

Cellular Organelles and its functions

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Cytoplasm

- ▶ The gel like fluid inside the cell
- ▶ It is the medium for chemical reaction
- ▶ Provide platform upon which other organelles can operate
- ▶ All the function for cell expansion ,growth and replication are carried out in the cytoplasm
- ▶ Material move by diffusion which is a physical process that can work only for short distance

Cytoplasmic organelles

These are little organs that are suspended in the Cytoplasm of the cell each type of organelle has a definite structure and a specific role in the function of the cell

Example:- Mitochondria ribosome endoplasmic reticulum Golgi apparatus lysosomes etc.

Mitochondria

- Double membrane bound organelle
- Outer membrane has phospholipids and cholesterol
- Inner membrane has more protein
- Outer membrane and Inner membrane divide its lumen in 2 components i.e. outer compartment and inner compartment
- Space between them is called per mitochondrial Space
- Inner membrane has folds called cristae
- Electron carrier cytochromes arranged in definite sequence in inner membrane form electron transport system (ETS)
- Semi autonomous cell organelles
- Number depends upon physiological activity of cell
- Maximum number of mitochondria found in flight muscles of birds in higher animals
- Differ in shape and size i.e. Sausage and cylinder
- Single , double stranded and circular naked DNA present in mitochondrial matrix
- DNA polymerase and RNA polymerase (enzymes for DNA replication) found in mitochondrial matrix
- Site of aerobic respiration

Function of mitochondria

- ▶ Production of ATP :- The Complex multistep process is essential for proper functioning of the body and dysfunction can contribute. to a variety diseases ranging from diabetes. to Parkinsons Disease. To rare genetic disorder
- ▶ Regulation of Innate immunity - innate immunity Is the born System that recognizes and respond to infection by pathogenic providing immediate, non - Specified defense. mitochondria antiviral Signaling Protein (mAvs) play a key role in the Innate Response to viral infection.
- ▶ Programmed cell death - Apoptosis is the highly Controlled process of programmed cell death, which is used by multicellular organisms in a number of biological process including mopping up damaged cells and maintaining cell number. The Production of apoptotic bodies which are engulfed by phagocytes can be activated by both an intrinsic and extrinsic Pathway

Endomembrane system

- ▶ Each membrane organelle is distinct in structure and function
many of these are considered together as **endomembrane system**
- ▶ It includes :-
 - a)Endoplasmic reticulum
 - b)Golgi complex
 - c)Lysosomes
 - d)Vacuoles

Endoplasmic reticulum

- ▶ Present in **eukaryotic cells**
- ▶ **Tiny tubular structure scattered in the cytoplasm**
- ▶ Components of **Endoplasmic reticulum**
 - 1 :- **Cisternae** : Long flattened and unbranched units arranged in stacks
 - 2 :- **Vesicles** : Oval membrane bound structures
 - 3 :- **Tubules** : Irregular often branched tubes bounded by membrane. May be free or associated with cisternae
- ▶ ER is widespread in cytoplasm, ER is often termed as **system of membrane**
- ▶ ER is **divided in two distinct compartment i.e. Rough ER and smooth ER**

Functions of endoplasmic reticulum

- ▶ Mechanical support :- Microfilament, microtubules and ER form endoskeleton of cell
- ▶ Intercellular exchange
- ▶ Lipid synthesis
- ▶ Cellular metabolism
- ▶ Detoxification:- smooth ER detoxify drugs pollutants and steroids
- ▶ formation of lysosomes Golgi body and some micro bodies

Comparison between SR & RER

Rough E.R. (Granular)	Smooth E.R. (Agranular)
<p>(1) 80s ribosomes binds by their larger subunit, with the help of two glycoproteins (Ribophorin I and II On the surface of Rough E.R.)</p> <p>(2) Mainly composed of cisternae.</p> <p>(3) Abundantly occurs in cells which are actively engaged in protein synthesis and secretion. e.g. liver, pancreas, goblet cells.</p>	<p>(1) Ribosomes and Ribophorins absent</p> <p>(2) Mainly composed of tubules.</p> <p>(3) Abundantly occurs in cells concerned with glycogen and lipid metabolism. ⇒ In animal cell lipid like steroidal hormones are synthesised in SER. e.g. Adipose tissue, Interstitial cells, muscles, Glycogen storing liver cells, and adrenal cortex.</p>

