# CELL AND MOLECULAR BIOLOGY

## UNIT II – GOLGI COMPLEX

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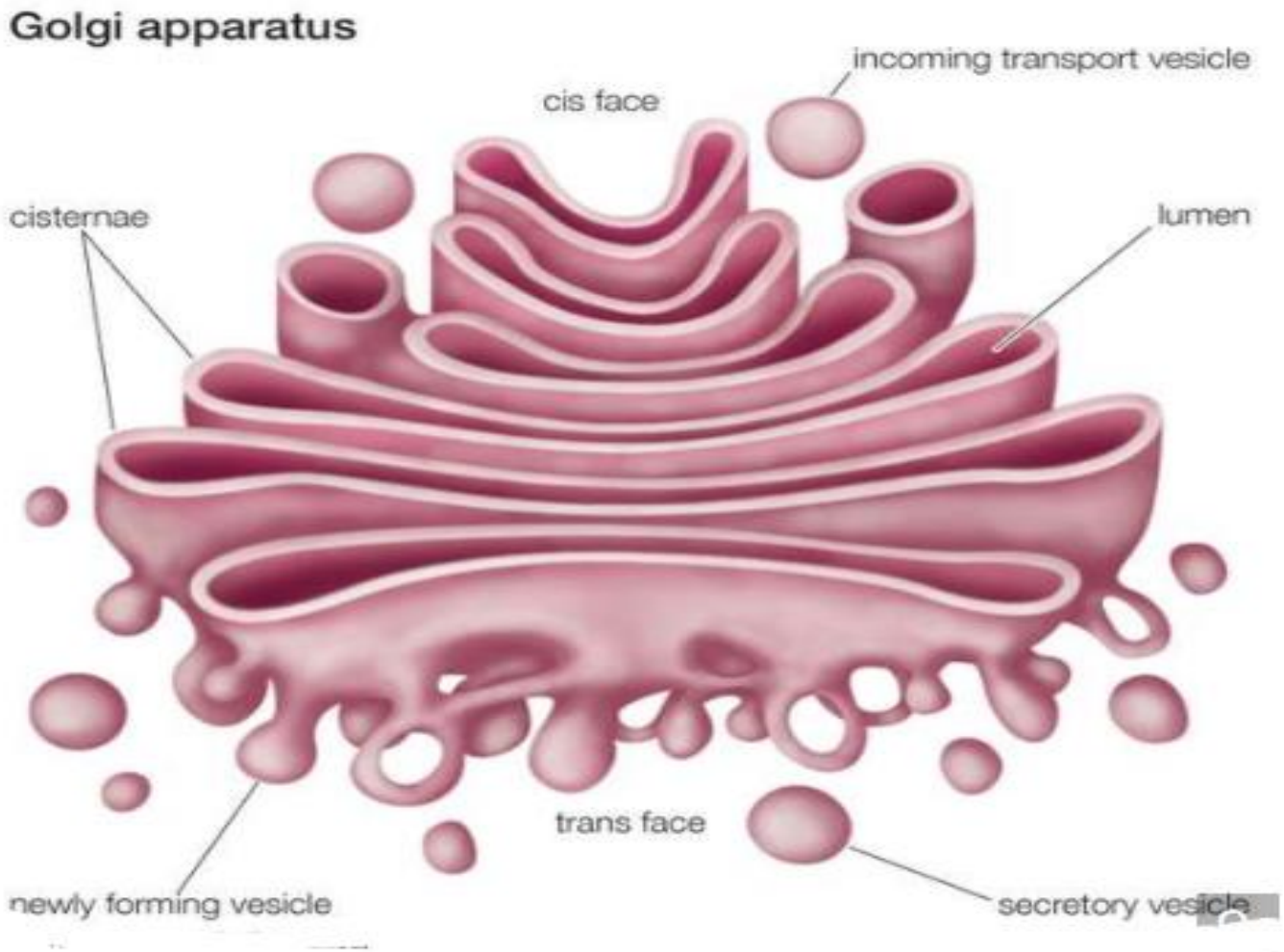


# *Golgi Complex*

Golgi complex is a cluster of smooth membranes associated with the endoplasmic reticulum. It was first described by ***Camillo Golgi*** (1898) in the nerve cells of barn owl. The Golgi complex has been variously named as ***Golgi body, dictyosome, lipochondrion, internal reticular apparatus, canalicular system*** and ***tropho-spongium*** by various workers. Generally, the term ***dictyosome*** is used for the Golgi body of invertebrates and plants.

The Golgi is located in the cytoplasm. It is a cell ***organelle.*** Most animal cells contain only one Golgi complex. But developing oocytes of chordates contain many Golgi bodies. Similarly, nerve cells and liver cells contain many Golgi. Plant cells usually contain hundreds of Golgi bodies.

The Golgi complex is absent from prokaryotic cells, certain fungi, sperm cells of bryophytes and pteridophytes, animal sperms and RBC.

