IMPORTANT EUKARYOTIC CELL ORGANELLES

ENDOPLASMIC RETICULUM

Endoplasmic reticulum is a complex network of tubular membranes exclusively present in the cytoplasm of the eukaryotic cell.
The endoplasmic reticulum transpires in two forms: a type with a ribosome-studded surface and another with a smooth surface. The latter is called the smooth endoplasmic reticulum, and the former is called the rough endoplasmic reticulum. These membranes form continuous folds, eventually joining the outer layer of the nuclear membrane. Except for sperm cells and red blood cells, the endoplasmic reticulum is observed in every other type of eukaryotic cell.
The below diagram shows the variants of the endoplasmic reticulum:

- Rough ER
- Smooth ER

Rough endoplasmic reticulum has ribosomes embedded within its structure, giving a "rough" appearance. The smooth endoplasmic reticulum does not have these ribosomes, hence appearing "smooth."

Structure of Endoplasmic Reticulum

The structure of the endoplasmic reticulum is shaped like a sac. Since ER is of two types, each has its own distinguishing features:

Rough Endoplasmic Reticulum Structure

- The rough endoplasmic reticulum is named so because of its appearance.
- It is a series of connected flattened sacs having several ribosomes on its outer surface, hence the name.
- It synthesizes and secretes proteins in the liver, hormones and other substances in the glands.
- Rough ER is prominent in cells where protein synthesis happens (such as hepatocytes)

Smooth Endoplasmic Reticulum Structure

- The smooth endoplasmic reticulum, on the other hand, does not have ribosomes.
- The smooth endoplasmic reticulum has a tubular form.
- It participates in the production of phospholipids, the chief lipids in cell membranes and are essential in the process of metabolism.
- Smooth ER transports the products of the rough ER to other cellular organelles, especially the Golgi apparatus.

Functions of Endoplasmic Reticulum

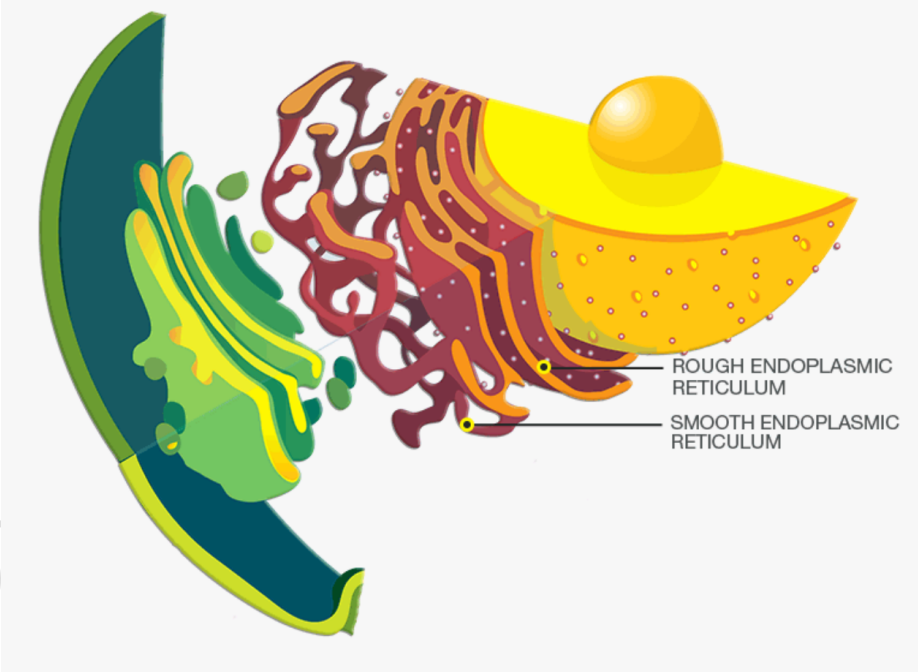
The endoplasmic reticulum is categorised into two types, and both these types of ER perform specific functions:

Smooth Endoplasmic Reticulum Function:

- Smooth ER is responsible for the synthesis of essential lipids such as phospholipids and cholesterol.
- Smooth ER is also responsible for the production and secretion of steroid hormones.
- It is also responsible for the metabolism of carbohydrates.
- The smooth ER store and releases calcium ions. These are quite important for the nervous system and muscular systems.

Rough Endoplasmic Reticulum Function:

- The majority of the functions of rough ER is associated with protein synthesis.
- The rough endoplasmic reticulum also plays a vital role in protein folding.
- Also ensures quality control (regarding correct protein folding).
- The second most important function after protein synthesis and protein folding is protein sorting.



