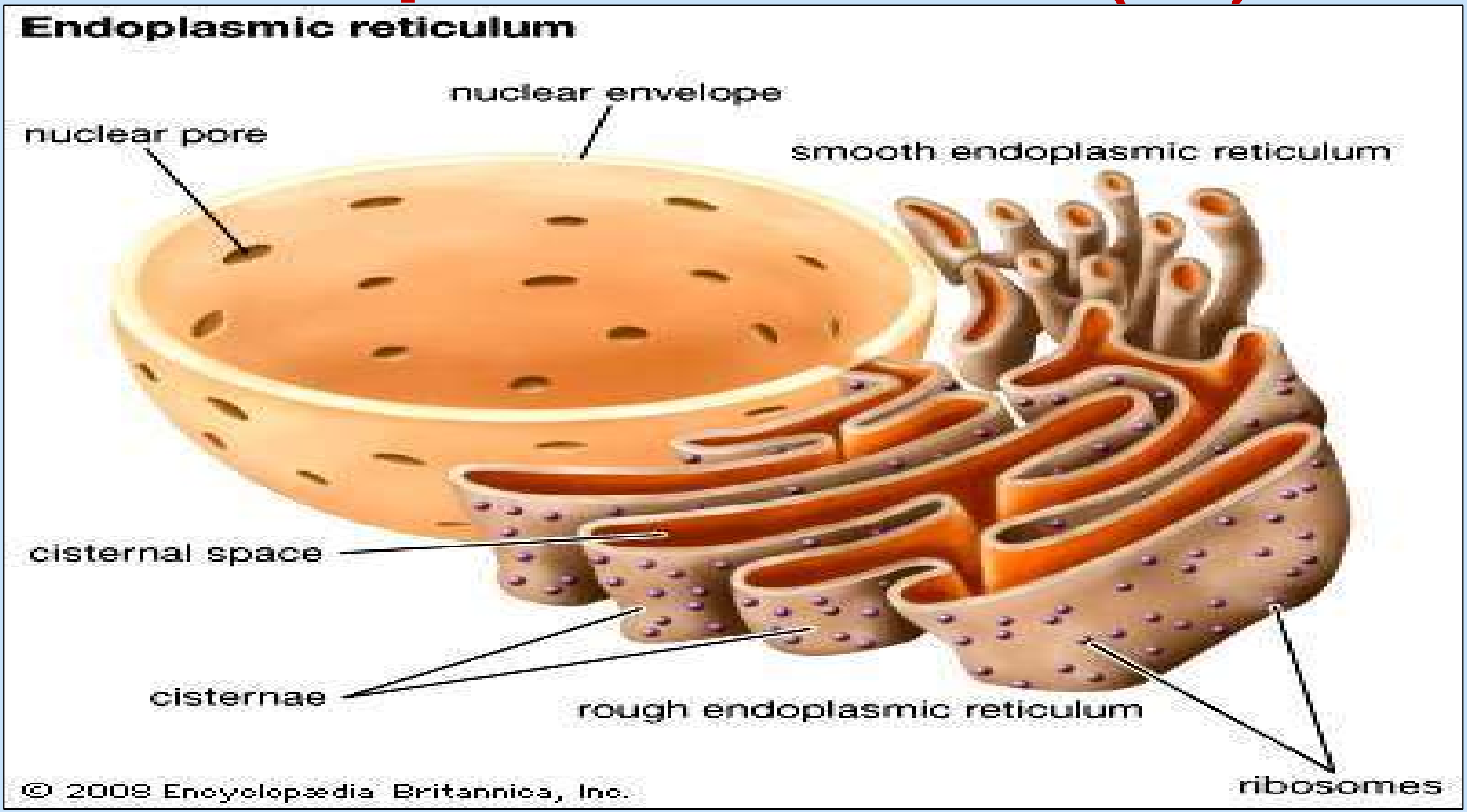
Structure and functions of Endoplasmic Reticulum (ER)



