# ENDOPLASMIC RETICULUM (ER)

## HISTORY :-

1) Garnies investigated a basophilic fibrillar material which could be seen in stained cell and it was called the ergastoplasm.

2) Porter and Thompson in 1945 reported a double walled structure forming a network in cytoplasm

3) Since, the network is more concentrated in the endoplasm of the cell than is in to called ectoplasm, the name Endoplasmic Reticulum (E.R) was proposed by Porter and Kallman in 1959

4) Porter and machado (1960) considered E.R as an extension of the nucleous membrane.

## OCCURENCE :

1) It is found in almost all eukaryotic cells but is very often absent in eggs and in embryonic an undifferentiated cells and mature mammalian erythrocytes.

2) The size and number varies from cell to cell In spermatocytes a few vacuoles are present.

3) In interstitial cells of testes and cells engaged in lipid metabolism, simple smooth endoplasmic reticulum is present.

4) It is extensively developed in pancreas and liver cells.

5. In Striated muscle, the ER takes a special form and is known as sarcoplasmic reticulum.

6. The ER is often small and relatively underdeveloped in eggs and in embryonic or undifferentiated cells. In reticulocytes, which Produce only proteins to be retained in the cytosols (hemoglobin) the ER is poorly developed or non-existent, although the cell may contain

## TYPES OF E.R :-

There are two types of E.R -

### A) AGRANULAR OR SMOOTH E.R (S.E.R)

1) It possesses smooth walls because the ribosomes are not attached with its membranes.

2) Frequently, it forms a tubular network is in the liver it is a related to Glycogen droplets (Glycosomes and peroxisomes)

### B) GRANULAR OR ROUGH E.R (R.E.R)

1) It posseses rough walls because the ribosomes remains attached with its membranes. These play a vital role in the

Process of protein synthesis. Particularly well developed in the basophilic regions of the cytoplasm i.e the ergastoplasm.