Golgi complex

- ▶ **Camillo Golgi (1898)** first observed densely stained reticular structure near the nucleus, later named after him i.e Golgi bodies
- ▶ The cytoplasm surrounding golgi body has few to no organelles it is called **zone of exclusion**

Structure :-

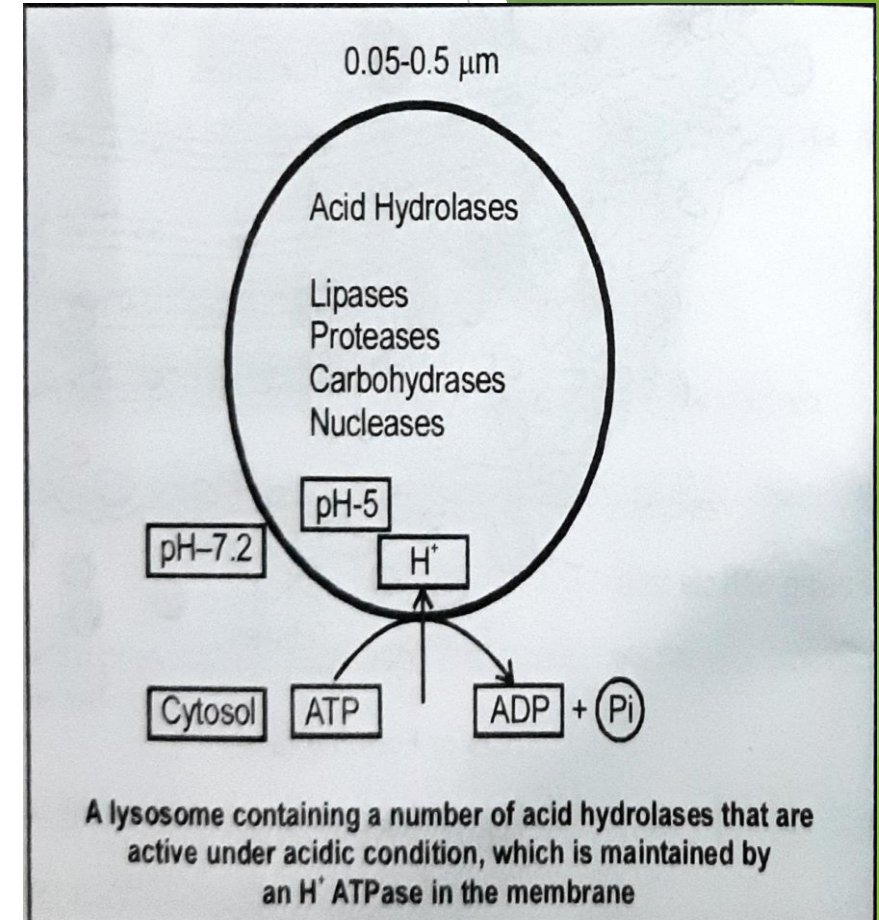
- ▶ Made up of 3 parts
 - 1:- **cisternae** :- flat disc shaped sac like structure many cisternae are arranged in stack
 - :- varied number of cisternae are present in golgi complex
 - :- cis face (**forming face**) and trans face (**maturing face**)
 - 2 :- **Tubules** :- branched and irregular tube like structure associated with cisternae
 - 3 :- **Vesicles** :- transition vesicle and mature vesicle

Function

- ▶ **Cell secretion :-** Export of macromolecules
- ▶ **Formation of lysosomes :-** Collective Function of golgi body and ER
- ▶ **Synthesis of cell wall material :-** Polysaccharide synthesis
- ▶ **Cell plate formation :-** During cell formation
- ▶ **Formation of acrosome during spermiogenesis :-** Formation of male gametes

Lysosomes

- ▶ Membrane bound vesicular structure formed by the process of packing in the Golgi apparatus
- ▶ They are rich in all types of hydrolytic enzymes optimally active at acidic pH (5) these enzymes are capable of digesting carbohydrate protein lipids and nucleic acid
- ▶ Found in all animal cells except mammalian RBC
- ▶ They are spherical bag like structure covered by a single unit membrane they are large sized in phagocytes (WBC)
- ▶ They are filled with 50 different enzymes termed as **acid hydrolases**
- ▶ Highly polymorphic because they have different physiological states