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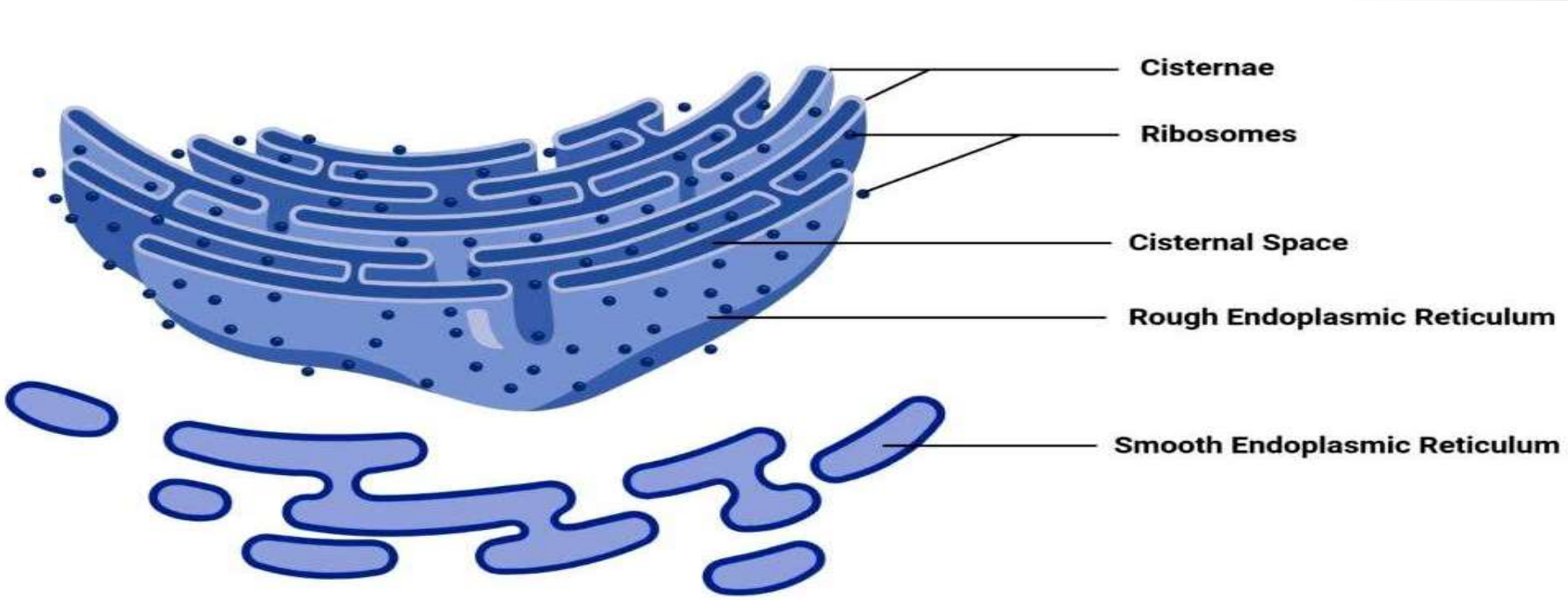
"Endoplasmic Reticulum is a complex network of tubular membranes exclusively present in the cytoplasm of the eukaryoticcell."

- ~~It plays a major role in the production, processing, and transport of~~ proteins and lipids.
- The ER produces transmembrane proteins and lipids for its membrane and for many other cell components including lysosomes, secretory vesicles, the Golgi apparatus, the cell membrane, and plant cell vacuoles.
- The ER contains special membrane-embedded proteins that stabilize its structure and curvature.

- **This organelle acts as an important regulator of cell function because it interacts closely with a number of other organelles.**

