جامـــــعة المـــــستقبل
AL MUSTAQBAL UNIVERSITY

كلية العلـــوم

قـســـــــم الادلة الجنائية

المحاضرة السابعة

L

المادة : الخلية The Cell

المرحلة : الأولى

اسم الاستاذ: د.عماد هادي الطائي

Endoplasmic Reticulum, Ribosome, Golgi Bodies

Endoplasmic reticulum:

Endoplasmic reticulum is a complex, finely divided vacuoles or tubular system, extending from nucleus through cytoplasm to the margins of the cells. This system is enclosed by double membrane. In eukaryotic cells endoplasmic reticulum is generally the largest membrane which forms extensive system of intercommunicating membranous sacs or channels. It represents 30 to 60% of total membrane in a cell.

The membrane of endoplasmic reticulum may or may not have ribosomes attached to their outer membrane. Accordingly, these are classified as rough (RER) or smooth endoplasmic reticulum (SER).

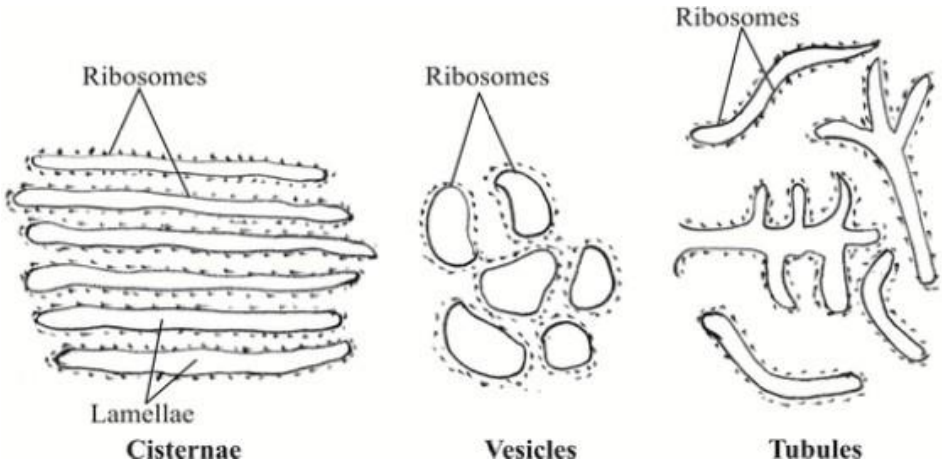

Figure: Various form of ER.

ER comprises three types of elements:

1. **Cisternae:** These are flattened, unbranched, sac like elements with about 40-50µm in diameter. They lie in stacks parallel to but interconnected with one another. They are separated from one another by cytosolic spaces. The
   small granular structures called the ribosomes may or may not be present on the surface of cisternae.

2. **Tubules:** These are irregular, branching elements, which form a network along with other elements. They are about 50-100µm in diameter and are often free of ribosomes.

3. **Vesicles:** These are oval, vacuole like elements, about 25-500µm in diameter. They often occur isolated in the cytoplasmic matrix. They are also free of ribosomes. A fluid called the endoplasmic matrix is present in
   the lumen of ER.

Ultra-structure of Endoplasmic Reticulum

The membrane bounding the cisternae, tubules and vacuoles of the ER is similar to the cell membrane. It is 50-60Å thick. The membranes of endoplasmic reticulum are composed of two layers of phospholipids molecules sandwiched by two layers of protein molecules like other membranes in the cell. The ER membrane has a relatively high protein/lipid ratio. Certain cisternae open out by pores in the cell membrane. In the lumen of endoplasmic reticulum, secretary granules were observed. The lumen acts as a passage for the secretary products.

On the basis of absence or presence of ribosomes, two kinds of ER are found in cells.