Functions

1 :- Intracellular digestion

- (a) **Hetrophagy :-** This is digestion of materials received in cell
- (b) **Autophagy :-** Digestion of old or dead organelles, takes place during starvation of cell

2 :- Extracellular digestion :- Lysosomes of osteoclast (bone eating cells) dissolve unwanted parts of bones

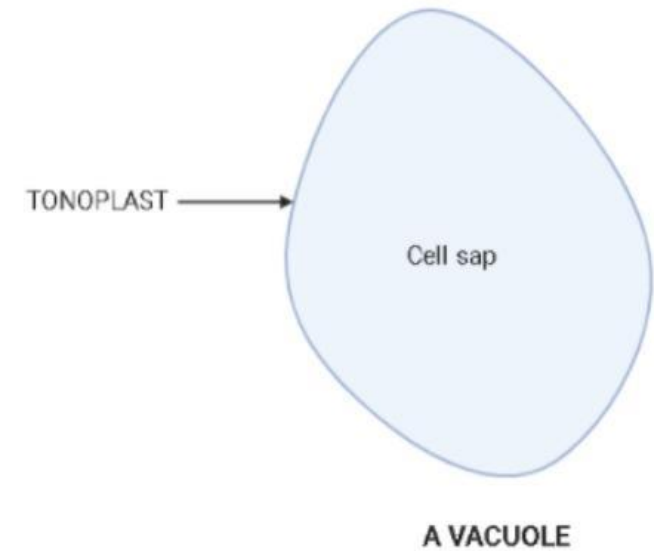
3 :- cellular digestion (Autolysis) :- Sometimes all lysosomes of cell burst to dissolve the cell completely

Vacuoles

- ▶ Membrane bound organelle present in plant and fungal cells some protists animals and bacterial cells
- ▶ Closed compartment filled with water containing inorganic and organic molecule including enzyme
- ▶ Formed by the fusion of multiple Membrane vesicles
- ▶ Has no basis shape or size
- ▶ Animal vacuoles are smaller than plants

