comprised of highly organized assemblies of macromolecules, which undergo continuous dynamic rearrangements. Our contributors in this issue of *Current Opinion in Cell Biology* review some of the most exciting recent advances in our understanding of how various such dynamic assemblies function at the molecular level. As (to use the much-quoted phrase of Theodosius Dobzhansky) "nothing in biology makes sense except in the light of evolution", Peroxisomes are vesicle-like packets containing specialized enzymes that rid cells of toxins and utilize fats as an energy source. They can be called into being or dismissed depending upon the metabolic needs of the cell, which may therefore have few or many peroxisomes at different times. Significant recent progress has been made in understanding peroxisomal biogenesis, and it turns out both fission and *de novo* assembly occur, depending on the cellular circumstances. The ER provides membranous materials for both processes, while the contents of the peroxisomes are imported by a long-mysterious mechanism that is only now being revealed. The coatomer family of vesicle coating complexes are shown to have significant structural relationships among themselves and, tellingly, to the nuclear pore complex; while the ESCRT system has been found to have a lineage that extends back into the Archea. Analyses of these factors indicate that a complex endomembrane system predates the initial radiation of eukaryotic lineages, and suggest new insights on the origins of eukaryotes. The biogenesis of cellular organelles represent another huge leap in complexity, generally involving either division of pre-existing organelles or *de novo* assembly from precursors generated by other organelles. With an insightful discussion of informational and algorithmic complexity, he argues persuasively that the problem is not as insurmountable as some had thought, and does not require the elaborate assumptions made by some previous theories. A mainstay of this review series has been the relentless and exciting progress made on the cytoskeleton. As several topics including septins, intermediate filaments, and the bacterial cytoskeleton were covered in excellent reviews in last year's issue, this year we focused instead on recent progress on actin and microtubule function in cells.

Keywords: Cell, Prokaryotic Cell, Eukaryotic Cell, Cytoplasm, Cytoskeleton

INTRODUCTION

The cell is the structural and functional unit of any animal or plant. It consists of various cellular components that carry out the functions of the cell. These structures are called cell organelles and they make up the structural organization of a cell. Animal cells secrete a variety of vesicular particles, from the micron-sized platelets released by megakaryocytes, to smaller vesicles that have the approximate size of virus particles. Several names have been used to describe these smaller vesicles, primarily exosomes and microvesicles. This article discusses our current understanding of the structure of these vesicles, their biogenesis, and their functional significance. While some investigators differentiate between exosomes and microvesicles based on where they are made within the cell, that view is fraught with conceptual, mechanistic, and technical difficulties. For this reason, exosomes and microvesicles will be referred to by the collective acronym of exosome and microvesicle (EMV) in this article, though the term exosome will be used when discussing the classic model of exosome biogenesis. Tissues are organic material that makes up organs and other bodily structures. Tissues are formed from cells and have similar structures and functions. There are four types of tissues in animal bodies: Human body organs like the lungs, heart, stomach, etc are made of two or more types of tissues that serve a particular function. The lungs bring in oxygen and eliminate CO_2, the heart pumps blood through the body- just to name a few examples. Most of the organs have all four types of tissues and they make up the whole organ system. Organs are grouped into organ systems and they work together to carry out a particular function. The major organ systems of the human body are listed below: An animal's cell structure and function begin with an outer cell membrane, which separates the cell from the external environment. Sometimes cell membranes are modified. For example, amoebas develop pseudopodia for feeding and movement. Cell membranes also help protect the cell from pathogens. Cytoplasm is a jelly-like fluid that fills the inside of the cell and covers the cell organelles. Organelles are structures that perform specific jobs inside the cells. The nucleus is the control center of the cell. It contains DNA and controls most cell activities, such as metabolism, growth, and reproduction. Mitochondria are responsible for cellular aerobic respiration. Other organelles, like lysosomes, handle digesting and recycling toxic substances and waste. Animal cells lack a cell wall, which is what gives plants rigidity and support.

OBJECTIVES -

To study of the Cell Structure

To study of the cell Organelles

To study of cells Function and structure

Research methods used – In the present research, research method in used Internet surveys, other Famous book, writers and author.