The ***size*** of the Golgi is variable. It is larger and well developed in active cells like gland cells and nerve cells and poorly developed in muscle cells. As the cells become older, the Golgi tends to decrease in size.

The ***shape*** of the Golgi complex varies from one cell to another. They may be in the form of rods, granules, vesicles or network. Even in the same cell, there are variations with the functional stages.

The ***position*** of Golgi is relatively fixed for each cell-type. It usually occupies the peripheral position in the cell. For example, in secretory exocrine cells, it is disposed between the nucleus and secretory side. In the cells of the invertebrates and plants, the Golgi is distributed throughout the cytoplasm.

Under the electron microscope, the Golgi apparatus appears to consist of three components. They are (1) ***Cisternae***, (2) ***Vacuoles*** and (3) ***Vesicles***.

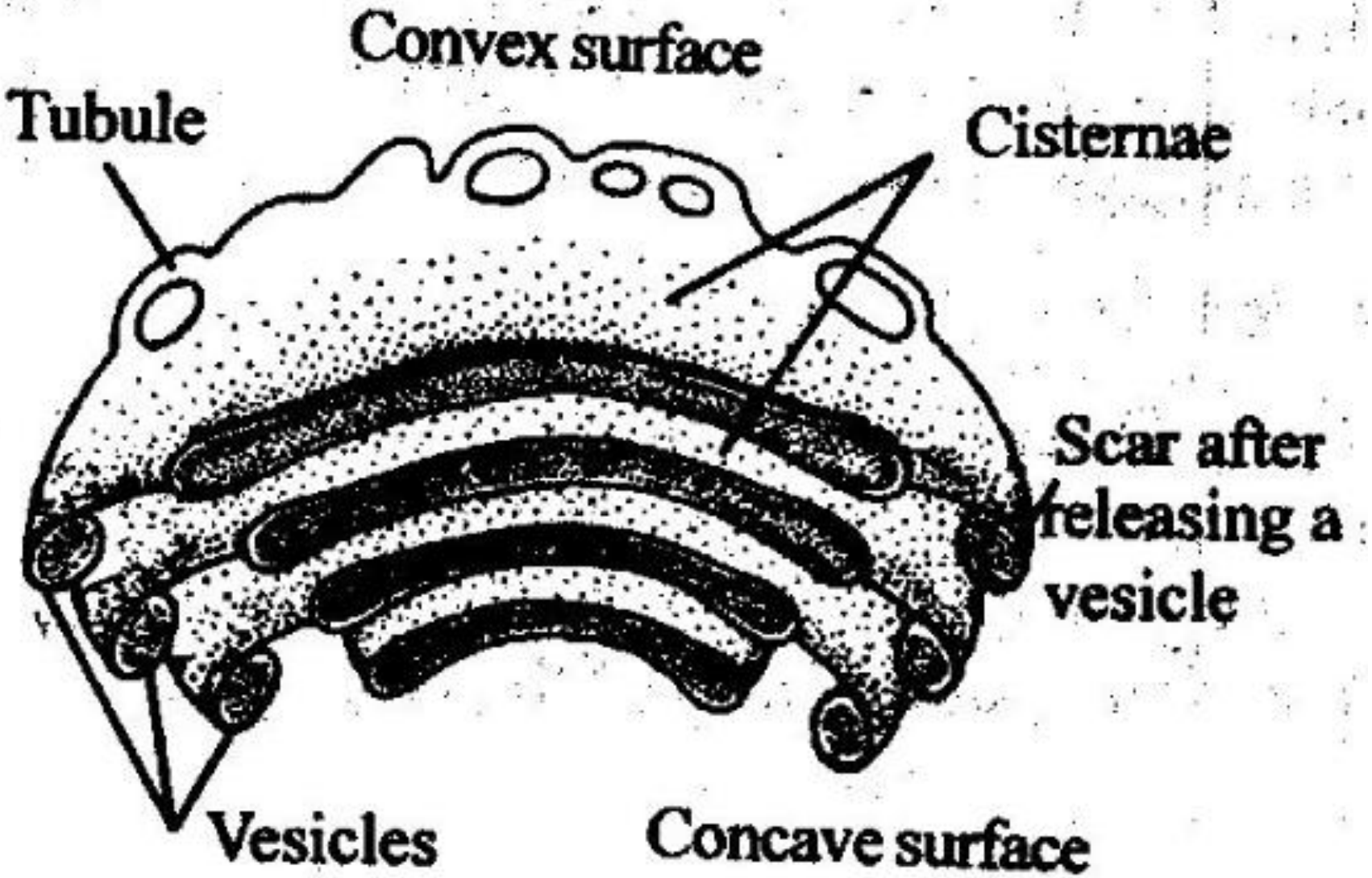
## 1. Cisternae (Lamellae)

The cisternae are elongated flattened sacs filled with fluids, and piled one upon the other to form ***stacks.*** They are arranged in parallel bundles one above the other. In most cells, the number of cisternae varies from 2 to 8 in a stack. Other cell types may have as many as 25-30 cisternae.