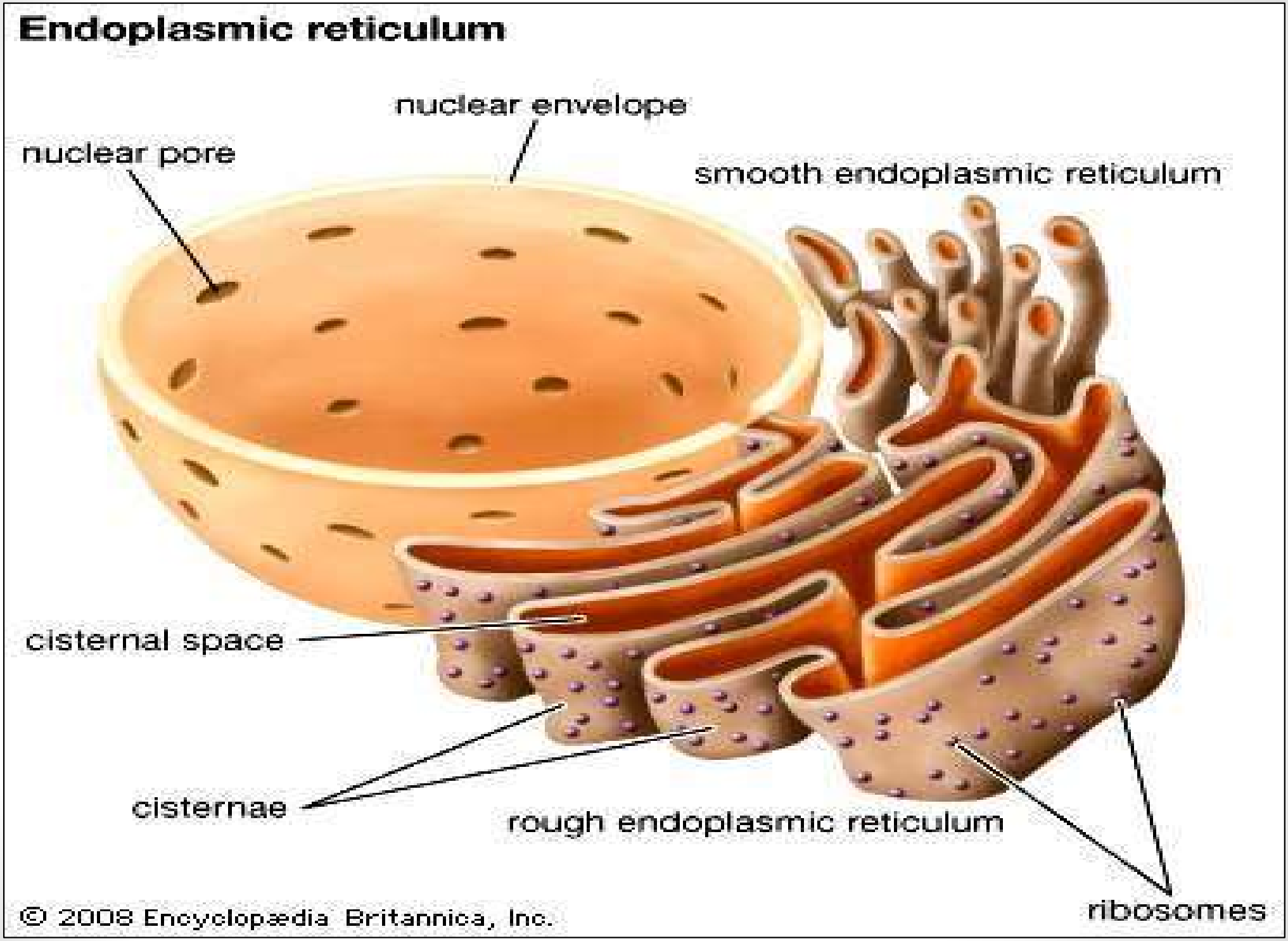
Structure of ER



The structure of endoplasmic reticulum is shaped like a sac.

- The ER membrane system can be morphologically divided into two structures-cisternae and sheets.
- Cisternae are tubular in structure, and form a three-dimensional polygonal network.
- They are about 50 nm in diameter in mammals and 30 nm in diameter in yeast.

- ER sheets, on the other hand, are membrane-enclosed, two-dimensional flattened sacs that extend across the cytoplasm.
- They are frequently associated with ribosomes and special proteins called translocons.
- ER is an extensive membrane network of cisternae (sac-like structures), which are held together by the cytoskeleton.
- The phospholipid membrane encloses a space, the lumen from the cytosol, which is continuous with the perinuclear space.
- ER varies extensive extending from the cell membrane through the cytoplasm and forming a continuous connection with the nuclear envelope.