1. **Smooth Endoplasmic Reticulum**: Ribosomes are absent on the walls of ER and so it appears smooth and hence called smooth or agranular ER. It mainly occurs as tubular forms. Smooth ER is commonly found in the cells involved in the synthesis of steroids or lipids (non protein type of synthesis) such as:
   - adrenal or sebaceous glands gonadial interstitial cells.
   - Certain cells with carbohydrate metabolism (e.g. liver cells)
   - impulse conduction (e.g. muscle cells)
   - pigment production (e.g., retinal pigment cell)
2. **Rough Endoplasmic Reticulum (RER):** It is characterized by the presence of ribosomes on the surface of reticulum and so it is also known as granular ER. It is in the form of flattened cisternae with the width of 400-500Å. RER occurs largely in the cells that are actively involved in the synthesis of proteins such as:
   - enzymes (e.g. pancreatic cells, plasma cells and liver cells)
   - mucus (goblet cells)

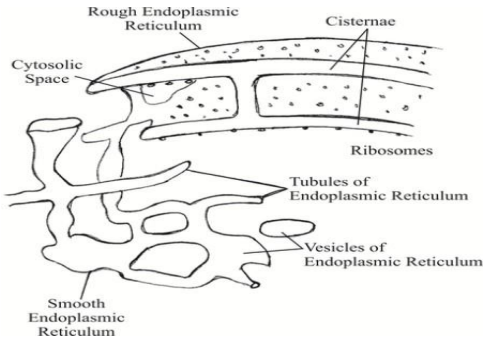

Figure: Various types of elements of endoplasmic reticulum.

Functions of Endoplasmic Reticulum: -

1. Functions of smooth endoplasmic reticulum: -

A- Surface for Synthesis- such as fatty acids, phospholipids, glycolipids, steroids and visual pigments.

B- Glycogen Metabolism- Glycogen granules are attached in larger numbers to the outside of the SER's membranes in liver cells.

C- Formation of organelles- The SER produces Golgi apparatus, lysosomes, micro bodies and vacuoles.

D- Fat Oxidation- The SER membranes carry out the initial reactions in the oxidation of fats.

2. Functions of rough endoplasmic reticulum

A. Surface for Ribosomes - The RER provides a large surface for the attachment of ribosomes.

B. Surface for synthesis - The RER offers extensive surface on which protein synthesis can be carried on by ribosomes.

C. Packaging - The proteins in ER lumen are processed and get enclosed in spherical membrane bound vesicles which get pinch off from the ER. These vesicles have various fates. Some remain in the cytoplasm as storage vesicles while others migrate to the plasma membrane and releasel their contents by exocytosis. Some fuse with Golgi apparatus for further processing of their proteins for storage or release from the cell as showed in below figure.

D. Formation of Nuclear Envelope- The RER forms nuclear envelope around daughter cells in cell division.

Ribosomes:

Ribosomes are of two types 70S and 80S. 'S' is Svedberg unit, a measure of particle size dependent on the speed with which the particles sediment in the ultracentrifuge.

The 70S ribosomes are found in the prokaryotic cells and in the mitochondria and plastids of eukaryotic cells.

The 80S ribosomes occur in the cytoplasm of the eukaryotic cells. Both the 70S and 80S ribosomes are similar in structure. **They are small, spherical structures of which 70S ribosomes are around 200Å in diameter, while 80S are 250 to 300Å in diameter**. They are porous and hydrated having two subunits, one is larger (140-160Å in diameter) having dome shaped structure and the other is smaller in size, found over the larger subunit, forming a cap like structure. The two subunits are separated by clefts. Membrane is absent around them. The subunits occur separately in the cytoplasm, and join to form ribosomes only at the time of protein synthesis.

Many ribosomes line up and join the mRNA chain. After the synthesis of protein, the ribosomes leave the mRNA chain and dissociate into subunits.

