Endoplasmic Reticulum: Structure, Types and Function

In this article we will discuss about:- 1. Discovery of Endoplasmic Reticulum 2. Types of Endoplasmic Reticulum 3. Structure 4. Functions.

Discovery of Endoplasmic Reticulum (ER):

It was discovered independently by Porter (1945) and Thompson (1945). The name was given by Porter in 1953. Endoplasmic reticulum is a 3-dimensional, complicated and interconnected structure of membrane-lined channels that run through the cytoplasm.

At places, it is connected with plasma lemma as well as nuclear envelope. Plasmodesmata contain it in the form of desmotubules. It is not visible under light microscope but can be observed under electron microscope.

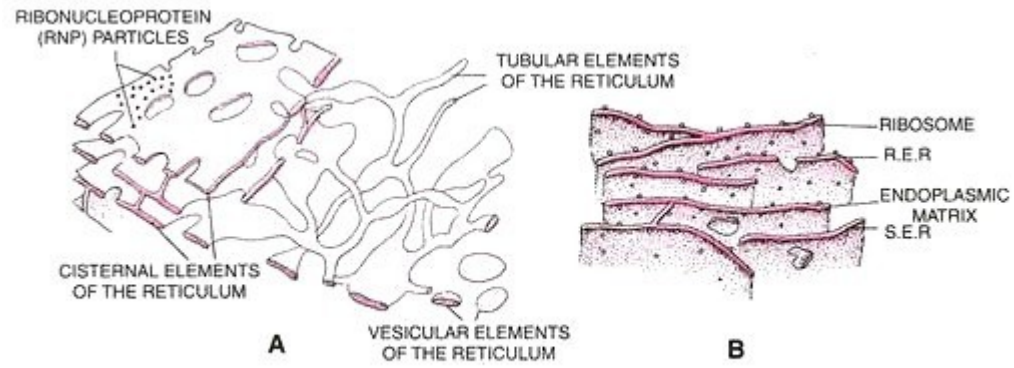

Fig. 8.30. Part of endoplasmic reticulum showing its three dimensional nature.

Endoplasmic reticulum divides the intracellular space into two compartments luminal (inside the endoplasmic reticulum) and extra-luminal (rest of cytoplasm). The extent of endoplasmic reticulum varies from cell to cell. Normally it forms 30-60% of membrane

system of the cell which increases the internal surface 30-40 times as compared to external surface.

Endoplasmic reticulum is quite extensive in metabolically active cells (e.g., cells of pancreas, liver), simple in storage cells (in the form of tubules in adipose cells), reduced in spermatocytes (in the form of a few vesicles), and absent in eggs, mature erythrocytes, embryonic cells, resting cells, prokaryotic cells, etc.

Types of Endoplasmic Reticulum:

Depending upon the nature of its membranes, endoplasmic reticulum is of two main types, smooth and rough. The two types of ER may be continuous with one another, plasma membrane and nuclear envelope. Endoplasmic reticulum may develop from pre-existing E.R., plasma lemma or nuclear envelope.

i. Smooth Endoplasmic Reticulum (SER):
It has smooth membranes which do not bear ribosomes. It is, therefore, also called agranular endoplasmic reticulum. This type of ER is found in cells engaged in the synthesis and storage of glycogen, fat and sterols (e.g., glycogen storing liver cells, interstitial cells, adrenal cortical cells, adipose cells, muscle cells, retinal cells, etc.).

It is also commonly found in leucocytes. Smooth endoplasmic reticulum is mostly made of vesicles and tubules. Sphaerosomes are believed to originate from SER.

ii. Rough Endoplasmic Reticulum (RER):
It has rough membranes because a number of ribosomes occur attached to their outer surfaces. RER is, therefore, also called granular endoplasmic reticulum. The membrane of the endoplasmic reticulum bears a fine pore in the area of attached ribosome to pass the synthesized polypeptide into the channel of endoplasmic reticulum for transport.

RER contains two types of glycoproteins (ribophorin I and ribophorin II) for attachment to ribosomes. On account of the presence of ribosomes, the rough ER is engaged in synthesizing proteins and enzymes.

It is, rich in cells which are actively engaged in protein synthesis and secretory activity, e.g., pancreatic acinus cells, plasma cells, fibroblasts, goblet cells. In conjunction with Golgi apparatus, RER helps to produce lysosomes. RER is mostly made of cisternae. Tubules are very few.

Structure of Endoplasmic Reticulum:

Endoplasmic reticulum consists of membrane lined channels or spaces. The channels or spaces contain a fluid called endoplasmic matrix, which is quite different from cytoplasmic matrix present outside the reticulum. The membranes of endoplasmic reticulum are 50-60 A thick. Endoplasmic reticulum can exist in three forms (Fig. 8.31) — cisternae, vesicles and tubules.

1. Cisternae:
They are flat interconnected sac-like parts of the endoplasmic reticulum which are 40-50 nm in diameter. The cisternae are found in bundles where they lie parallel to one another. They occur in the cells actively involved in synthetic activity.

