CELL BIOLOGY

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Lecture 10: Endomembrane system 6/12/2021

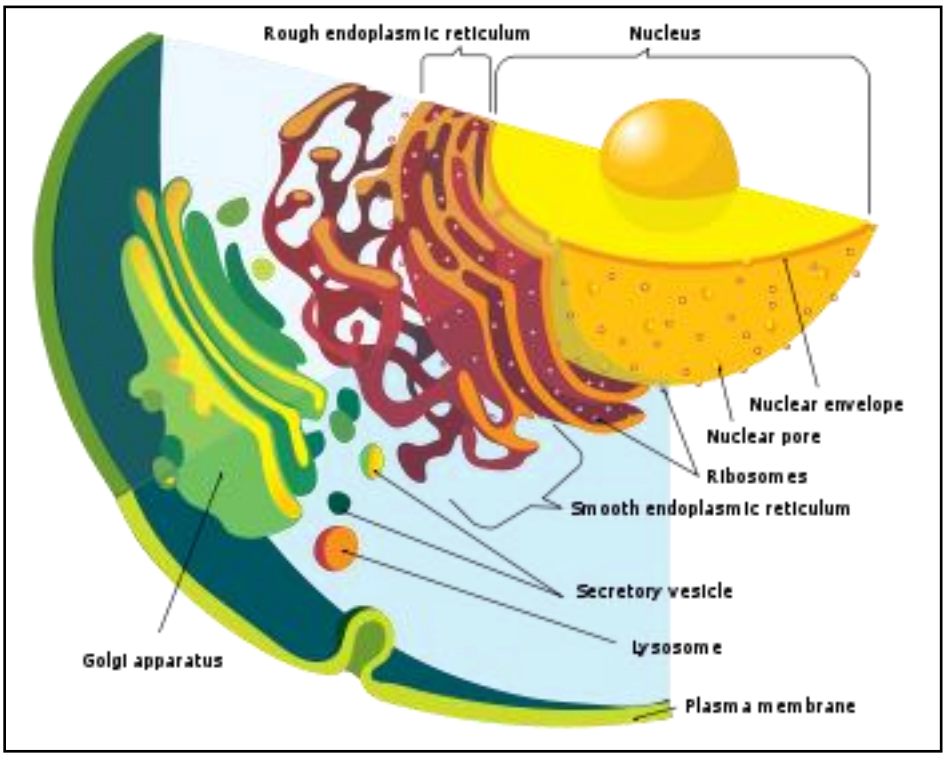
Many of the internal membranes in eukaryotic cell are part of the Endomembrane system. These membranes are either directly continuous or connected via transfer of **vesicles,** sacs of membrane.

In spite of these connections, these membranes are diverse in function and structure.

The thickness, molecular composition and types of chemical reactions carried out by proteins in a given membrane may be modified several times during a membrane's life.

The endomembrane system is a Group of membrane and organelles in eukaryotic cells that works together to modify, package, and transport lipids and proteins.

The **endomembrane system** includes the nuclear envelope, endoplasmic reticulum, Golgi apparatus, lysosomes, vacuoles, also allow the exchange of membrane components with the plasma membrane.



The Endoplasmic Reticulum (ER)

A continuous membrane system that forms a series of flattened sacs within the cytoplasm of eukaryotic cells and serves multiple functions, being important particularly in the synthesis, folding, modification, and transport of proteins and lipids.
-All eukaryotic cells contain an endoplasmic reticulum (ER).
-In animal cells, the ER usually constitutes more than half of the membranous content of the cell.
These are single membrane cell organelles, form an interconnected network of tubules, sacs called cisternae with in cells.
These sac-like structures are held together by the cytoskeleton. The phospholipid membrane encloses the cisternal space (or lumen), which is continuous with the perinuclear space but separate from the cytosol.

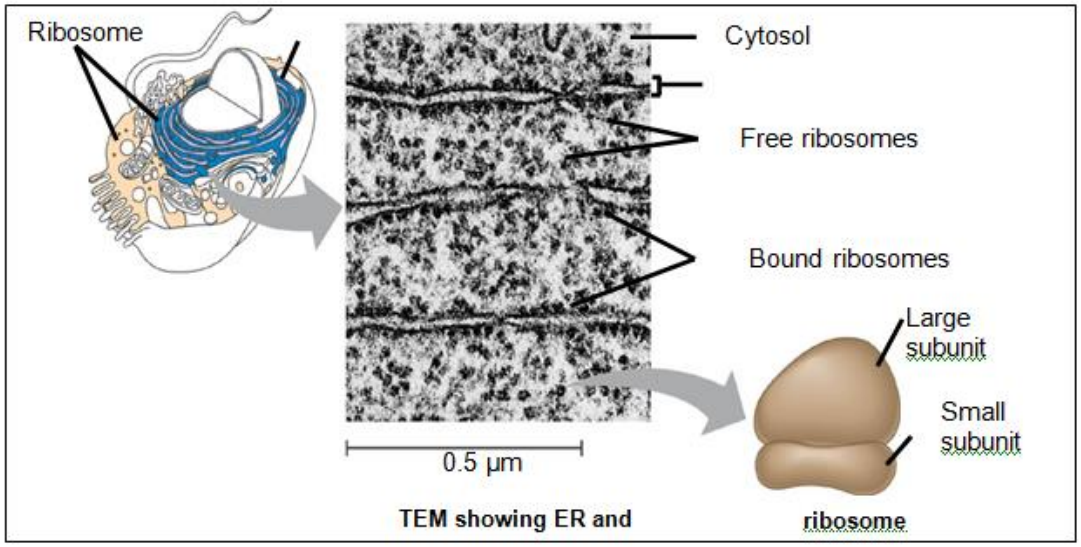
Differences in certain physical and functional characteristics distinguish the two types of ER, known as rough ER and smooth ER.