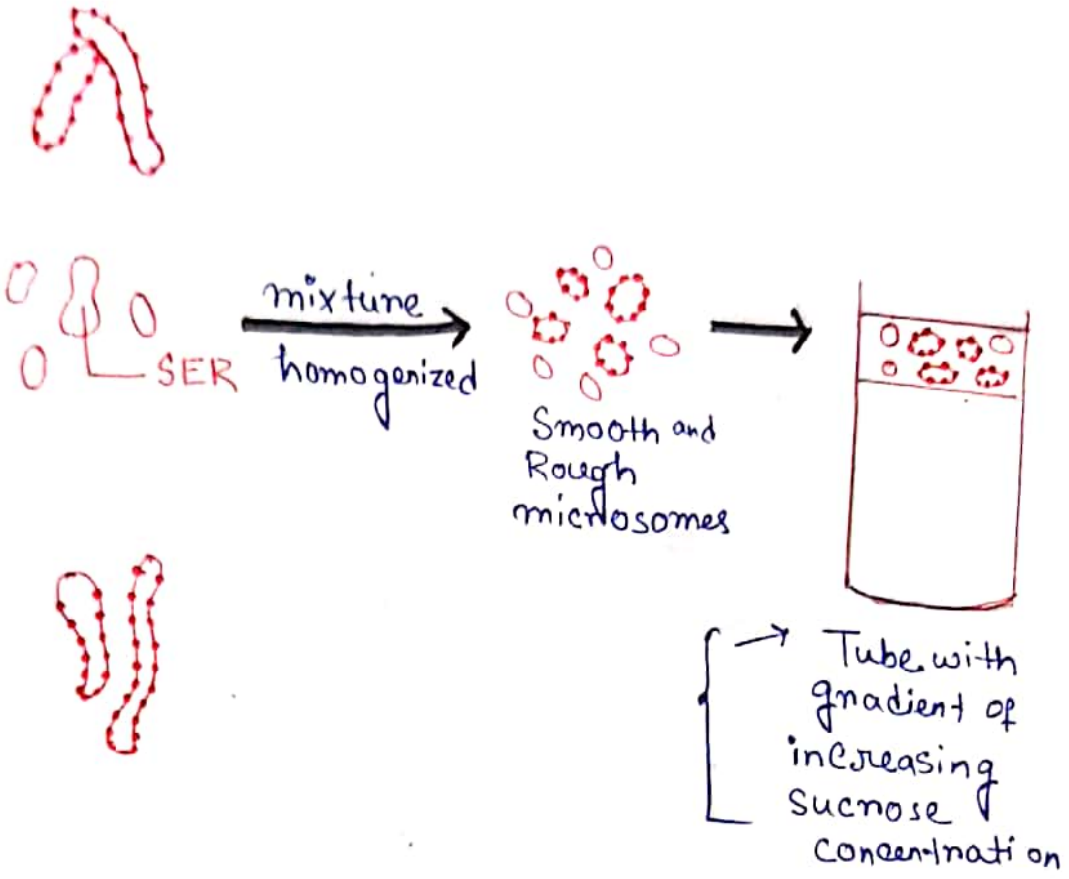



FIG : ISOLATION OF ER

## MORPHOLOGY

Endoplasmic reticulum occurs in three forms either in the same cell or in different cells.

### ① CISTERNAE

These are long, flattened, sac like, unbranched and parallel stacks.

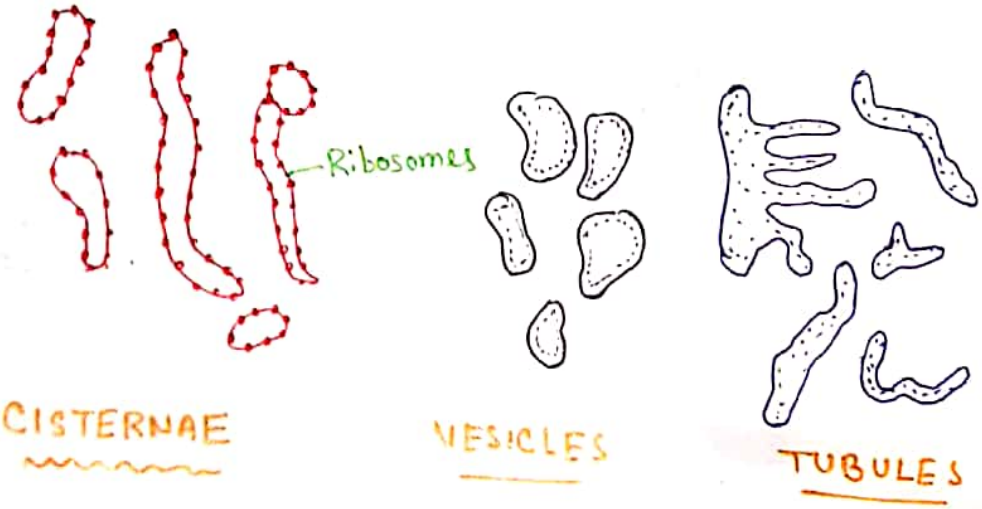
2) Cisternae are about 40-50 μ in diameter. This form of endoplasmic reticulum is present in the cells taking active part in protein synthesis such as Pancreas, notochord etc.

(ii) VESICLES

Vesicles are usually oval to sound in outline and contain about 25-500 μ in diameter.

(iii) TUBULES

Tubules contain variable shapes, Sometimes they forms reticular system along with the cisternae and vesicles. These are present in the non-secreting cells and contain about 50-100 μ in diameter.




ULTRASTRUCTURE

1) Under E.M, the ER appears as a complex membrane System composed of paired membrans (50-60 Å thick)

2) Paired membranes separated from each other by a gap of 100 - 1000 Å.

3) Vesicles, where present 2000 - 5000 Å width.

4) Membrane of ER is trilaminar like unit membrane.

5) In ER. Vesicular, tubular and broad cisternal Profiles often arranged in regular arrays certain variable contents bounded by a limiting membrane.

6) RER contain 150 - 200 Å ribosomal particles ~~Speed~~ spaced at approximately 150 Å intervals

7) SER appear as tightly packed vesicles which form a randomly disposed network usually at the periphery of the cell.

8) Cavity of ER well developed and act as a passage for secretory product.

9) Membrane of ER remains continious with plasma membrane of Golgi complex.

~~10) The membrane of ER remains c~~

10) The membrane of ER contain enzymes which are involved in synthesis of cholesterol triglycerides and other lipids.