Endoplasmic Reticulum diagram

GOLGI BODY

The Golgi apparatus has multiple names such as Golgi complex or Golgi body. The name is given on the name of the scientist, who discovered the organelle, i.e. Camillo Golgi. It is found in all the eukaryotic cells, plants as well as animals. They are membrane-bound organelle present in the cytosol of the cell. Let us explore more about Golgi complex.

Structure of Golgi Bodies

The Golgi body comprises 5 to 8 cup-shaped, series of compartments known as cisternae. Cisternae is a flattened, disk-shaped, stacked pouches that make up the Golgi apparatus. A Golgi stack mostly contains 4 to 8 cisternae. However, ~60 cisternae are found in some protists. A mammalian cell contains ~40 to 100 stacks of cisternae.
Animal cells generally contain around 10 to 20 Golgi stacks per cell, which are connected by tubular connections. Golgi complex is mostly found near the nucleus.

Creation, or evolution, whichever one, you hold a belief in has worked in wondrous ways to evolve or design the various living beings in this world in the most optimum ways. For example, take the Golgi complex, it has been designed in such a way, to ensure a sufficient number of Golgi bodies are present in the cell as per the requirement.

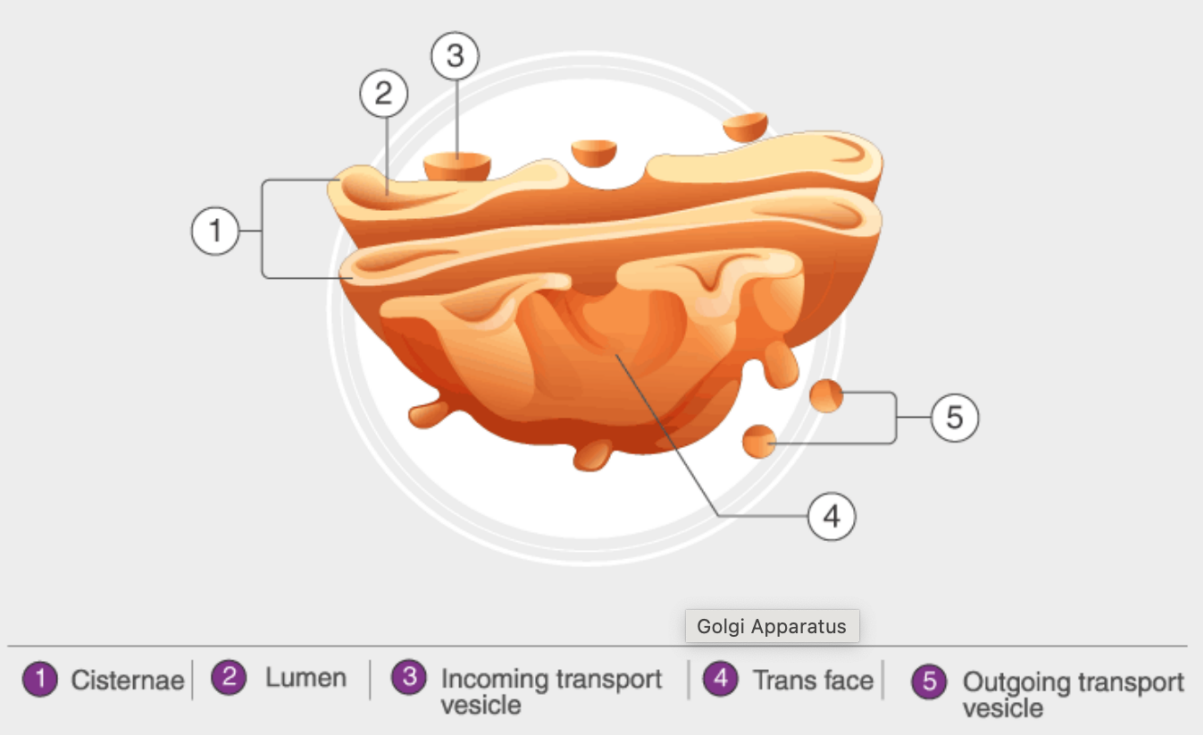
Functions of Golgi Bodies

Its main function is the packaging and secretion of proteins. It receives proteins from Endoplasmic Reticulum. It packages it into membrane-bound vesicles, which are then transported to various destinations, such as lysosomes, plasma membrane or secretion. They also take part in the transport of lipids and the formation of lysosomes.