ANALYSIS –

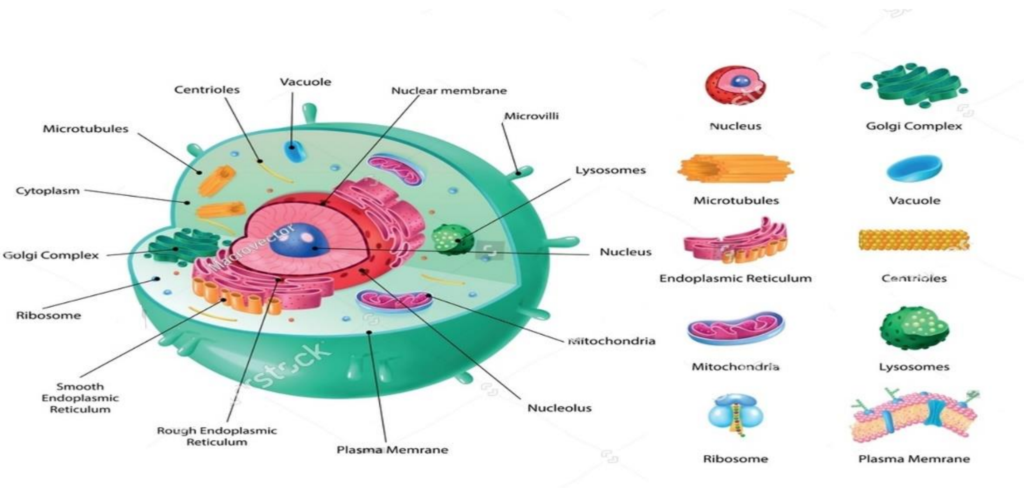


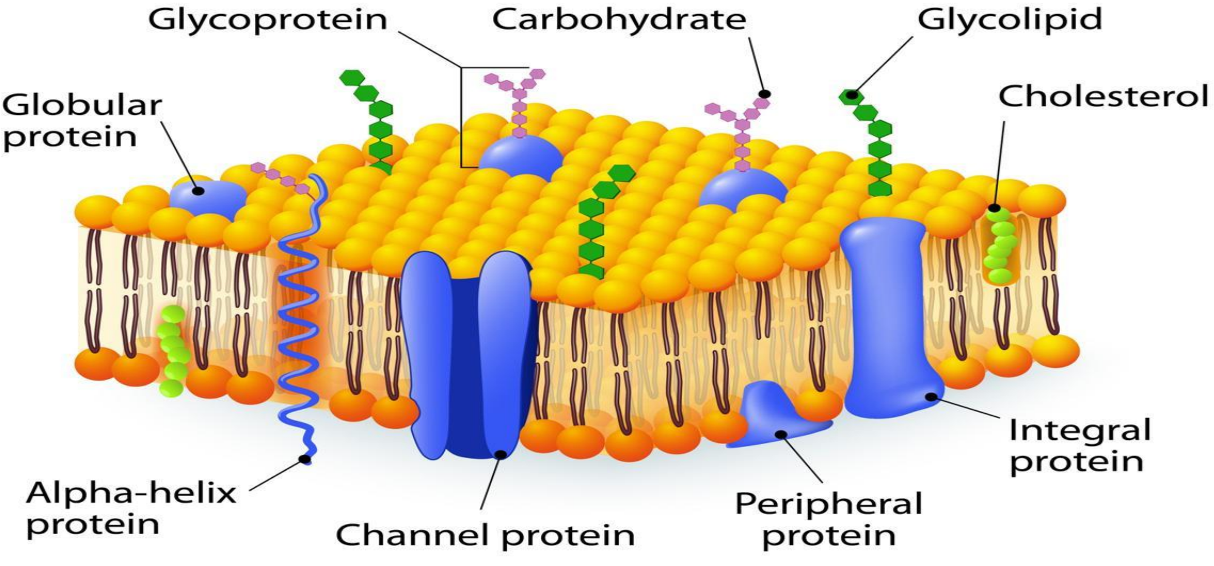
Fig.1- Animal Cell Structure

Animal Cell Structure

Animal cells are generally smaller than plant cells. Another defining characteristic is its irregular shape. This is due to the absence of a cell wall. But animal cells share other cellular organelles with plant cells as both have evolved from eukaryotic cells. A typical animal cell comprises the following cell organelles:-

1. Cell Membrane –

The cell membrane (also known as the plasma membrane or cytoplasmic membrane, and historically referred to as the plasmalemma) is a biological membrane that separates and protects the interior of a cell from the outside environment (the extracellular space).[1][2] The cell membrane consists of a lipid bilayer, made up of two layers of phospholipids with cholesterols (a lipid component) interspersed between them, maintaining appropriate membrane fluidity at various temperatures. The membrane also contains membrane proteins, including integral proteins that span the membrane and serve as membrane transporters, and peripheral proteins that loosely attach to the outer (peripheral) side of the cell membrane, acting as enzymes to facilitate interaction with the cell's environment.[3] Glycolipids embedded in the outer lipid layer serve a similar purpose. The cell membrane controls the movement of substances in and out of a cell, being selectively permeable to ions and organic molecules.[4] In addition, cell membranes are involved in a variety of cellular processes such as cell adhesion, ion conductivity, and cell signalling and serve as the attachment surface for several extracellular structures, including the cell wall and the carbohydrate layer called the glycocalyx, as well as the intracellular network of protein fibers called the cytoskeleton. In the field of synthetic biology, cell membranes can be artificially reassembled. While Robert Hooke's discovery of cells in 1665 led to the proposal of the cell theory, Hooke misled the cell membrane theory that all cells contained a hard cell wall since only plant cells could be observed at the time.



