CELL BIOLOGY : STRUCTURE AND FUNCTION OF ENDOPLASMIC RETICULAM

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Electron microscopic studies of eukaryotic cells reveal the presence of a network or reticulum of tiny tubular structures scattered in the cytoplasm that is called the endoplasmic reticulum (ER) (Figure 01). Hence, ER divides the intracellular space into two distinct compartments, i.e., luminal (inside ER) and extra luminal (cytoplasm) compartments.

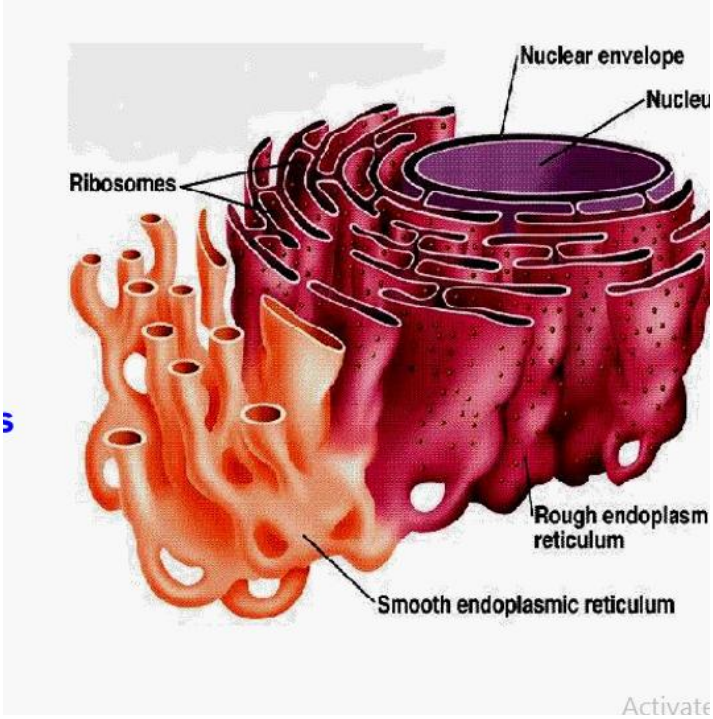

FIGURE 01

The ER often shows ribosomes attached to their outer surface. The endoplasmic reticulun bearing ribosomes on their surface is called rough endoplasmic reticulum (RER). In the absence of ribosomes they appear smooth and are called smooth endoplasmic reticulum (SER).

Rough (Granular) Endoplasmic Reticulum

Extensive membranous network of flattened sacs and cisternae, continuous with the outer membrane of nucleus. SER less extensive than RER in most cell types.

It differs from RER in two ways.

- Has no ribosomes
- Is in the form of a close – mashed network of tubules with less no. of cisternae.

Rough Endoplasmic Reticulum

Transporting material through the cell. Prominent in cells specialized for protein secretion e.g pancreatic acinar cells (digestive enzymes), fibroblast (collagen) plasma cells.

ER FUNCTIONS

The ER plays a crucial role in synthesis, modification and transport of secretory and membrane proteins, and is the site for the biosynthesis, processing and transport of several lipids.

ER regulates the intracellular calcium level and forms specialized regions such as sites for vesicular export (ERES, ER exit sites) as well as contact areas with other membrane-bound organelles, including mitochondria, endosomes, peroxisomes, lipid droplets, phagophores and the plasma membrane.

ER domains adopt distinct morphologies likely reflecting different functions. For instance, owing to their high curvature, tubules are better suited for surface-dependent functions, such as vesicular transport and inter-organelle signaling, whereas ER sheets immobilize polysomes on their flattened membranes and are thus specialized in protein synthesis, including protein translocation through the ER membrane, proteolytic processing, protein folding and secretion.

The flat ER sheets might also be more stable platforms than tubules, which would allow them to better support the bulky membrane-bound polyribosomes required for protein synthesis.

ER tubules might also be involved in lipid synthesis. For instance, it is known that phosphatidylserine is synthesized at ER regions called MAMs (mitochondria-associated membranes) that might have a tubular morphology.

The ER is a highly dynamic organelle changing its organization in relation to multiple conditions such as the cell cycle. In fact, during division of mammalian cells the ER undergoes spatial reorganization and a sheet-to-tubule transformation, starting with intact or fenestrated sheets (interphase ER) and changing into structures resembling tubular networks (mitotic ER).

This transformation is accompanied by a reduction in membrane-bound ribosomes and its extent varies between different cell lines [69]. Tubulation of the ER network might provide a simple, yet effective, mechanism for partitioning of the ER during mitosis.

On the cell type, the ER can adopt a wide range of organizations to adapt to different functions. Thus, the sheet-to-tubule ratio varies in

different cell types reflecting the need for biosynthetic processes occurring in these two structures.

In general, cells involved in synthesis and secretion of large amounts of protein (e.g., pancreatic or salivary gland cells) possess many ribosome–studded sheets, whereas poorly secreting cells (e.g., neurons, muscle cells, epithelial cells) contain an abundant tubular network.