Rough ER is named for its rough appearance, which is due to the ribosomes attached to its outer (cytoplasmic) surface.
1-Rough ER lies immediately adjacent to the cell nucleus, and its membrane is continuous with the outer membrane of the nuclear envelope.
2-The ribosomes on rough ER specialize in the synthesis of proteins.
(A number of other proteins in a cell, including those destined for the nucleus and mitochondria, are targeted for synthesis on free ribosomes, or those not attached to the ER membrane)
3-Proteins synthesized by the rough ER have specific final destinations. Some proteins, for example, remain within the ER, whereas others are sent to the Golgi apparatus, which lies next to the ER.
4-Proteins targeted for transport to the Golgi apparatus are transferred from ribosomes on rough ER into the rough ER lumen, which serves as the site of protein folding, modification, and assembly
5-The proximity of the rough ER to the cell nucleus gives the ER unique control over protein processing.
6-The rough ER is able to rapidly send signals to the nucleus when problems in protein synthesis and folding occur and thereby influences the overall rate of protein translation.
7-When misfolded or unfolded proteins accumulate in the ER lumen, a signaling mechanism known as the **unfolded protein response (UPR)** is activated. The response is adaptive, such that UPR activation triggers reductions in protein synthesis and enhancements in ER protein-folding capacity and ER-associated protein degradation.

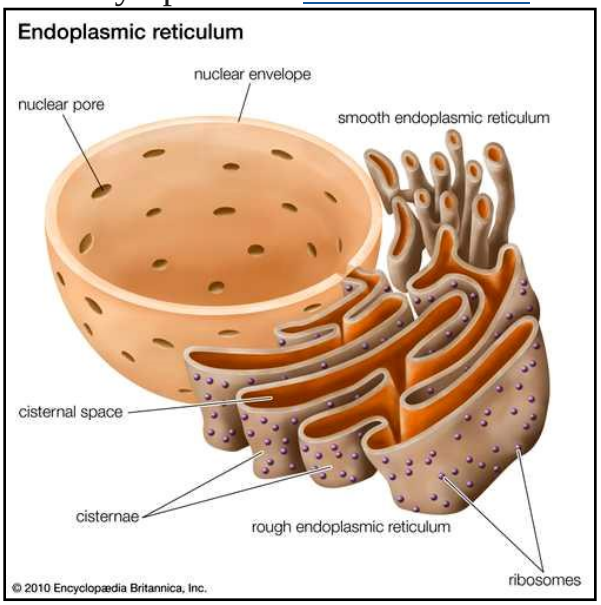
8-If the adaptive response fails, cells are directed to undergo apoptosis (programmed cell death).

Ribosomes build a cell's proteins.

- Ribosomes are Small semi-spherical, black dots 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.
- Ribosomes can be found floating within the cytoplasm or attached to the endoplasmic reticulum.
- Cell types that synthesize large quantities of proteins (e.g., pancreas cells) have large numbers of ribosomes and prominent nucleoli.
- They can be found in both prokaryote (bacteria) and eukaryote (animals and plants) cells.
- Prokaryotes have 70S ribosomes respectively subunits comprising the little subunit of 30S and the bigger subunit of 50S.
- Eukaryotes have 80S ribosomes respectively comprising of little (40S) and substantial (60S) subunits.
- **Eukaryote** ribosomes **are produced and assembled in the nucleolus.** Ribosomal **proteins enter the nucleolus and combine with the four rRNA strands to create the two** ribosomal **subunits (one small and one large) that will make up the completed** ribosome
- **The RBCs are good example of cells without** mitochondria **or ribosomes which survive for 120 days**