Structure –

Fig.2- Plasma Membrane

Fluid mosaic model

According to the fluid mosaic model of S. J. Singer and G. L. Nicolson (1972), which replaced the earlier model of Davson and Danielli, biological membranes can be considered as a two-dimensional liquid in which lipid and protein molecules diffuse more or less easily. Although the lipid bilayers that form the basis of the membranes do indeed form two-dimensional liquids by themselves, the plasma membrane also contains a large quantity of proteins, which provide more structure. Examples of such structures are protein-protein complexes, pickets and fences formed by the actin-based cytoskeleton, and potentially lipid rafts.

Lipid bilayer

Lipid bilayers form through the process of self-assembly. The cell membrane consists primarily of a thin layer of amphipathic phospholipids that spontaneously arrange so that the hydrophobic "tail" regions are isolated from the surrounding water while the hydrophilic "head" regions interact with the intracellular (cytosolic) and extracellular faces of the resulting bilayer. This forms a continuous, spherical lipid bilayer. Hydrophobic interactions (also known as the hydrophobic effect) are the major driving forces in the formation of lipid bilayers. An increase in interactions between hydrophobic molecules (causing clustering of hydrophobic regions) allows water molecules to bond more freely with each other, increasing the entropy of the system. This complex interaction can include noncovalent interactions such as van der Waals, electrostatic and hydrogen bonds.Lipid bilayers are generally impermeable to ions and polar molecules. The arrangement of hydrophilic heads and hydrophobic tails of the lipid bilayer prevent polar solutes (ex. amino acids, nucleic acids, carbohydrates, proteins, and ions) from diffusing across the membrane, but generally allows for the passive diffusion of hydrophobic molecules. This affords the cell the ability to control the movement of these substances via transmembrane protein complexes such as pores, channels and gates. Flippases and scramblases concentrate phosphatidyl serine, which carries a negative charge, on the inner membrane. Along with NANA, this creates an extra barrier to charged moieties moving through the membrane. Membranes serve diverse functions in eukaryotic and prokaryotic cells. One important role is to regulate the movement of materials into and out of cells. The phospholipid bilayer structure (fluid mosaic model) with specific membrane proteins accounts for the selective permeability of the membrane and passive and active transport mechanisms. In addition, membranes in prokaryotes and in the mitochondria and chloroplasts of eukaryotes facilitate the synthesis of ATP through chemiosmosis.

Function –

1. Passive osmosis and diffusion
2. Transmembrane protein channels and transporters
3. Endocytosis
4. Exocytosis

Nucleus –

The **cell nucleus** (from Latin *nucleus or nuculeus* 'kernel, seed'; pl.: **nuclei**) is a membrane-bound organelle found in eukaryotic cells. Eukaryotic cells usually have a single nucleus, but a few cell types, such as mammalian red blood cells, have no nuclei, and a few others including osteoclasts have many. The main structures making up the nucleus are the nuclear envelope, a double membrane that encloses the entire organelle and isolates its contents from the cellular cytoplasm; and the nuclear matrix, a network within the nucleus that adds mechanical support.

The cell nucleus contains nearly all of the cell's genome. Nuclear DNA is often organized into multiple chromosomes – long strands of DNA dotted with various proteins, such as histones, that protect and organize the DNA. The genes within these chromosomes are structured in such a way to promote cell function. The nucleus maintains the integrity of genes and controls the activities of the cell by regulating gene expression.

Because the nuclear envelope is impermeable to large molecules, nuclear pores are required to regulate nuclear transport of molecules across the envelope. The pores cross both nuclear membranes, providing a channel through which larger molecules must be actively transported by carrier proteins while allowing free movement of small molecules and ions. Movement of large molecules such as proteins and RNA through the pores is required for both gene expression and the maintenance of chromosomes. Although the interior of the nucleus does not contain any membrane-bound subcompartments, a number of nuclear bodies exist, made up of unique proteins, RNA molecules, and particular parts of the chromosomes. The best-known of these is the nucleolus, involved in the assembly of ribosomes.

2. Structure

The nucleus contains nearly all of the cell's DNA, surrounded by a network of fibrous intermediate filaments called the nuclear matrix, and is enveloped in a double membrane called the nuclear envelope. The nuclear envelope separates the fluid inside the nucleus, called the nucleoplasm, from the rest of the cell. The size of the nucleus is correlated to the size of the cell, and this ratio is reported across a range of cell types and species.[1] In eukaryotes the nucleus in many cells typically occupies 10% of the cell volume.[2]:178 The nucleus is the largest organelle in animal cells. In human cells, the diameter of the nucleus is approximately six micrometres (μm).