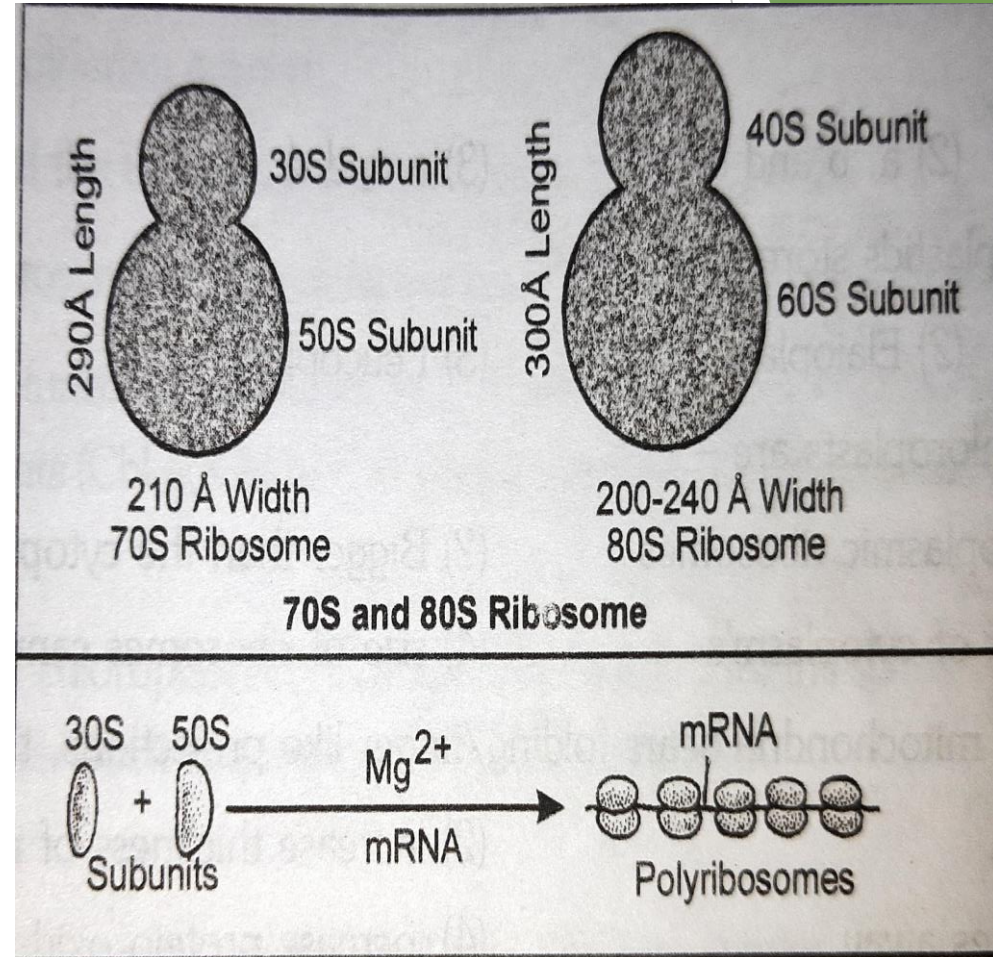
FUNCTIONS

- ▶ Isolating materials that might be harmful to cell
- ▶ containing waste product
- ▶ Maintain an acidic internal pH



Ribosome

- ▶ Known as the **engine of the cell**
- ▶ **Granular structure** observed under the electron microscope as dense particles by **George Palade (1953)**
- ▶ Composed of **RNA and proteins** and are **not surrounded by any membrane**
- ▶ Except mammalian RBC all living cell have ribosome
- ▶ They are the **smallest organelle**
- ▶ Also know as **organelle within organelle** and **protein factory of cell**



Type of ribosome

- (1) Eukaryotic ribosome :- 80s occur in cytoplasm of eukaryotic cells
- (2) Prokaryotic ribosome :- 70s occur in cytoplasm and associated with plasma membrane of prokaryotic cells

Ribosome composed of two subunits i.e. larger and smaller subunits

$80S = 60S + 40S$

$70S = 50S + 30S$

FUNCTIONS

translation :- work places of protein biosynthesis the process of translating mRNA in to proteins

Chemical Composition of Ribosomes :