Post-translational modification and enzymatic processing occur near the membrane surface in Golgi bodies, e.g. phosphorylation, glycosylation, etc.

Golgi apparatus is the site for the synthesis of various glycolipids, sphingomyelin, etc.

In plant cells, complex polysaccharides of the cell wall are synthesised in the Golgi apparatus.



LYSOSOMES

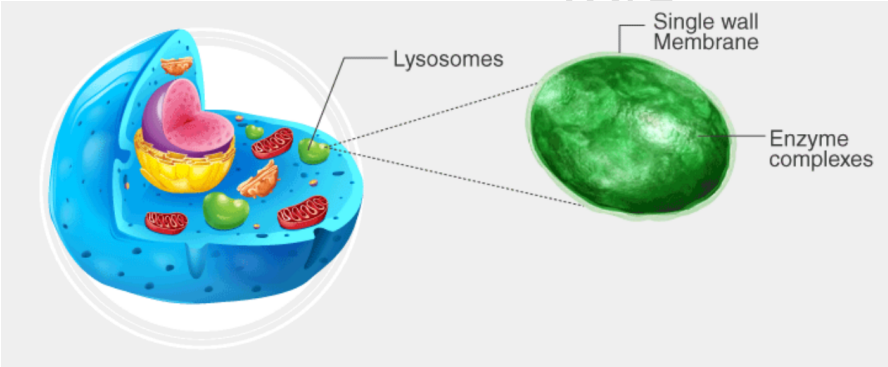
Lysosomes are sphere-shaped sacs filled with hydrolytic enzymes that have the capability to break down many types of biomolecules.

Lysosomes are an important cell organelle found within eukaryotic animal cells. Due to their peculiar function, they are also known as the "*suicide bags"* of the cell.

The term was coined by Christian de Duve, a Belgian biologist, who discovered it and ultimately got a Nobel Prize in Medicine or Physiology in the year 1974.

Lysosome Structure

Lysosomes are membrane-bound organelles and the area within the membrane is called the lumen, which contains the hydrolytic enzymes and other cellular debris.



The pH level of the lumen lies between 4.5 and 5.0, which makes it quite acidic. It is almost comparable to the function of acids found in the stomach.

Besides breaking down biological polymers, lysosomes are also involved in various other cell processes such as counting discharged materials, energy metabolism, cell signalling, and restoration of the plasma membrane.

The sizes of lysosomes vary, with the largest ones measuring in more at than 1.2 µm. But they typically range from 0.1 µm to 0.6 µm.

Lysosome Functions: The key function of lysosomes is digestion and removal of waste. Cellular debris or foreign particles are pulled in to the cell through the process of endocytosis. The process of endocytosis happens when the cell membrane falls in on itself (invagination), creating a vacuole or a pouch around the external contents and then bringing those contents into the cell.

On the other hand, discarded wastes and other substances originating from within the cell is digested by the process of auto-phagocytosis or autophagy. The process of autophagy involves disassembly or degradation of the cellular components through a natural, regulated mechanism.

Suicidal bags: Lysosomes work as the waste discarding structures of the cell by processing undesirable materials and degrading them, both from the exterior of the cell and waste constituents inside the cell.

But sometimes, the digestive enzymes may end up damaging the lysosomes themselves, and this can cause the cell to die. This is termed as autolysis, where "auto" means "*self*" and "lysis" means "*the disintegration of the cell by the destruction of its cell membrane*".

Hence, lysosomes are known as "Suicidal Bags" of the cell.

PEROXISOMES

Peroxisomes are small vesicles, single membrane-bound organelles found in the eukaryotic cells. They contain digestive enzymes for breaking down toxic materials in the cell and oxidative enzymes for metabolic activity. They are a heterogeneous group of organelles and the presence of the marker enzymes distinguished them from other cell organelles.

Peroxisomes play an important role in lipid production and are also involved in the conversion of reactive oxygen species such as hydrogen peroxide into safer molecules like water and oxygen by the enzyme catalase.

Mostly peroxisomes occur as an individual organelle, e.g. in fibroblasts. They also exist in the form of interconnected tubules in liver cells known as peroxisome reticulum.

Peroxisome Structure:

Peroxisomes vary in shape, size and number depending upon the energy requirements of the cell. These are made of a phospholipid bilayer with many membrane-bound proteins.

The enzymes involved in lipid metabolism are synthesised on free ribosomes and selectively imported to peroxisomes. These enzymes include one of the two signalling sequences- Peroxisome Target Sequence 1 being the most common one.