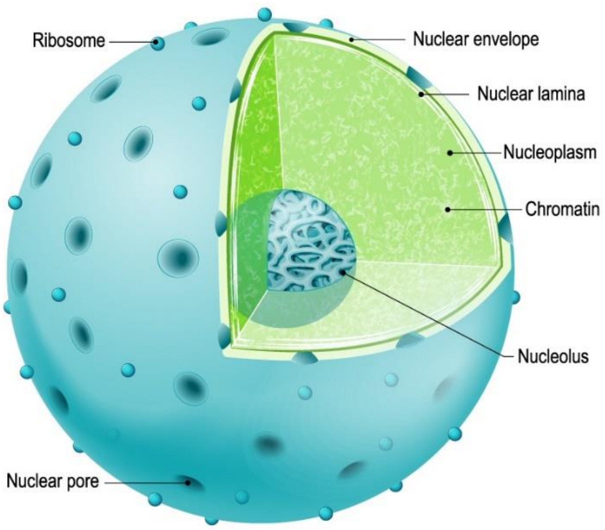


Fig.3- Nucleus

Nuclear envelope and pores

A cross section of a nuclear pore on the surface of the nuclear envelope (1). Other diagram labels show (2) the outer ring, (3) spokes, (4) basket, and (5) filaments.

The nuclear envelope consists of two membranes, an inner and an outer nuclear membrane, perforated by nuclear pores. Together, these membranes serve to separate the cell's genetic material from the rest of the cell contents, and allow the nucleus to maintain an environment distinct from the rest of the cell. In a mammalian nuclear envelope there are between 3000 and 4000 nuclear pore complexes (NPCs) perforating the envelope. Each NPC contains an eightfold-symmetric ring-shaped structure at a position where the inner and outer membranes fuse.

Nuclear lamina

In animal cells, two networks of intermediate filaments provide the nucleus with mechanical support: The nuclear lamina forms an organized meshwork on the internal face of the envelope, while less organized support is provided on the cytosolic face of the envelope. Both systems provide structural support for the nuclear envelope and anchoring sites for chromosomes and nuclear pores.

Chromosomes

A mouse fibroblast nucleus in which DNA is stained blue. The distinct chromosome territories of chromosome 2 (red) and chromosome 9 (green) are stained with fluorescent in situ hybridization. The cell nucleus contains the majority of the cell's genetic material in the form of multiple linear DNA molecules organized into structures called chromosomes. Each human cell contains roughly two meters of DNA.

Nucleolus

An electron micrograph of a cell nucleus, showing the darkly stained nucleolus The nucleolus is the largest of the discrete densely stained, membraneless structures known as nuclear bodies found in the nucleus. It forms around tandem repeats of rDNA, DNA coding for ribosomal RNA (rRNA). These regions are called nucleolar organizer regions (NOR). The main roles of the nucleolus are to synthesize rRNA and assemble ribosomes.

Function

1. Cell compartmentalization
2. Replication
3. Gene expression
4. Processing of pre-mRNA

3. Centrosome

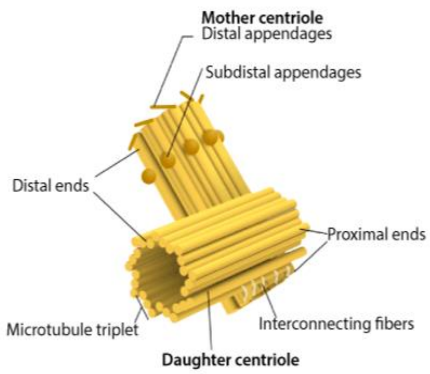


Fig.4 – Centrosome

In cell biology, the centrosome (Latin centrum 'center' + Greek sōma 'body') (archaically cytocentre is an organelle that serves as the main microtubule organizing center (MTOC) of the animal cell, as well as a regulator of cell-cycle progression. The centrosome provides structure for the cell. The centrosome is thought to have evolved only in the metazoan lineage of eukaryotic cells. Fungi and plants lack centrosomes and therefore use other structures to organize their microtubules. Although the centrosome has a key role in efficient mitosis in animal cells, it is not essential in certain fly and flatworm species. Centrosomes are composed of two centrioles arranged at right angles to each other, and surrounded by a dense, highly structured mass of protein termed the pericentriolar material (PCM). The PCM contains proteins responsible for microtubule nucleation and anchoring — including γ-tubulin, pericentrin and ninein. In general, each centriole of the centrosome is based on a nine-triplet microtubule assembled in a cartwheel structure, and contains centrin, cenexin and tektin. In many cell types, the centrosome is replaced by a cilium during cellular differentiation. However, once the cell starts to divide, the cilium is replaced again by the centrosome.