70S Ribosome: found in bacterial cells and have the molecular wt. 2.7×10^{-6} daltons and sedimentation coefficient 70S. 70S ribosome consists of a large 50S subunit and a small 30S subunit. Each subunit is composed of rRNA and several basic proteins. The 50S subunit has two species of RNA: 23S and 5S and about 34 different ribosomal proteins. The 30S subunit has only one species of rRNA, i.e., 16S and about 21 different ribosomal proteins. They also occur in mitochondria and chloroplasts of eukaryotic cells.

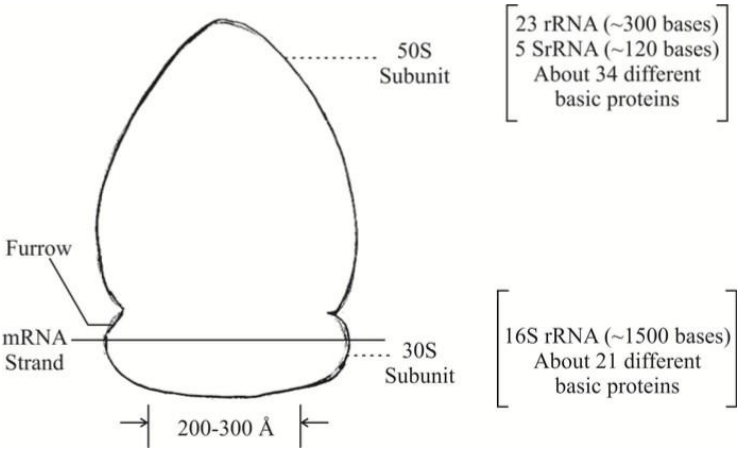

Figure: structure of 70S Ribosomes

80S Ribosome: Having the sedimentation coefficient 80S, these are somewhat larger and contain more RNA and proteins than 70S ribosomes.

An 80S ribosome is over 250 to 300Å in diameter. Their mol. wt. is 4×10^{-6} daltons. It consists of a large 60S subunit and a small 40S subunit. Each subunit is composed of rRNA and several specific basic proteins. The 60S subunit has three species of rRNA: 28S, 5.8S and 5S and over 45 different ribosomal proteins. The 40S subunit has only one species of rRNA, i.e., 18S and over 33 different ribosomal proteins. They are found in eukaryotic cells.

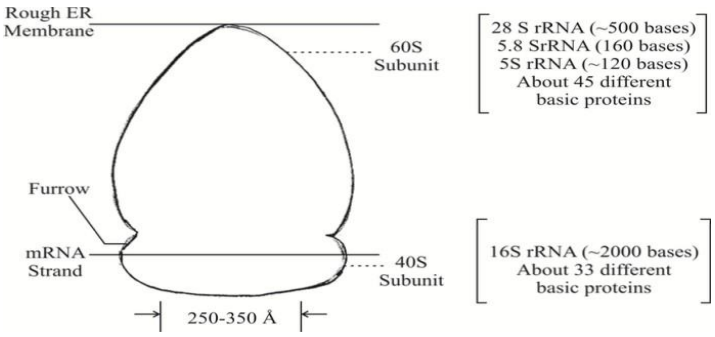

Figure: structure of 80S Ribosomes

Functions of Ribosome

1. **Attached Ribosomes**- The ribosomes provide space and enzymes for the synthesis of proteins in the cell. The ribosomes bound to the ER membranes synthesize:
   (i) integral proteins for cellular membranes,
   (ii) lysosomal proteins
   (iii) secretary proteins for export as secretions.
2. **Free Ribosomes**- The free ribosomes produce structural and enzymatic proteins for use in the cell itself. These proteins include glycolytic enzymes and most extrinsic membrane proteins, such as spectrin.

Importance of Ribosome

- Ribosomes are known as protein factories. Ribosomal RNA molecules possibly serve as a skeletal framework in the ribosomes.
- Smaller ribosomal subunit is required for the formation of initiation complex at the start of the protein synthesis. Whereas larger ribosomal subunit is necessary for peptide bond formation and the elongation for the polypeptide.
- The ribosome function as a template in order to bring together various components involved in the synthesis of proteins. Ribosomes co-ordinate the interaction of t-RNA-amino acid complex with m-RNA. This co- ordination results in the translation of genetic code forming specific proteins.