11) Invertebrate ER and ER of oocytes and Spermatocytes has pores on annule

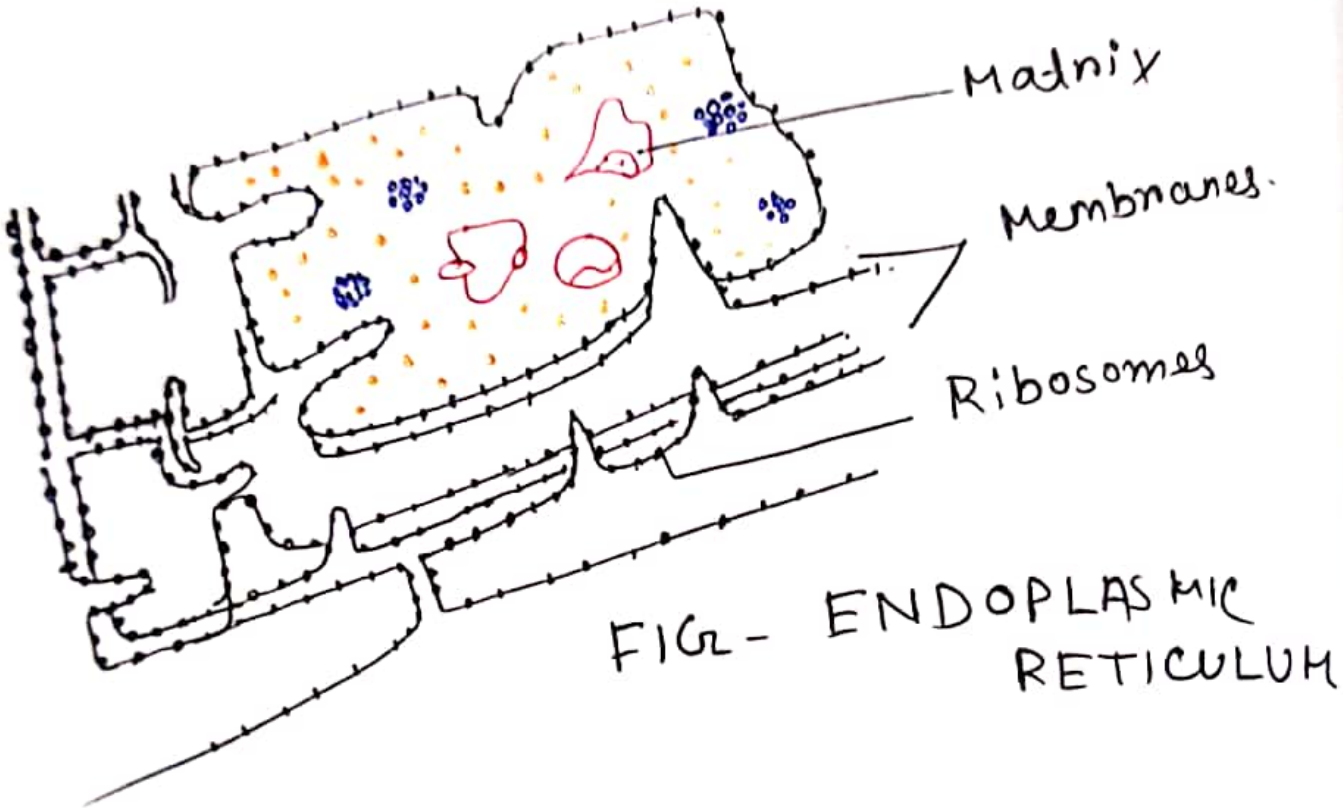



FIG- ENDOPLASMIC RETICULUM

## BIOGENESIS :

The origin of ER membrane is no definitely known -

1) The membranes of ER resembles nuclear membrane and at telophase, the nuclear envelop is re-formed by vesicles of the ER. The close relationships between these two portions of the system is also sugge by cytochemical studies. Some EM observati of differentiately cells suggest that ER membra may develop by evagination from the nuclear envelope.

2) In some cells ER is ~~differentiating cells~~ derived from plasma membrane or golgi comple

3) From studies of differentiating cells in rat liver a preferential increase of RER before birth and a subsequent growth of SER has been noticed. Experimental studies using the protein ($^{14}C$-lucine) or lipid ($^{14}C$-Glycerol) Precursons have shown that in the Period of rapid growth of ER, the incorporation into proteins and lipids is greater in the rough than in the smooth type. These findings suggests that the synthesis of membrane follows the direction RER ⟶ SER (Seikevitz and Palade 1966)

4) Leskes et al (1971) suggests that one cell receives a full set of membranes from its ancestral cells and there is no de novo synthesis of membranes, they grow by expansion of pre-existing membrane. The process by which a membrane is modified chemically and structurally may be regarded as membrane differentiation