Function –

Centrosomes are associated with the nuclear membrane during the prophase stage of the cell cycle. During mitosis, the nuclear membrane breaks down, and the centrosome-nucleated microtubules can interact with the chromosomes to build the mitotic spindle.

4. Lysosome

A lysosome is a membrane-bound organelle found in many animal cells. They are spherical vesicles that contain hydrolytic enzymes that can break down many kinds of biomolecules. A lysosome has a specific composition, of both its membrane proteins, and its lumenal proteins. The lumen's pH (~4.5–5.0) is optimal for the enzymes involved in hydrolysis, analogous to the activity of the stomach. Besides degradation of polymers, the lysosome is involved in various cell processes, including secretion, plasma membrane repair, apoptosis, cell signaling, and energy metabolism. Lysosomes are termed to be degradative organelles that act as the waste disposal system of the cell by digesting used materials in the cytoplasm, from both inside and outside the cell. Material from outside the cell is taken up through endocytosis, while material from the inside of the cell is digested through autophagy. The sizes of the organelles vary greatly—the larger ones can be more than 10 times the size of the smaller ones. They were discovered and named by Belgian biologist Christian de Duve, who eventually received the Nobel Prize in Physiology or Medicine in 1974

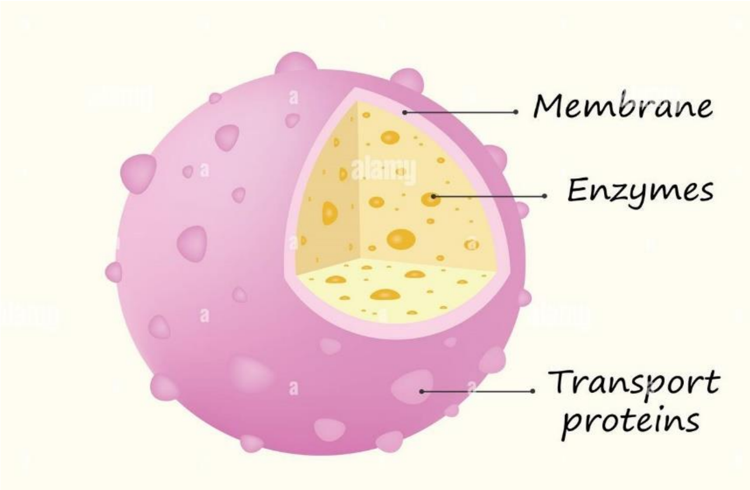


Fig.5 – Lysosome

Function –

Lysosomes contain a variety of enzymes, enabling the cell to break down various biomolecules it engulfs, including peptides, nucleic acids, carbohydrates, and lipids (lysosomal lipase). The enzymes responsible for this hydrolysis require an acidic environment for optimal activity.

5. Golgi Apparatus –

The Golgi apparatus also known as the Golgi complex, Golgi body, or simply the Golgi, is an organelle found in most eukaryotic cells. Part of the endomembrane system in the cytoplasm, it packages proteins into membrane-bound vesicles inside the cell before the vesicles are sent to their destination. It resides at the intersection of the secretory, lysosomal, and endocytic pathways. It is of particular importance in processing proteins for secretion, containing a set of glycosylation enzymes that attach various sugar monomers to proteins as the proteins move through the apparatus. It was identified in 1897 by the Italian biologist and pathologist Camillo Golgi and was named after him in 1898.