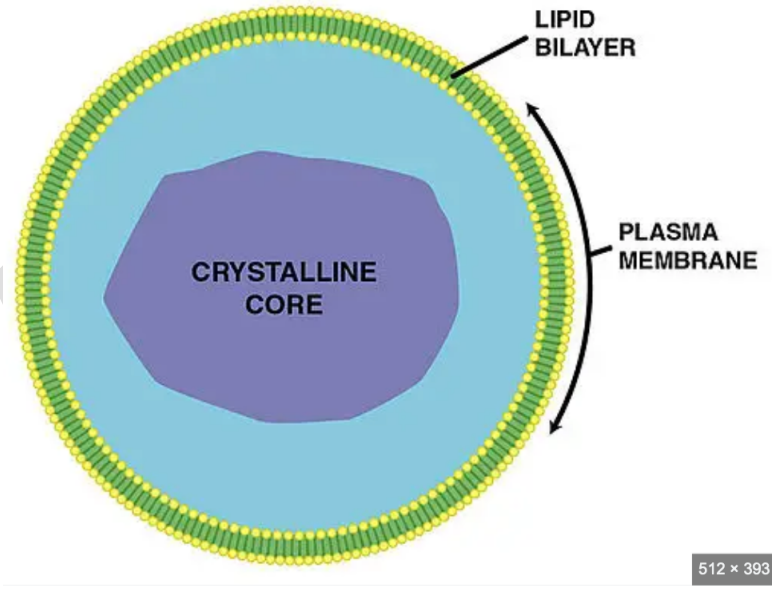
The phospholipids of peroxisomes are usually synthesised in smooth Endoplasmic reticulum. Due to the ingress of proteins and lipids, the peroxisome grows in size and divides into two organelles.

Peroxisomes do not have their own DNA. Proteins are transported from the cytosol after translation.

Peroxisome Functions: The main function of peroxisome is the lipid metabolism and the processing of reactive oxygen species. Other peroxisome functions include:

- They take part in various oxidative processes.
- They take part in lipid metabolism and catabolism of D-amino acids, polyamines and bile acids.
- The reactive oxygen species such as peroxides produced in the process is converted to water by various enzymes like peroxidase and catalase.
- In plants, peroxisomes facilitate photosynthesis and seed germination. They prevent loss of energy during carbon fixation in photosynthesis.

Metabolism: Isolated peroxisomes are permeable to small molecules such as sucrose. During the isolation process, they often lose proteins that are normally confined to the peroxisomal matrix. In all living cells, peroxisomes are the sealed vesicles surrounded by a single membrane.

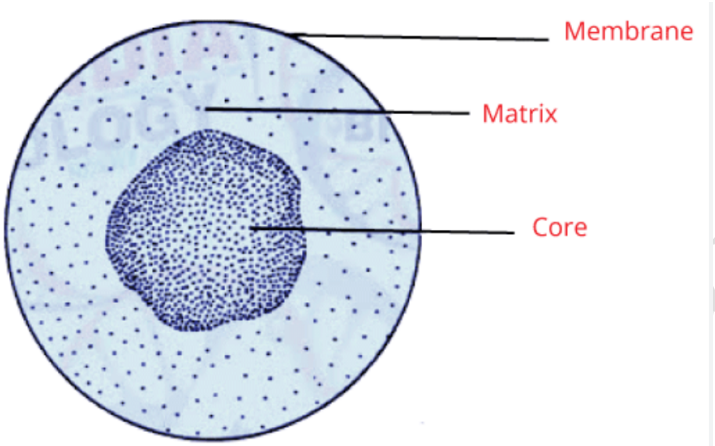


GLYOXYSOMES

Glyoxysomes are microbodies which occur only in fat rich plant cell, where they take part in β-oxidation of fats and perform glyoxylate cycle. Glyoxysomes are a type of peroxisomes found in plants and few filamentous fungi. Glyoximes were discovered by Beevers and Breidenbach. Bill Breidenbach was Beevers' postdoctoral fellow, he demonstrated that the enzymes for the glyoxylate cycle were found in a separate organelle, which they named as

glyoximes. They are particularly found in fat storage tissues of germinating seeds (peanuts, soybeans etc.) in plants.

It helps in fatty acid oxidation, glyoxylate cycle and gluconeogenesis. They contain enzymes (citrate synthase, isocitrate lyase and malate synthase etc.) which are responsible for beta-oxidation of fatty. It also contains enzymes which produce intermediate products for the synthesis of sugars by gluconeogenesis.



Structure of Glyoxysome

527 × 4

*Disclaimer: Diagrams and pictures are taken from the internet.