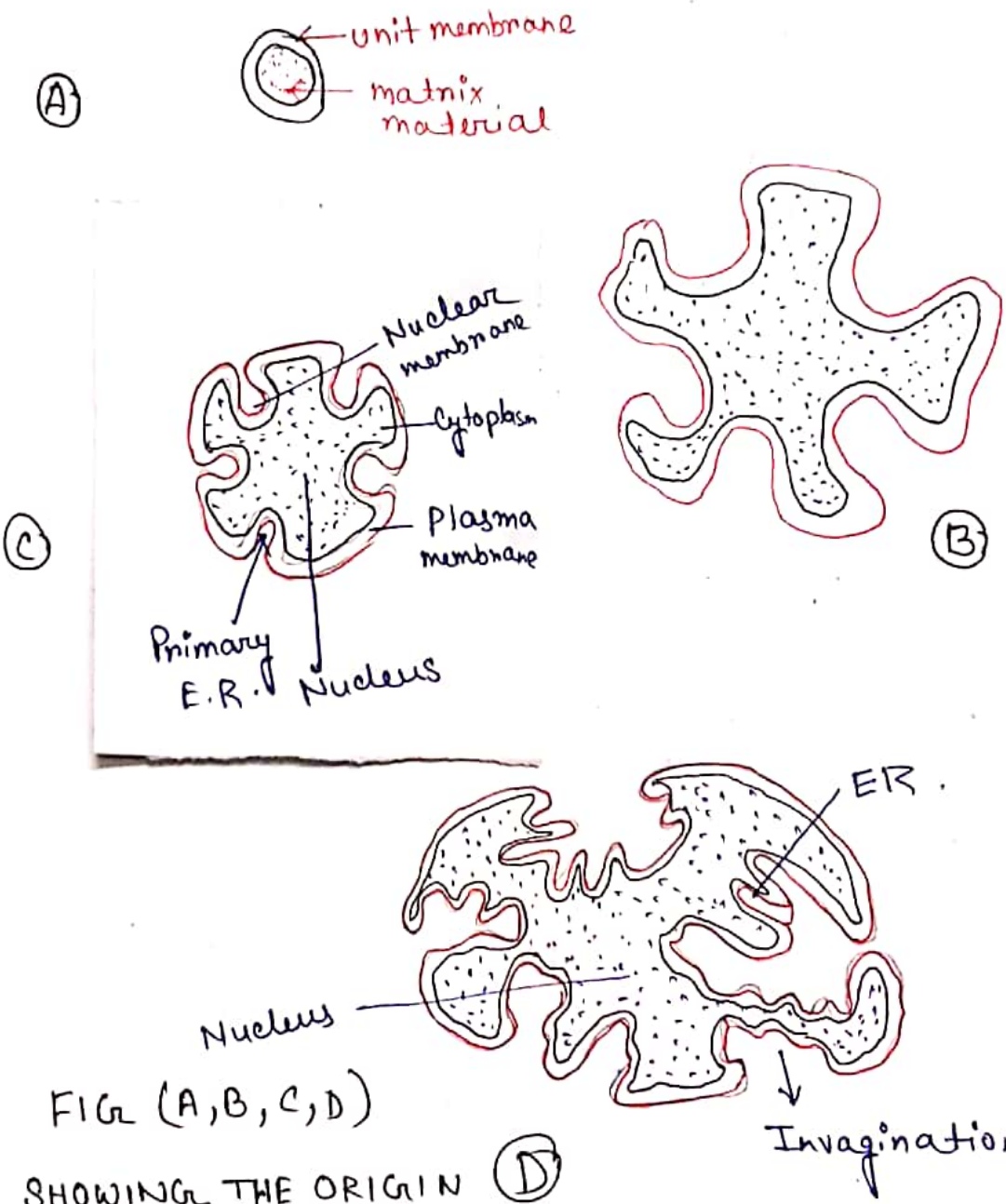



FIG (A, B, C, D)

SHOWING THE ORIGIN OF ER

# COMPOSITION AND CHEMISTRY OF E.R.

As a result of isolation of ER from its homogenate by ultra centripugation method, we get two types of sedimentation →

(1) Fragmented Canaliculi or Cisternae,
(2) Ribosomal fragments.

These two fragments are collectively called as microsomal fragments or "microsome"

1) The lipid content of microsome is estimated to be 30-50% which about 70% is phospholipid 50-90% of the .