Endoplasmic reticulum
nuclear envelope
nuclear pore
smooth endoplasmic reticulum
cisternal space
cisternae
rough endoplasmic reticulum
ribosomes
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The membrane of the endoplasmic reticulum is:

- 50 to 60 Aº thickness and **fluid-mosaic** like the unit membrane of the plasma membrane.

- They are found to contain many kinds of enzymes that are needed for various important synthetic activities. The most important enzymes are the stearases, NADH-cytochrome C reductase, glucose-6-phosphatase and Mg++ activated ATPase.

- It remains continuous with the membranes of the plasma membrane, nuclear membrane, and Golgi apparatus.

- The cavity of the endoplasmic reticulum is well developed and acts as a passage for the secretory products.

Rough ER

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

Rough Endoplasmic Reticulum Structure:

- Rough ER is named for its rough appearance, which is due to the ribosomes attached to its outer (cytoplasmic) surface.

- It is a series of connected flattened sacs having several ribosomes on its outer surface, hence the name.

- It synthesizes and secretes proteins in the liver, hormones and other substances in the glands.
- Rough ER is prominent in cells where protein synthesis happens (such as hepatocytes).

Smooth ER

Smooth Endoplasmic Reticulum Structure:

- The smooth ER, on the other hand, does not have ribosomes.
- The smooth ER consists of tubules, which are located near the cell periphery. This network increases the surface area for the storage of key enzymes and the products of these enzymes.
- It participates in the production of phospholipids, the chief lipids in cell membranes and are essential in the process of metabolism.
- Smooth ER transports the products of the rough ER to other cellular organelles, especially the Golgi apparatus.

Different forms of ER

The endoplasmic reticulum may occur in the following three forms:

- **Lamellar form or cisternae**
- **Vesicular form or vesicle**
- **Tubular form or tubules**

The Cisternae

- RER usually exists as cisternae that occur in those cells which have synthetic roles as the cells of the pancreas, notochord, and brain.
- The cisternae are long, flattened, sac-like, unbranched tubules having a diameter of 40 to 50 µm.
- They remain arranged parallelly in bundles or stakes.

The Vesicles

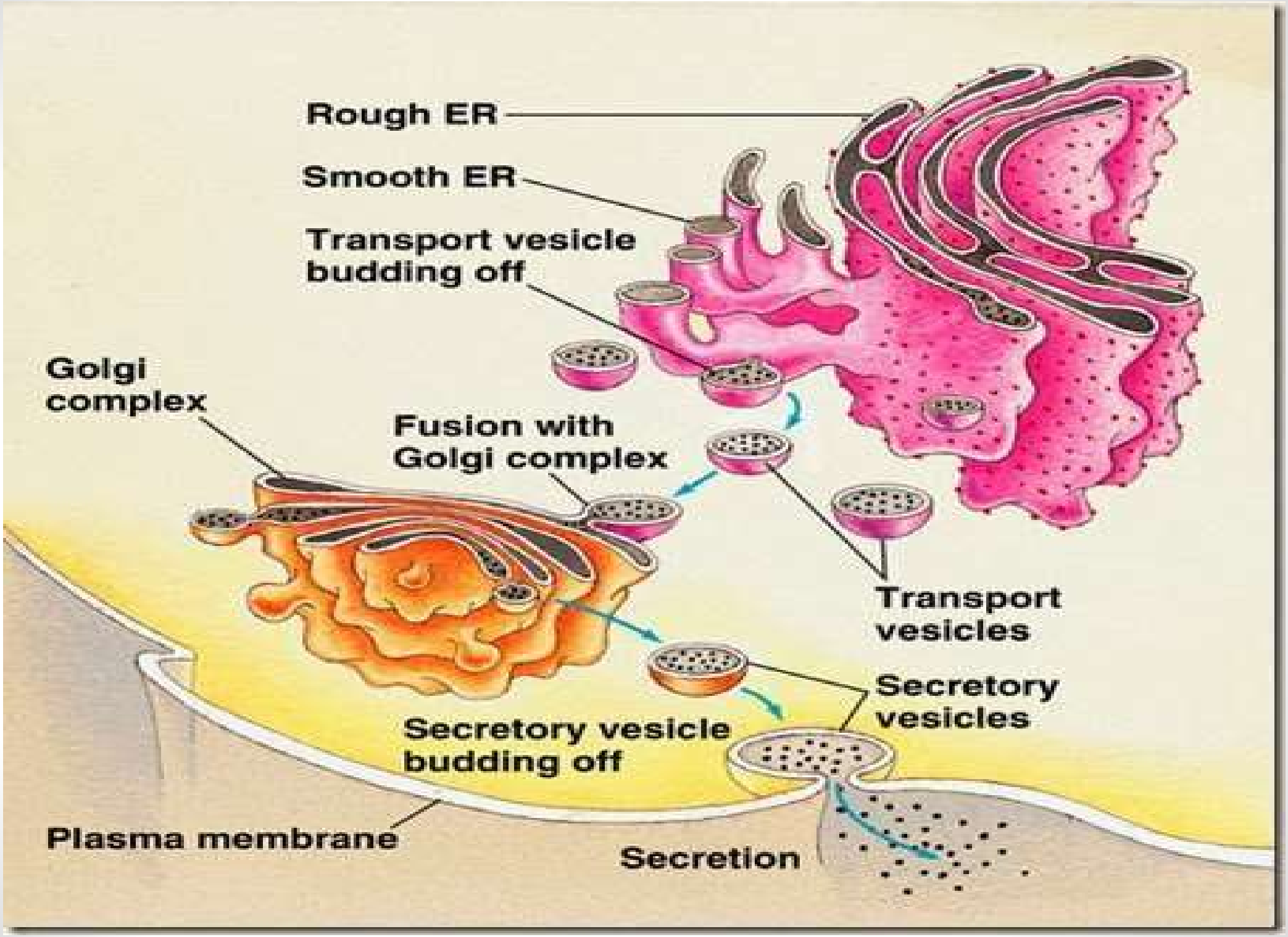
- The vesicles are oval; membrane-bound vacuolar structures having a diameter of 25 to 500 µm.
- They often remain isolated in the cytoplasm and occur in most cells but especially abundant in the SER.