Golgi Complex

Golgi bodies varies in size and form in different types of cells, but they have similar organization in all kinds of cells. For example, it is well developed in secretory and nerve cells, but is rather small in muscle cells. Golgi bodies are compiled as a central stack (pile) of flattened sacs or cisternae and many peripheral tubules and vesicles.

They are of three types: transitional, smooth or secretary and coated vesicles.

A. **Transitional Vesicles:** These are the small outgrowths formed from the transitional ER. They migrate to, converge and coalesce to cis face of Golgi, where they form new cisternae.
B. **Smooth Vesicles:** These have smooth surface and contain secretions of the cell and so they are also called secretary vesicles. They arise from the ends of the cisternae tubules.
C. **Coated vesicles**: These have rough surface and they also arise from the cisternae tubules. They play a role in intracellular traffic of secretary protein molecules.

The Golgi complex has 3 functional regions:

- cis region that lies nearest the ER
- medial region in the middle and
- Tran's region with trans Golgi reticulum nearest to the plasma membrane.

These regions have different enzymes which introduce different modifications to secretary and membrane proteins passing through them. The principal modification is glycosylation, i.e., addition of sugars to proteins, forming glycoproteins. Glycosylation starts in the ER and is completed in the Golgi complex. Modification of proteins in the Golgi apparatus also involves addition of lipids, forming lipoproteins (liposylation).

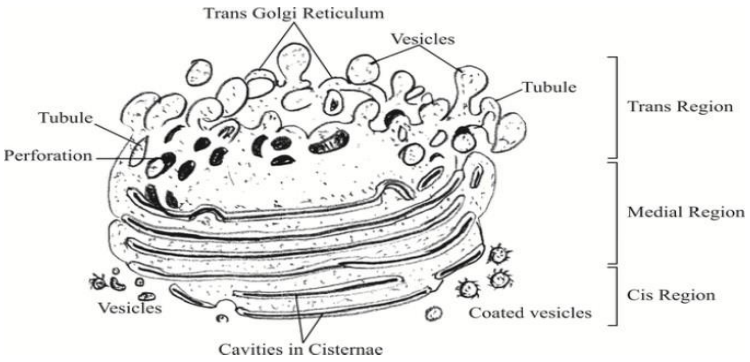

Figure: Thee-dimensional view of Golgi apparatus

Functions of Golgi Bodies:-

1. **Formation of secretary vesicles**- The Golgi complex processes and packages proteins and lipids coming from the ER for transport to other parts of the cell or out of the cell. Packaging involves wrapping the materials by a membrane, forming secretary vesicles.
2. **Synthesis of carbohydrates-** The Golgi apparatus synthesizes certain mucopolysaccharides from simple sugars.
3. **Formation of Glycoproteins-** The Golgi apparatus links the sugars with proteins coming from rough ER to form glycoproteins.
4. **Formation of Lipoproteins-** Lipids and proteins coming from the ER are complexed into lipoproteins in the Golgi apparatus.
5. **Membrane Transformation-** The Golgi apparatus changes one type of membrane into another type. Membranes are gradually modified from the ER type to one with characteristics of the plasma membrane as they shift through the Golgi complex.
6. **Formation of cell wall-** In some algae, cellulose plates for cell wall is synthesized in Golgi complex. In higher plants the Golgi complex (a) synthesizes pectin and some carbohydrates necessary for the formation of cell wall and (b) produces some secretions such as mucilage, gums, etc.
7. **Formation of lysosomes-** The Golgi complex gives rise to primary lysosomes

by budding. The lysosomes may also arise from ER.

8. **Acrosome Formation-** The Golgi complex gives rise to the acrosome in a sperm.
9. **Storage of Secretions-** The Golgi complex stores cell secretions such as proteins and lipids.