The adjacent cisternae are cemented together by a cementing substance called ***intercisternal material.***

In many cases many anastamosing tubules are given off from the ***cisternae.*** In certain cases the cisternae contain pores and they are said to be ***fenestrated.***

The cisternae are slightly curved. Hence the cisternae have ***convex*** and ***concave surfaces.***




*Components of Golgi apparatus.*

The Golgi complex has two sides, namely ***forming face*** and ***maturing face.*** The convex surface is the ***forming face.*** Here new lamellae are added from endoplasmic reticulum. The concave surface is the ***maturing face.*** Here ***secretory*** vesicles are budded off. Thus the cisternae are continually receiving the lamellae on the forming face and losing membranes on the maturing face through the formation of secretory vesicles.

Each of the cisternae is made up of a pair of membranes continuous at the ends. The two membranes enclose a cavity of about 150A°. The cavities of cisternae at the maturing face are wider.

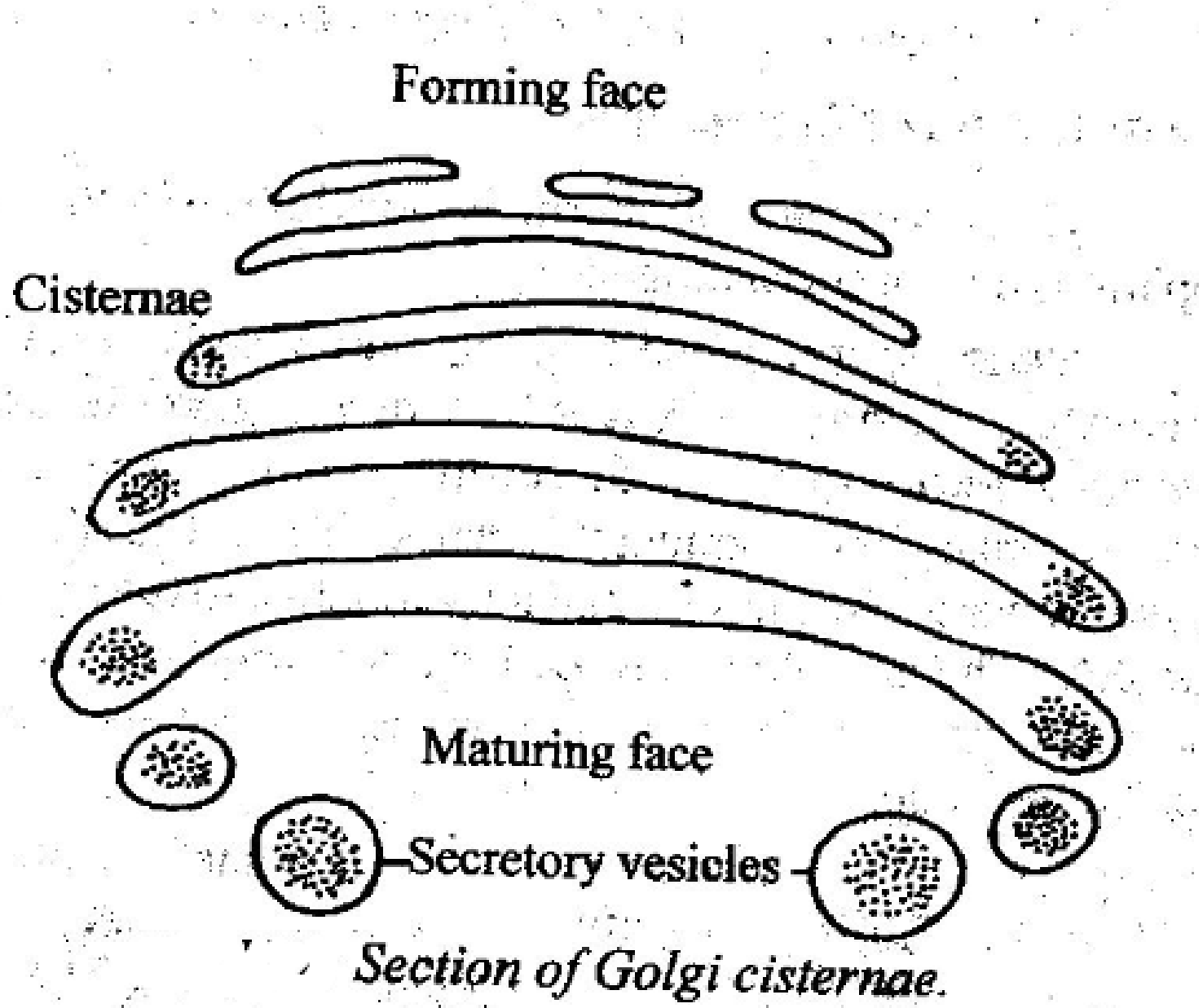
The Golgi complex (cisternae) membranes are ***intermediate*** between the membrane of endoplasmic reticulum and plasma membrane. The membranes at the forming face are similar to the membrane of endoplasmic reticulum and those of the maturing face are similar to the plasma membrane.