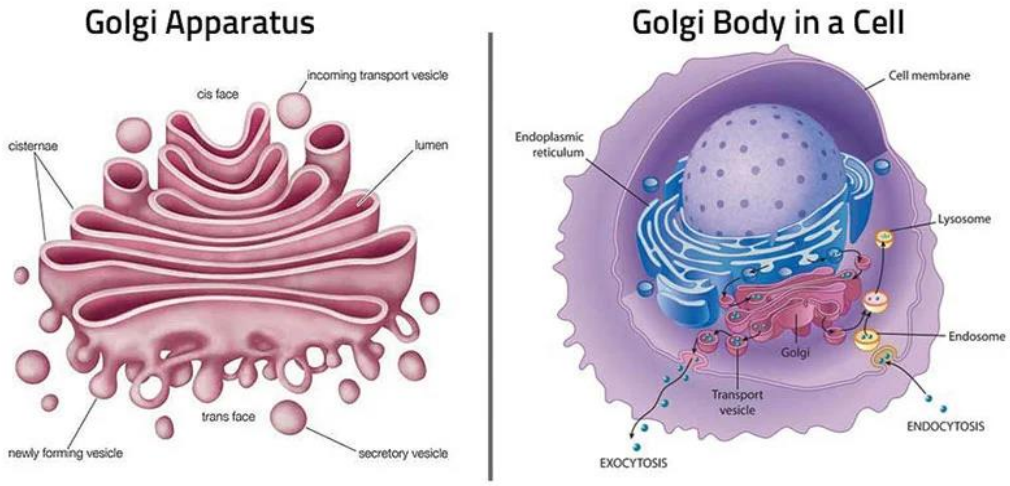


Fig.6- Golgi apparatus

It was discovered in 1898 by Italian physician Camillo Golgi during an investigation of the nervous system. After first observing it under his microscope, he termed the structure as *apparato reticolare interno* ("internal reticular apparatus").

Function –

The Golgi apparatus is a major collection and dispatch station of protein products received from the endoplasmic reticulum (ER). Proteins synthesized in the ER are packaged into vesicles, which then fuse with the Golgi apparatus. These cargo proteins are modified and destined for secretion via exocytosis or for use in the cell.

6. Mitochondria –

A mitochondrion is an organelle found in the cells of most eukaryotes, such as animals, plants and fungi. Mitochondria have a double membrane structure and use aerobic respiration to generate adenosine triphosphate (ATP), which is used throughout the cell as a source of chemical energy. They were discovered by Albert von Kölliker in 1857 in the voluntary muscles of insects. The term *mitochondrion* was coined by Carl Benda in 1898. The mitochondrion is popularly nicknamed the "powerhouse of the cell", a phrase coined by Philip Siekevitz in a 1957 article of the same name. Some cells in some multicellular organisms lack mitochondria (for example, mature mammalian red blood cells). A large number of unicellular organisms, such as microsporidia, parabasalids and diplomonads, have reduced or transformed their mitochondria into other structures. Mitochondria are commonly between 0.75 and 3 μm^2 in cross section, but vary considerably in size and structure. Unless specifically stained, they are not visible. In addition to supplying cellular energy, mitochondria are involved in other tasks, such as signaling, cellular differentiation, and cell death, as well as maintaining control of the cell cycle and cell growth. Mitochondrial biogenesis is in turn temporally coordinated with these cellular processes. Mitochondria have been implicated in several human disorders and conditions, such as mitochondrial diseases, cardiac dysfunction, heart failure and autism. The number of mitochondria in a cell can vary widely by organism, tissue, and cell type. A mature red blood cell has no mitochondria, whereas a liver cell can have more than 2000.

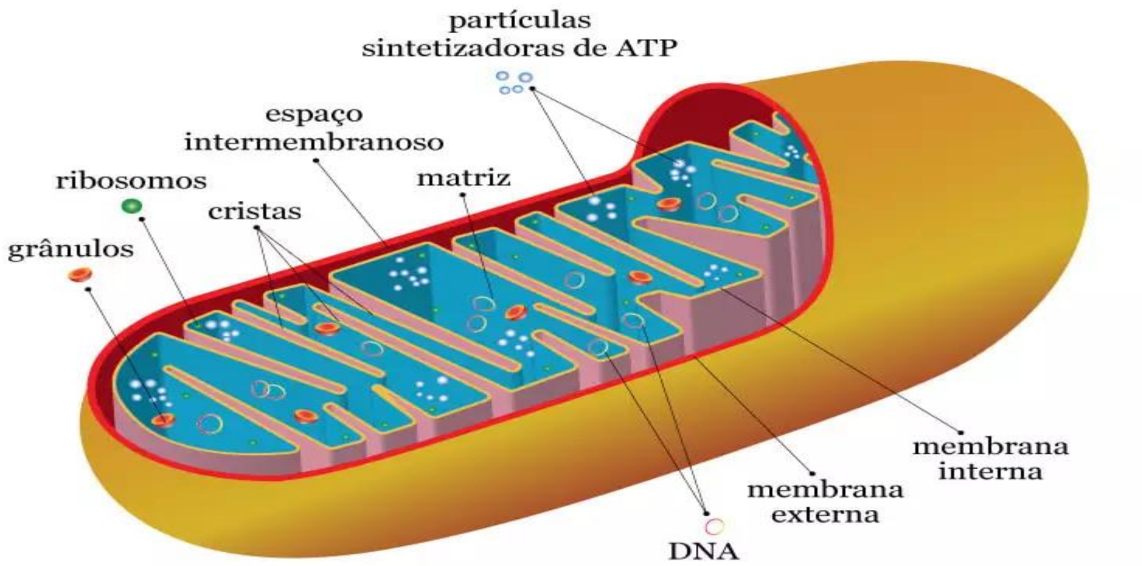


Fig.7- Mitochondria

Function –

1. Energy conversion
2. Pyruvate and the citric acid cycle
3. O_2 and NADH: energy-releasing reactions
4. Heat production
5. Mitochondrial fatty acid synthesis
6. Uptake, storage and release of calcium ions
7. Cellular proliferation regulation