70 S – 60% r-RNA + 40% proteins

80 S – 40% r-RNA + 60% proteins

60 S – r-RNA 28 S, 5.8 S, 5 S

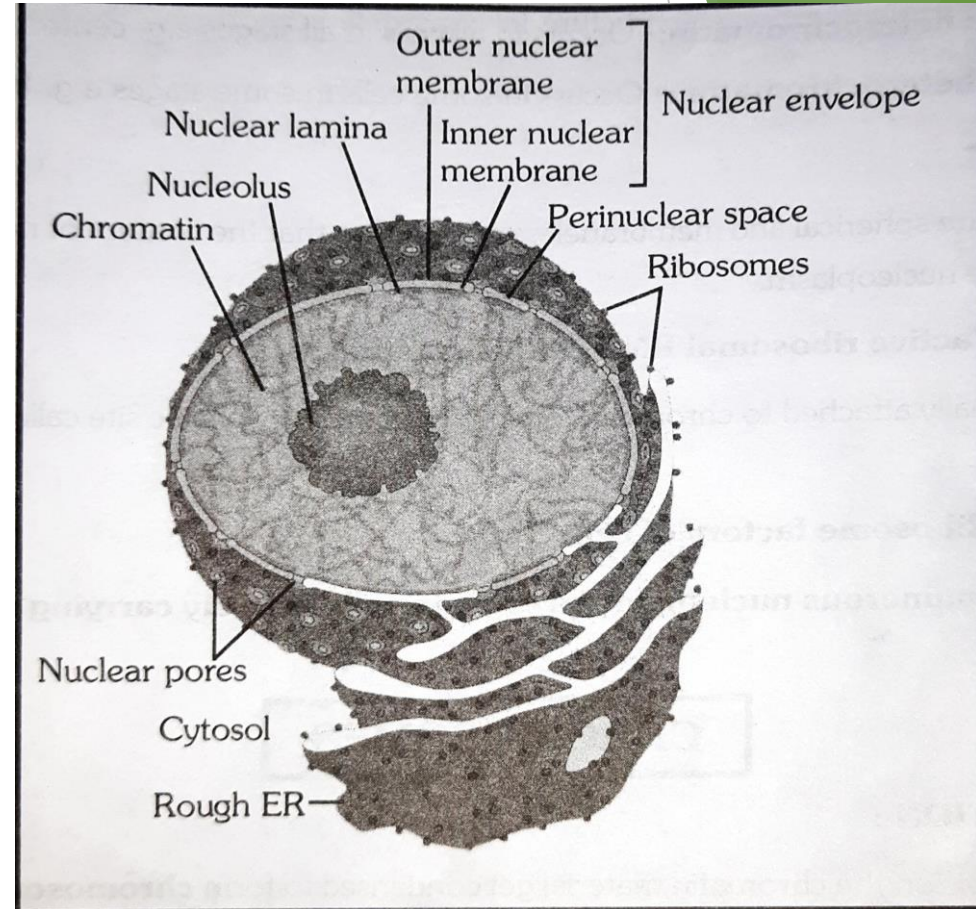
40 S – r-RNA 18 S

50 S – r-RNA 23 S, 5 S

30 S – r-RNA 16 S

Nucleus

- ▶ First described by Robert brown in early 1831
- ▶ Material of the nucleus stained by basic dyes (**Acetocarmine**) was given the name **chromatin** by Flemmings
- ▶ Considered as controller or **director of cell**
- ▶ **Importance of nucleus** in control of heredity growth and metabolism was experimentally Proved by **hammerling**
- ▶ Nucleus is absent in **sieve tube** elements are **mature RBCs of mammals**



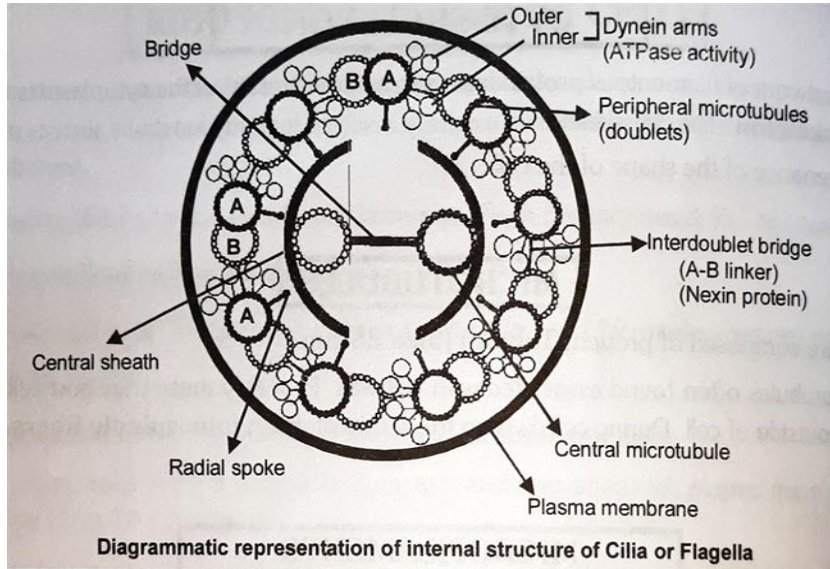
Structure of nucleus

- ▶ Nuclear membrane:- consist of two parallel membrane with a space between called perinuclear space , the outer membrane usually remains continuous with the endoplasmic reticulum and also bears ribosome on it . Minute pores are present on nuclear envelope called nuclear pore, it is guarded by a octagonal discoid structure of nucleoplasmin protein. The inner side of nuclear membrane is lined by nuclear lamina this structure is formed by filament of lamin protein
- ▶ Nucleoplasm:- complex colloidal formed of a number of chemical like nucleotides nucleosides ATPs protein and enzymes, chromatin net and nucleolus are components of nucleoplasm
- ▶ Called the ribosome factory of cell
- ▶ larger and more numerous nucleoli are present in cells actively carrying out protein synthesis