## 2. *Vacuoles*

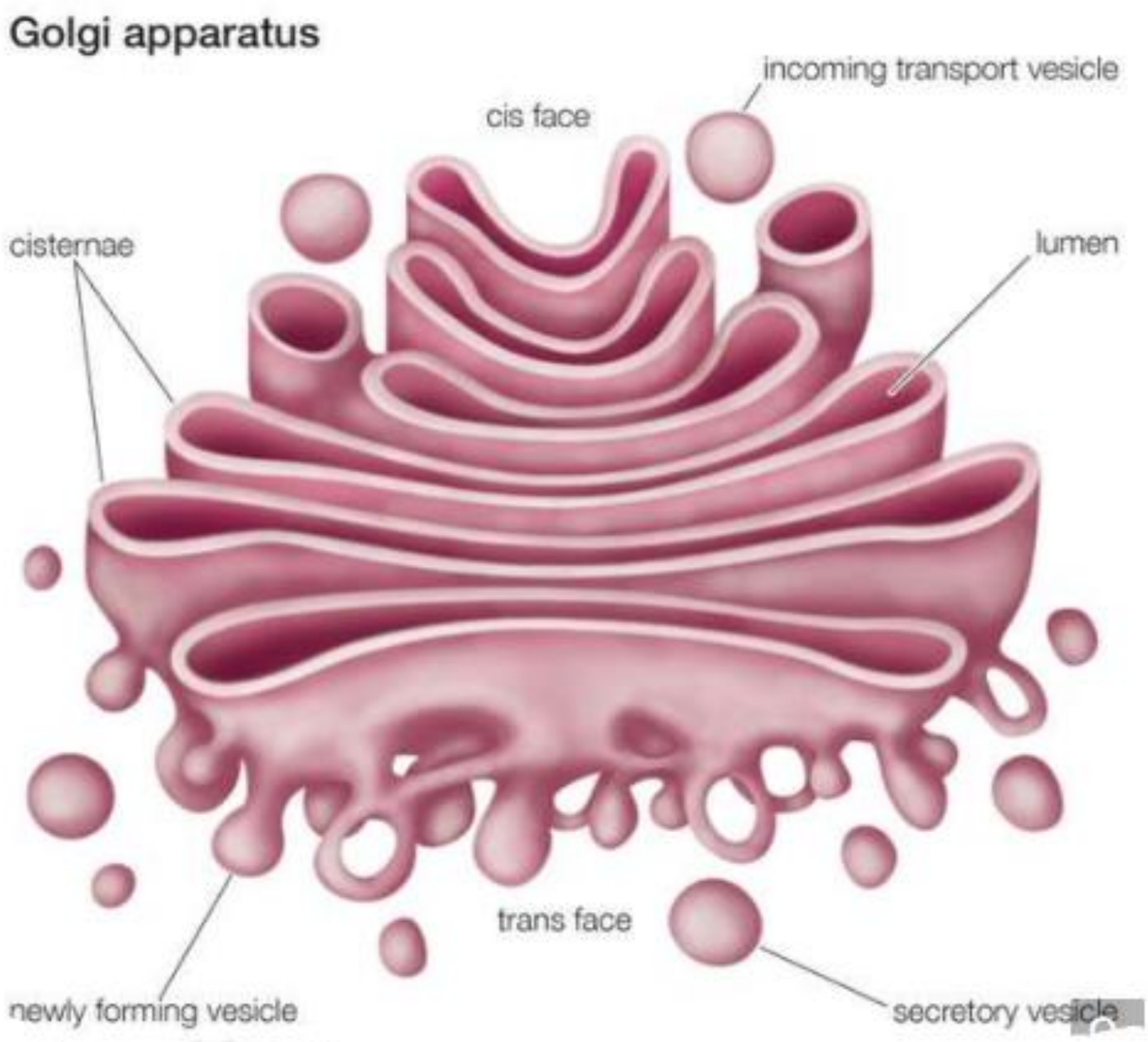
These are large spacious round sacs found at the edges of cisternae. These are formed by the expansion of the cisternae, in which the two membranes are widely separated. The cavity is about 60-200 A°.

## 3. *Vesicles*

These are small drop-let like structures of about 40A° in diameter. These are closely associated with the periphery of the cisternae. They develop either by budding or by constriction of the ends of the cisternae.




*Section of Golgi cisternae.*


Golgi apparatus
incoming transport vesicle
cis face
cisternae
lumen
trans face
newly forming vesicle
secretory vesicle

## Origin of Golgi

According to ***Palade*** (1955), the Golgi apparatus originates from the endoplasmic reticulum.

Another hypothesis suggested by ***Mc Alear*** provides an explanation for the origin of Golgi bodies from nuclear membrane.