7. Ribosome –

Ribosomes are macromolecular machines, found within all cells, that perform biological protein synthesis (mRNA translation). Ribosomes link amino acids together in the order specified by the codons of messenger RNA (mRNA) molecules to form polypeptide chains. Ribosomes consist of two major components: the small and large ribosomal subunits. Each subunit consists of one or more ribosomal

RNA (rRNA) molecules and many ribosomal proteins (RPs or r-proteins). The sequence of DNA that encodes the sequence of the amino acids in a protein is transcribed into a messenger RNA chain. Ribosomes bind to messenger RNAs and use their sequences to determine the correct sequence of amino acids to generate a given protein. Amino acids are selected and carried to the ribosome by transfer RNA (tRNA) molecules, which enter the ribosome and bind to the messenger RNA chain via an anti-codon stem loop. For each coding triplet (codon) in the messenger RNA, there is a unique transfer RNA that must have the exact anti-codon match, and carries the correct amino acid for incorporating into a growing polypeptide chain. Once the protein is produced, it can then fold to produce a functional three-dimensional structure. A ribosome is made from complexes of RNAs and proteins and is therefore a ribonucleoprotein complex. Each ribosome is composed of small (30S) and large (50S) components, called subunits, which are bound to each other:

1. (30S) has mainly a decoding function and is also bound to the mRNA
2. (50S) has mainly a catalytic function and is also bound to the aminoacylated tRNAs.

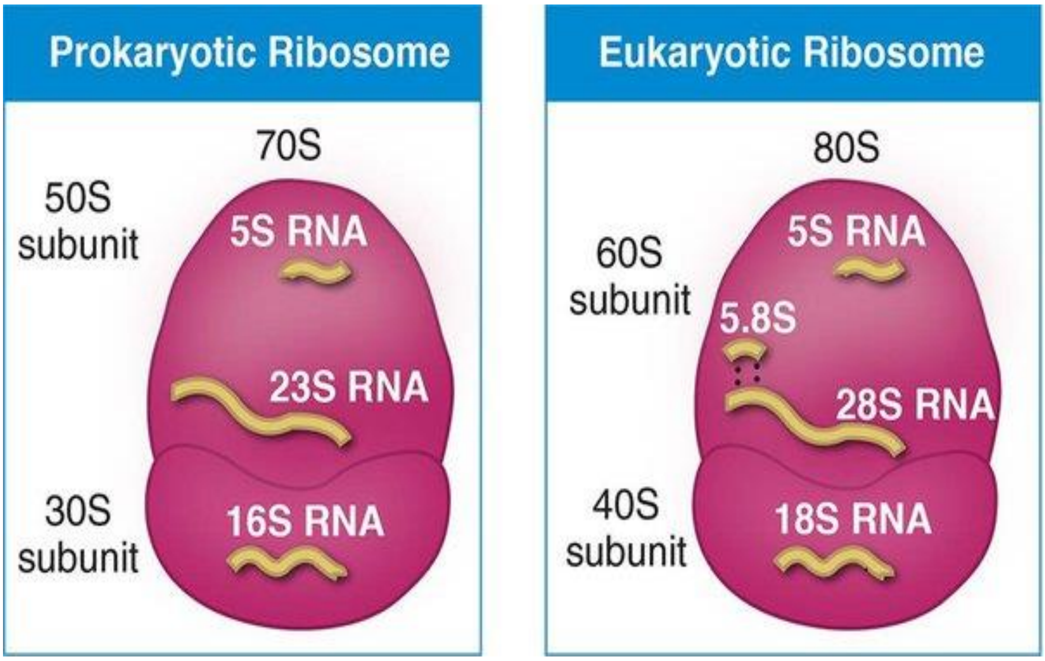


Fig.8 – Ribosome

Function –

Ribosomes are minute particles consisting of RNA and associated proteins that function to synthesize proteins. Proteins are needed for many cellular functions, such as repairing damage or directing chemical processes.

8. Endoplasmic Reticulum –

The endoplasmic reticulum (ER) is, in essence, the transportation system of the eukaryotic cell, and has many other important functions such as protein folding. It is a type of organelle made up of two subunits – rough endoplasmic reticulum (RER), and smooth endoplasmic reticulum (SER).

Rough endoplasmic reticulum

The surface of the rough endoplasmic reticulum (often abbreviated *RER* or *rough ER*; also called *granular endoplasmic reticulum*) is studded with protein-manufacturing ribosomes giving it a "rough" appearance (hence its name).