Cilia and flagella

- ▶ **Cilia and flagella are hair like outgrowths of the cell membrane.**
- ▶ **Cilia** are small structure which work like oars causing the movement of either the cell or the surrounding fluid.
- ▶ **Flagella** are comparatively longer and responsible for cell movement. Bacteria also possess flagella but these are structurally different from that of the eukaryotic flagella
- ▶ They are covered with **plasma membrane** and **core** is called **axoneme**, possess a number of microtubules running parallel to long axis. **Axoneme has 9 doublets of radially arranged peripheral microtubules and a pair of centrally located microtubules (9 doublet + 2 singlet)**
- ▶ Arms of a tubules consist of an enzymatic protein dynein similar to myosin of muscle cells. Dynein have ability to hydrolysis to ATP and liberates energy for ciliary movement

Comparison of Cilia and flagella



Cilia	Flagella
1. The cilia are small in size (5–10 μ m)	1. Flagella are long (up to 150 μ m)
2. Number of cilia per cell is very large.	2. Few in number
3. Cilia beat in a coordinated manner (Pendular movement)	3. Flagella beats independently (Undulating movement)
4. They take part in locomotion, attachment, feeding and sensation.	4. Flagella involved only in locomotion

Peroxisomes

- ▶ Membrane bound organelle
- ▶ Found in the cytoplasm of all eukaryotic cells
- ▶ Small subcellular compartment with a fine granules matrix and surrounded by a single biomembrane which are located in the cytoplasm of cell

FUNCTIONS

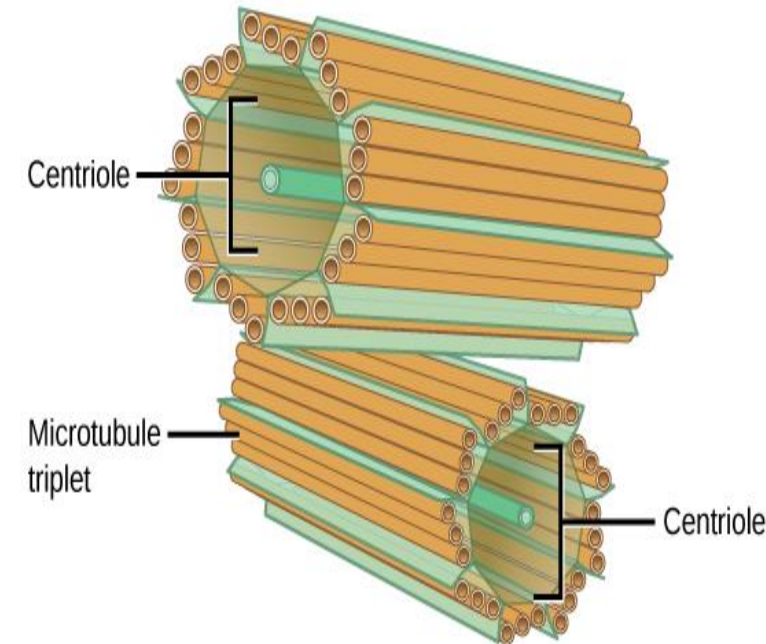
- ▶ Lipid metabolism
- ▶ Processing of reactive oxygen species
- ▶ Catabolism of D-amino acids polyamines and bile acid
- ▶ The reactive oxygen species such as peroxides produced in the process is converted to water by various enzymes like peroxidase and catalyse
- ▶ Detoxification of alcohol and other toxic compounds

Centriole

- ▶ Paired barrel shaped organelle
- ▶ Located in the cytoplasm of animal cells near the nuclear envelope
- ▶ Play a role in organizing microtubules that serve as the cell skeleton system
- ▶ Help determine the locations of the nucleus other organelles within the cells

FUNCTIONS

- ▶ Involved in the formation of the spindle apparatus which function during cell division
- ▶ The absence of centrioles cause divisional errors and delays in the mitotic process
- ▶ Single centriole forms the anchor point or basal body for each individual cilia or flagella
- ▶ Basal bodies direct the formation of Cilla and flagella as well



References

- ▶ Allen cell biology
- ▶ <https://www.shutterstock.com>
- ▶ <https://www.genome.gov>
- ▶ http://cnx.org/contents/GFy_h8cu@10.53:rZudN6XP@2/Introduction

Thank you