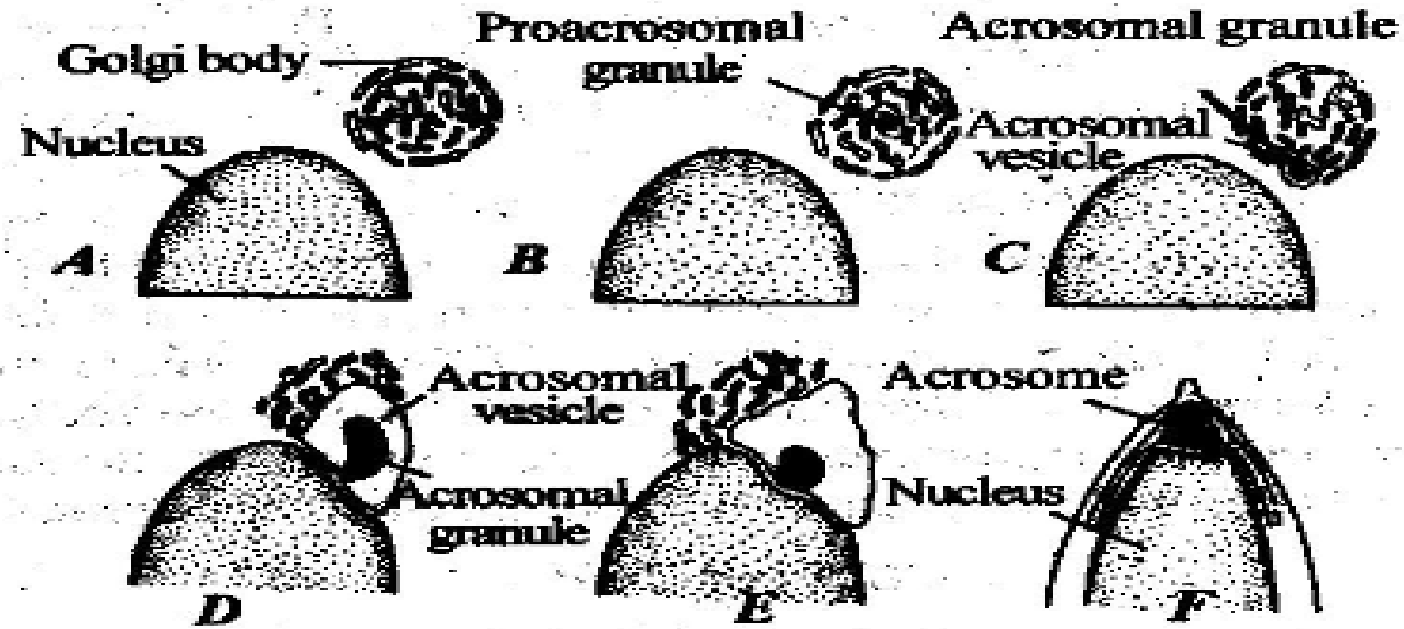
***Beams and Kessel*** (1968) suggested that the Golgi lamellae are derived from endoplasmic reticulum.

## Functions of Golgi Apparatus

### 1. Formation of Acrosome

The *acrosome* of sperm is developed from Golgi apparatus during spermatogenesis.

During spermiogenesis, a vacuole appears in the Golgi apparatus. Inside the vacuole a dense granule called *proacrosomal* granule develops. The vacuole and proacrosomal granule gradually enlarge. The entire apparatus moves towards the nucleus and gets attached to the tip of the nucleus. The granule is now called *acrosomal granule* and the entire structure is called *acrosome*. It spreads over the nucleus as a cap.