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Smooth endoplasmic reticulum In most cells the smooth endoplasmic reticulum (abbreviated **SER**) is scarce. Instead there are areas where the ER is partly smooth and partly rough, this area is called the transitional ER.

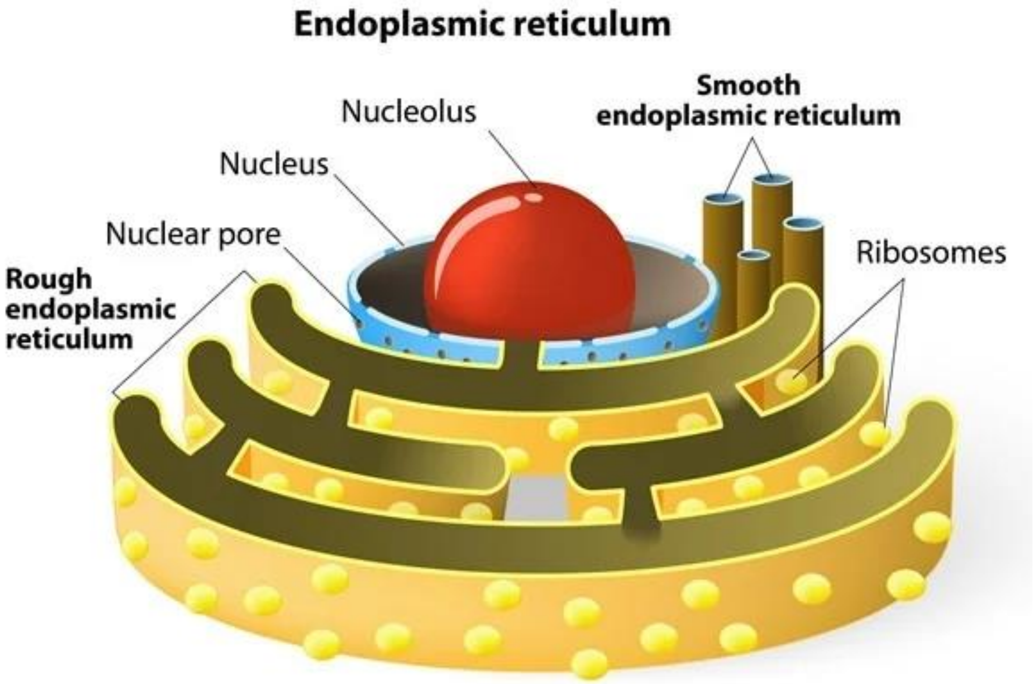

Fig.9- Endoplasmic Reticulum

Function –

1. Protein transport
2. Bioenergetics regulation of ER ATP supply by a CaATiER mechanism

CONCLUSION –

A Brife study on cells and their organelles and his function. The cell are divide in three part one is cell envelop, this part are consider of cell wall (in plant cell) & cell membrane. Second is matrix, this part are consider complete organelles of a cell. And third is Nucleus, this part are consider the nuclear membrane, nucleolus, nucleoplasm and chromatin. Cell is a structure and functional unit of life. A cell can be a cell only if a nucleus is present in it. Without a nucleus it cannot be a cell. The structures in which the nucleus is not present are viruses, viroids and prions. Which are called particles.

References –

Books –

1. *"Endoplasmic Reticulum (Rough and Smooth)". British Society of Cell Biology.*
2. *"Les filaments basaux des cellules glandulaires. Note préliminaire". Bibliographie Anatomique.*
3. *"Electron Microscopy of Plant Protoplasm". International Review of Cytology Volume 14. International Review of Cytology.*
4. *"mitochondrion". Lexico UK English Dictionary. Oxford University Press. Archived from the original*
5. *^ Campbell NA, Williamson B, Heyden RJ (2006). Biology: Exploring Life. Boston, Massachusetts*

6. "A systematic genomic screen implicates nucleocytoplasmic transport and membrane growth in nuclear size control"
7. *Molecular Biology of the Cell* (6 ed.). New York: Garland Science.
8. Tom Herrmann; Sandeep Sharma (March 2, 2019). "Physiology, Membrane"
9. "Chemists create artificial cell membrane". kurzweilai.net
10. "Fluorescence probe measurement of the intralysosomal pH in living cells and the perturbation of pH by various agents

Website –

1. https://www.ncbi.nlm.nih.gov/books/NBK9953/
2. https://www.britannica.com/science/cell-membrane
3. https://www.britannica.com/science/nucleus-biology
4. https://www.medicalnewstoday.com/articles/320875
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4700099/#:~:text=The%20endoplasmic%20reticulum%20(ER)%20is,sheets%20and%20the%20nuclear%20envelope.