The Tubules

- The tubules are branched structures forming the reticular system along with the cisternae and vesicles.
- They usually have a diameter from 50 to 190 µm and occur almost in all the cells.
- Tubular form of ER is often found in SER and is dynamic in nature, i.e., it is associated with membrane movements, fission and fusion between membranes of cytocavity network.

Functions of ER

- Functions of smooth ER include lipid metabolism (both catabolism and anabolism; they synthesize a variety of phospholipids, cholesterol, and steroids).
- Glycogenolysis (degradation of glycogen; glycogen being polymerized in the cytosol).
- Drug detoxification (by the help of the cytochrome P-450).
- It provides an ultra structural skeletal framework to the cell and gives mechanical support to the colloidal cytoplasmic matrix.
- The exchange of molecules by the process of osmosis, diffusion and active transport occurs through the membranes of the endoplasmic reticulum.
- The ER is the main component of the endomembrane system, also called the cytoplasmic vacuolar system or cytocavity network.


Rough ER
Smooth ER
Transport vesicle budding off
Golgi complex
Fusion with Golgi complex
Transport vesicles
Secretory vesicles
Secretory vesicle budding off
Plasma membrane
Secretion

- The endoplasmic membranes contain many enzymes that perform various synthetic and metabolic activities. Further, the endoplasmic reticulum provides an increased surface for various enzymatic reactions.

- The ER acts as an intracellular circulatory or transporting system.

- They provide the increased surface area for cellular reactions.

- They help in the formation of nuclear membrane during cell division.

- They play a vital role in the formation of the skeletal framework.

Rough Endoplasmic Reticulum Function:

- The majority of the functions of rough ER is associated with protein synthesis.
- Rough endoplasmic reticulum also plays a vital role in protein folding.
- Also ensures quality control (regarding correct protein folding).
- The second most important function after protein synthesis and protein folding is protein sorting.

Smooth Endoplasmic Reticulum Function:

- Smooth ER is responsible for the synthesis of essential lipids such as phospholipids and cholesterol.
- Smooth ER is also responsible for the production and secretion of steroid hormones.
- It is also responsible for the metabolism of carbohydrates.
- The smooth ER store and release calcium ions. These are quite important for the nervous system and muscular system.