*Formation of acrosome from Golgi.*

## 2. Cell wall formation

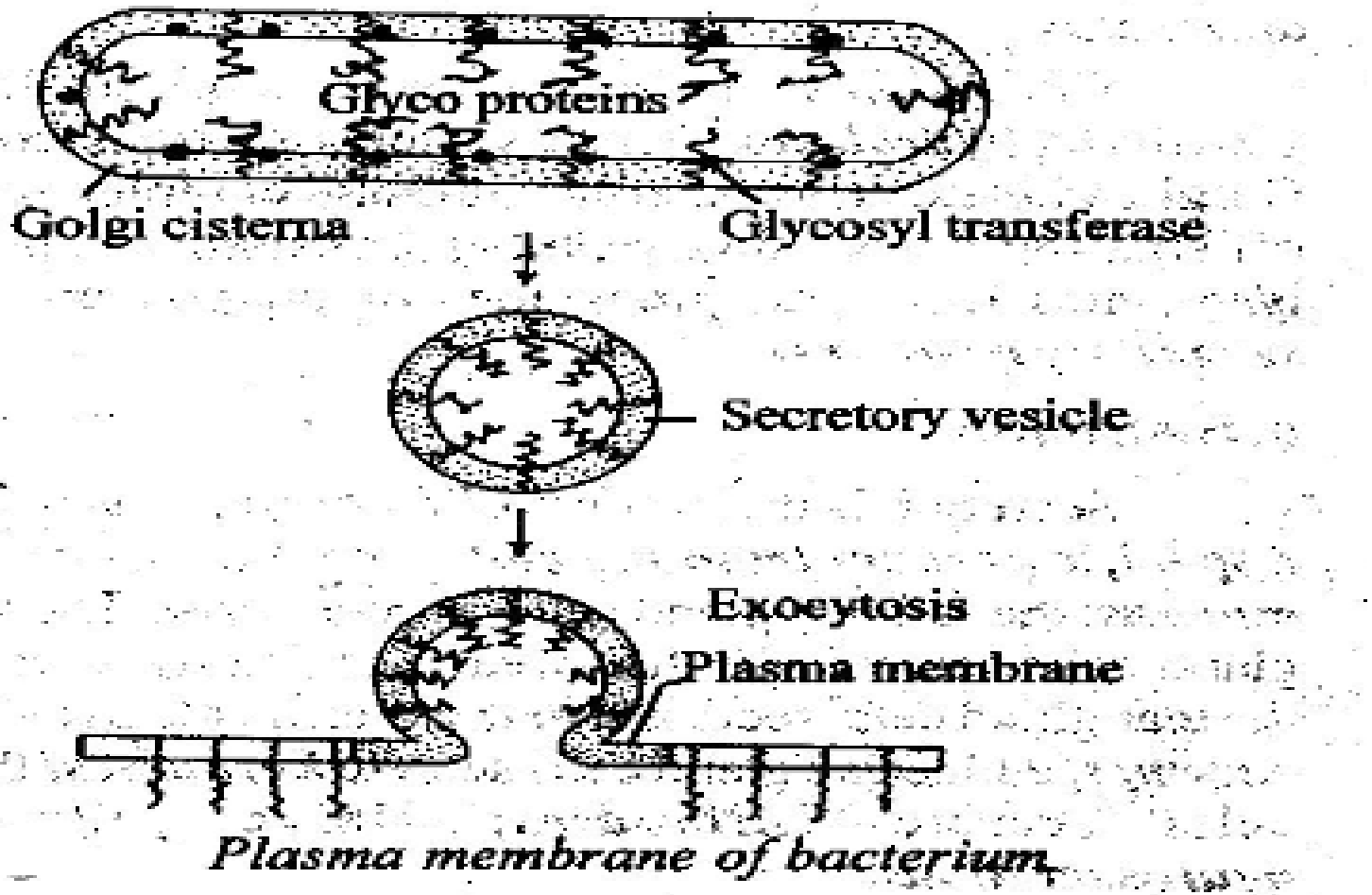
Golgi complex is involved in cell wall formation in plant cells. During cytokinesis, the Golgi vesicles accumulate in the equatorial plane and help in the formation of *cell plate*.

The materials present in the Golgi apparatus help in the formation of cell wall. The polysaccharide of cell wall is formed in the Golgi complex and is transported to the cell wall.


*): Formation of cell wall in a plant cell.*

### Plasma membrane formation

Golgi complex involves in the formation of plasma membrane. During exocytosis, the secretory vesicles formed from Golgi complex fuse with the plasma membrane. The membrane of the granule becomes incorporated into the plasma membrane. This helps in the renewal of the membrane constituents.



## 4. Biogenesis of Lysosomes

Golgi complex is involved in the formation of *primary lysosomes*.