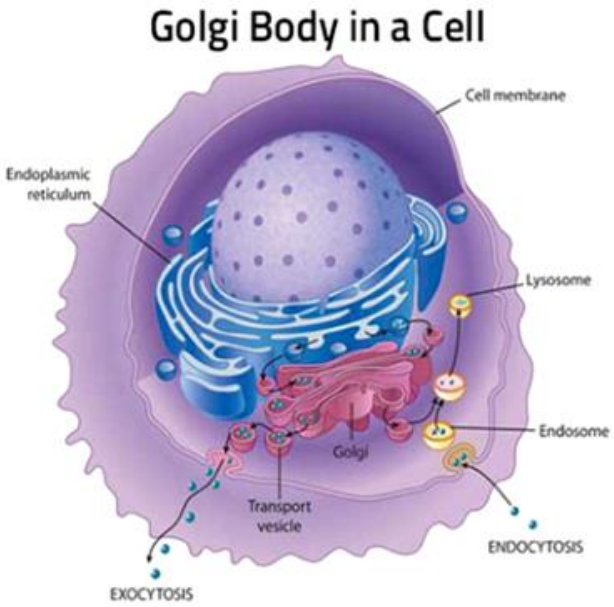


Smooth ER, is not associated with ribosomes, and its functions is involved in the synthesis of lipids, including cholesterol and phospholipids, which are used in the production of new cellular membrane.
-In certain cell types, smooth ER plays an important role in the synthesis of steroid hormones from cholesterol.
-In cells of the liver, it contributes to the detoxification of drugs and harmful chemicals such as alcohol and barbiturates.
-The sarcoplasmic reticulum is a specialized type of smooth ER that regulates the calcium ion concentration in the cytoplasm of striated muscle cells



Golgi apparatus

- Also known as **Golgi complex, Golgi body or Golgi.**
- Membrane bound organelles, which are sac-like.
- Found in cytoplasm of most eukaryotic cells and **absent in prokaryotes, Mammalian RBCs and sperm cells of bryophytes.**
- Ranges from one to several within a cell.
- In plant cells several small Golgi complex – dictyosomes.
- It is responsible for transporting, modifying and packaging proteins and lipids into vesicles.



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.

Main parts of Golgi are:

The ***cis face*** is closest to the endoplasmic reticulum.

The ***trans face*** is the side furthest from the nucleus, which secretes vesicles to various parts of the cell.

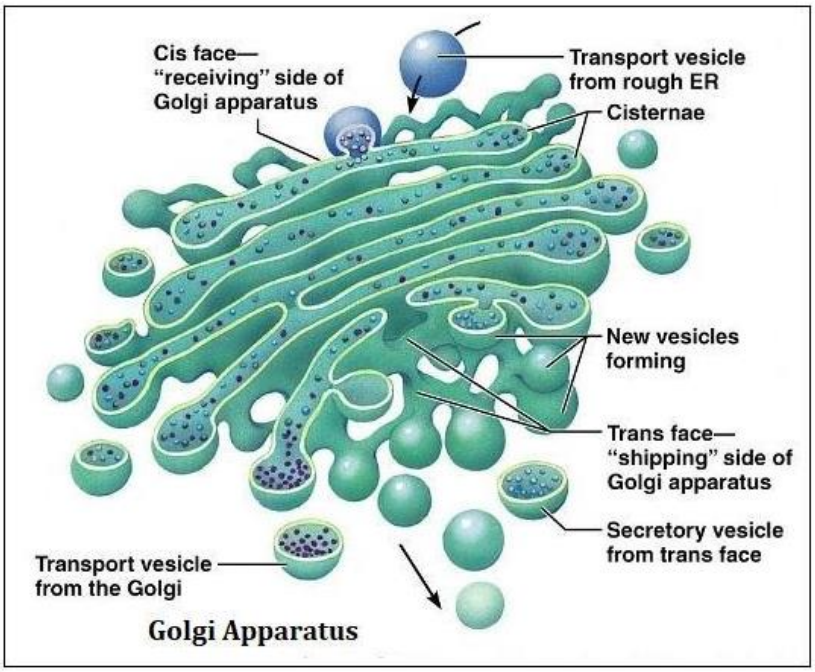
The **cisternae** through which products flow.

Golgi Apparatus Structure:

Cisternae: They are parallely arranged sacs like structure which are covered by single membrane. The number of sacs in the stack ranges from 3-20 in number which depends on the cell type.

Small vesicles: The vesicles are small droplet-like sacs and originate from the cisternae by building or "pinching off" process.

Large vacuoles: They are clear and large sac-like structures. They contain electron-dense materials.



In general Golgi complex is of vital importance and serves many functions:

1. Absorption of compounds:
2. Formation of secretory vesicles and secretion:
3. Helps in enzyme formation:
4. Production of hormones:
5. Storage of protein:
6. Formation of acrosome:
7. Formation of intracellular crystals:
8. Milk protein droplet formation:
9. Formation of plant cell wall:
10.Glycoproteins secretion:

Golgi Apparatus Function

The golgi apparatus modifies proteins and lipids that it receives from the endoplasmic reticulum. These biochemicals leave the golgi by **exocytosis** before being delivered to different **intracellular** or **extracellular** targets.