2. Vesicles:
They are oval or rounded sacs of 25-500 nm in diameter. The vesicles appear as small vacuoles. They remain isolated in the cytoplasm. The vesicles are also called microsomes.

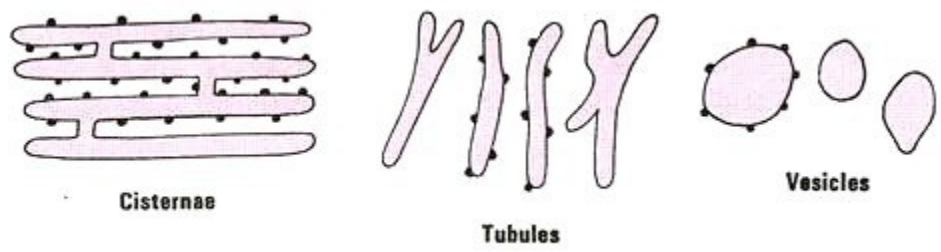

Fig. 8.31. The three components of endoplasmic reticulum.

Functions of Endoplasmic Reticulum:

i. Common Functions of ER:

1. It provides a large surface inside the cell for various physiological activities.

2. It functions as cytoskeleton or intracellular and ultra-structural skeletal framework by providing mechanical support to colloidal cytoplasmic matrix.

3. Endoplasmic reticulum keeps the various organelles in their position.

4. Endoplasmic reticulum (as desmotubules) controls movement of materials between two adjacent protoplasts through plasmodesmata.

5. Endoplasmic reticulum acts as a means of quick intracellular transport.

6.In cells, endoplasmic reticulum conducts information from cell exterior to inside and from one part of the cell to another, e.g., cytoplasm to nucleus and vice versa.

7. It provides membranes to nuclear envelope after telophase.

8. It provides precursors of different secretory substances to Golgi apparatus.

9. It gives membranes to Golgi apparatus for the formation of vesicles and lysosomes.

10. It gives rise to vacuoles.

11. Complexing of proteins and lipids to form lipoproteins occurs in ER.

12. The membranes of endoplasmic reticulum contain a number of enzymes (e.g., ATP- ase, reductases, dehydrogenases, phosphatases) for various metabolic activities and cytochromes that take part in electron transport.

ii. Functions of Rough Endoplasmic Reticulum (RER):

1. It contains SRP receptors or ribophorins for providing attachment to ribosomes.

2. RER provides a large surface area to ribosomes.

3. It bears enzymes in the region of pores for modifying polypeptides synthesised by attached ribosomes, e.g. glycosylation.

4. It synthesizes serum proteins, membrane proteins and a number of other proteins.

5. Proteins and enzymes synthesised by ribosomes enter the channels of RER both for intracellular use as well as secretion.

6. It provides enzyme precursors for the formation of lysosomes by Golgi complex.

7. SER can develop from RER by discarding ribosomes.

iii. Functions of Smooth Endoplasmic Reticulum (SER):

1. It is responsible for synthesis of fats inside the cells of adipose tissue, formation of sphaerosomes, synthesis of glycogen as well as glycogenolysis (hydrolysis of glycogen) in liver cells (for this, SER possesses enzyme bodies called glycosomes) synthesis of ascorbic acid, synthesis of sterols and steroid hormones as in the interstitial cells of testis and ovary and formation of visual pigments from vitamin A in retinal cells.

2. As sarcoplasmic reticulum, it stores Ca2+ for release during muscle contraction.

3. It takes part in detoxification of toxic chemicals with the help of cytochrome P-450.

4. Synthetic products of RER pass on to Golgi complex through SER.

Difference between Smooth and Rough Endoplasmic Reticulum | Cytoplasm

The upcoming discussion will update you about the differences between Smooth Endoplasmic Reticulum and Rough Endoplasmic Reticulum.

Difference # Smooth Endoplasmic Reticulum:

1. SER does not bear ribosomes over the surface of its membranes.

2. It is mainly formed of vesicles and tubules.

3. It is engaged in the synthesis of glycogen, lipids and steroids.

4. SER gives rise to sphareosomes.

5. Pores are absent so that materials synthesized by SER do not pass into its channels.

6. SER is often peripheral. It may be connected with plasma lemma.

7. Ribophorins are absent.

8. It may develop from RER.

9. It has enzymes for detoxification.

10. Vesicles for cis- face of Golgi apparatus are provided by SER.

Difference # Rough Endoplasmic Reticulum:

1. RER possesses ribosomes attached to its membranes.

2. It is mainly formed of cisternae and a few tubules.

3. The reticulum takes part in the synthesis of proteins and enzymes.

4. It helps in the formation of lysosomes through the agency of Golgi apparatus.

5. RER possesses narrow pores below its ribosomes for the passage of synthesized polypeptides into ER channels.

6. It is often internal and connected with nuclear envelope.

7. RER contains Ribophorins for providing attachment to ribosomes.

8. It may develop from nuclear envelope.

9. The same are absent.

10. It provides bio-chemicals for Golgi apparatus.