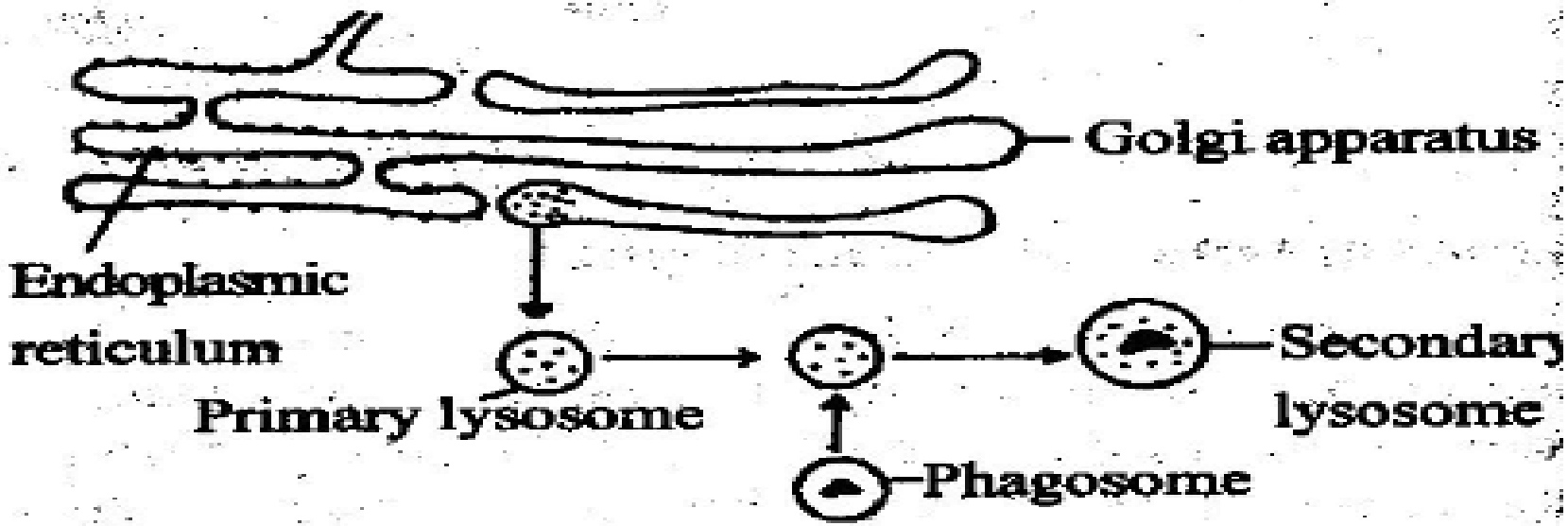



*Fig. 11.6: Formation of lysosome from Golgi apparatus.*

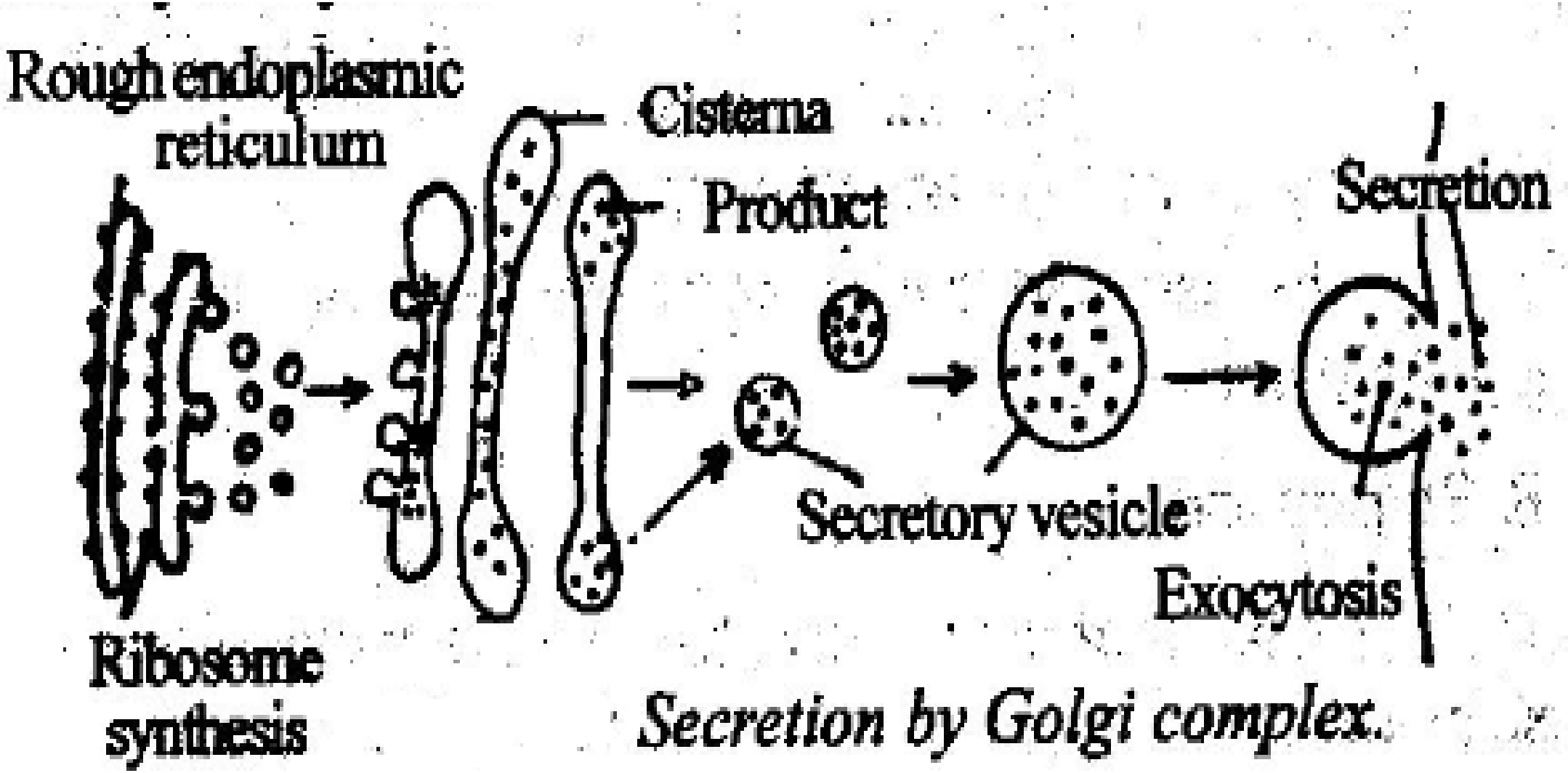
The endoplasmic reticulum buds off small vesicles containing ***hydrolases.*** These vesicles are transferred to the Golgi complex. The cisternae of Golgi complex in turn bud off small vesicles called ***primary lysosomes***. The primary lysosomes fuse with pinosomes or phagosomes to form ***secondary lysosomes.***