2) Cholesterase : Found in SER and helps in cholesterol Synthesis.

3) Gluco-oxidase : In converts gluconolactose into ascorbic acid and thus helps in biosynthesis of Vitamin C.

4) Cholin-esterase : helps in phospholipid Synthesis

5) Cytochrome reductase: Responsible for cellular respiration.

Ribosomal fragments contain RNA and protein as RNP. The basophilic nature of ER is due to presence of RNP. The RNP ribosomes synthesis different types of Protein, which are synthesized in the fare of enzymes, hormones and structural proteins.

## FUNCTIONS OF THE E.R

1. AS CIRCULATORY SYSTEM :- The E.R. may act as circulatory system for intracellular circulation of various substances.

2. ION EXCHANGE :-

Watson (1959) Suggested that the exchange between the nucleus and the cytoplasm takes place through the nuclear openings which communicate with the E.R.

3. E.R. MEMBRANE FLUIDITY : i) MEMBRANE flow may also be an important mechanism for carrying particles, molecules and ions into and out of the cells.

ii) The observed in some cases between the E.R and the nuclear envelope suggests that the membrane flow may also be active at their point.

iii) This flow would provide one of the several mechanisms for export of RNA and nucleoprot from the nucleus to the cytoplasm.

iv) The membrane of the ER on body temperatu is highly dynamic and also fluid.

v) The bound ribosomes are mobile on the membrane and their mobility is controlle by fluidity.

Nuclear membrane → Pores → ER → Golgi complex

← Plasma membrane

Transfer of secretory proteins is accompanied by a flow of newly synthesized membrane proteins that are incorporated into the RER.

4. IONIC GRADIENTS :-

The sarcoplasmic reticulum of striated muscle is involved in the concentration of $Ca^{2+}$ by the energy requiring process utilising ATP. The presence of permeases and carriers involved active transport. Ionic gradients and electrical potentials exist across the membrane.

5. MECHANICAL SUPPORT :

By dividing the fluid content of the cell into compartments the ER provides supplementary mechanical support for the colloidial structure of the cytoplasm.

6. FORMATION OF MICROBODIES : Closely related with the ER are microbodies, which are small granular bodies filled with an electron dense substance and limited by single membrane.

Microbodies are formed as dialations of the ER, and frequently show rich in the enzymes paroxidases catalase and amino acid oxidase.

7. ~~Detoxifi~~

7. DETOXIFICATION :

SER membrane have been shown to contain an enzyme system with detoxification properties. Administration of repeated doses of the drug phenobarbital to rat and resulted in increase activity of detoxification enzymes.

## 8. LIPID SYSTHESIS AND STORAGE :

Electron microscopic and autoradiographic studies of Stein and stein (1967) suggested that ER was the site of Triglyceride foundation.

The SER membrane also appear to be involved in the formation of lipoprotein complexes. The SER is also implicated in the initial stages of the breakdown of fatty acids.

Conversion of fatty acids to acyl coenzyme A ester occur mainly in the ER.

Phospholipid biosynthesis is largely confined to the membranes of the ER.

## 9. SYNTHESIS OF CHOLESTEROL AND STEROID HORMONES :

Cholesterol is an important precursor of Steroid hormones. The major sites of Cholesterol Synthesis in the ER.

In the testis, ovary and the adrenal cortex the SER has a role in the Synthesis of steroid hormones.

10. GLYCOGENOLYSIS : In fasted animals it has been absorbed that the residual glycogen remains associated with the tubules and vesicles of the ER. When feeding is resumed there is an increase of SER. Then enzyme UDPGr - glycogen transferase, is to the glycogen particle rather than to the membranous component. This suggests that the ER is related to Glycogenolysis, but not glycogenesis (De Robertis + De Robertis, 1967)

11. THE ER AND SYNTHESIS OF EXPORTABLE PROTEINS :

During protein synthesis as the Polypeptide chain grows through a "groove" in the large subunit of ribosomes, that is directly linked to a channel in the E.R. membrane The chain is finally deposited into the lumen of the ER.

12. IN ANTIBODY FORMATION :

In the process of development of antibody from B lymphocyte to plasma cells, then amount of ER and ribosome markedly increases.

14. PROTEIN SYNTHESIS :-

The RER is the site of secretion of secretory proteins. Proteins are synthesized on the ribosomes enter ER. Secretory Proteins leaves the ER and enter the Golgi complex from where they are secreted outside the cell.