## 5. Secretion

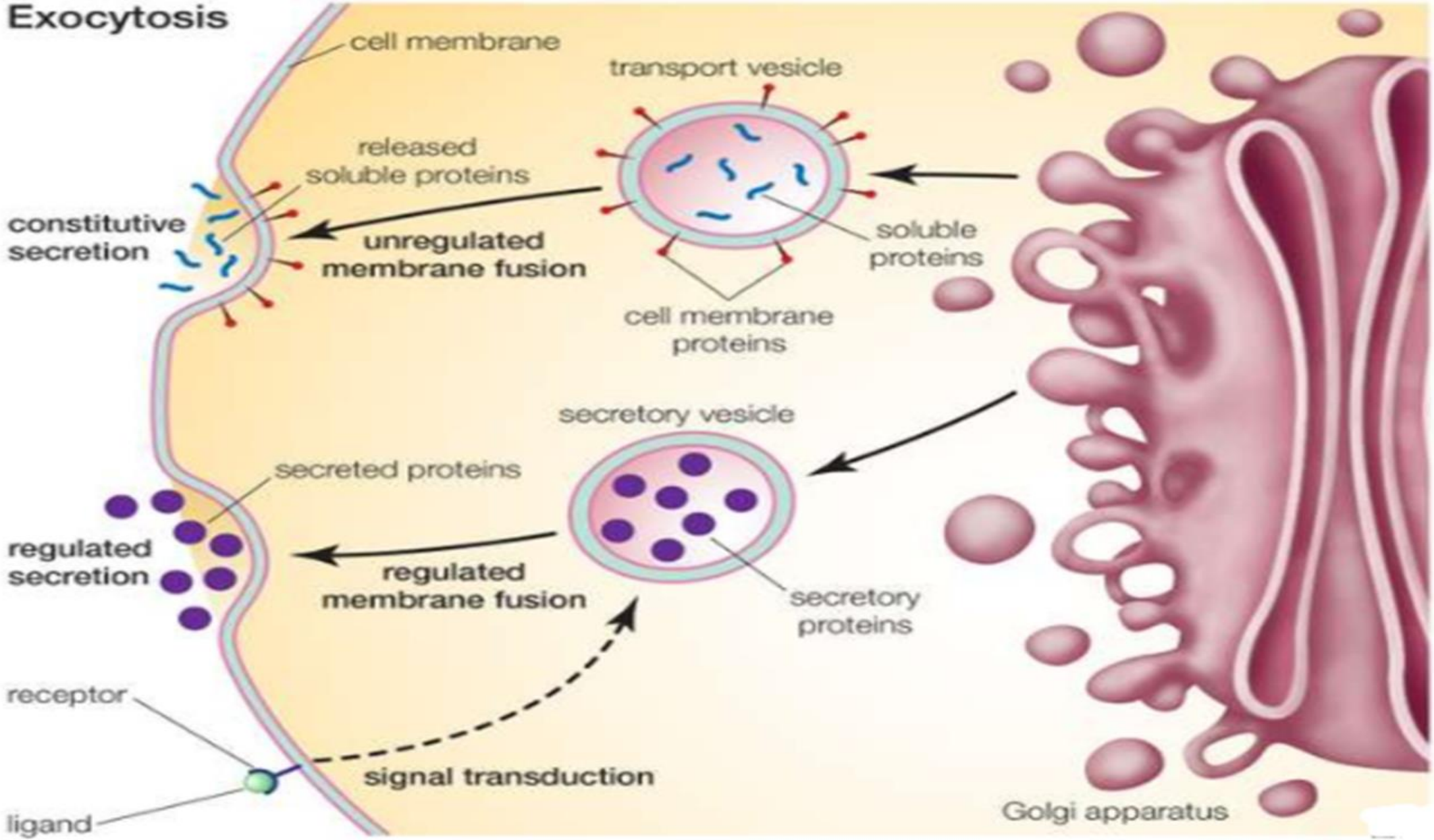
Secretion is the process of ***elaborating and releas*** ***a specific product from the cell.*** The mucous cells secr ***mucous;*** the salivary gland cells secrete ***saliva;*** The sebace gland cells secrete ***oil;*** the sweat gland cells secrete ***swe*** the tear gland cells secrete ***tears;*** exocrine gland cells sec ***enzymes,*** endocrine gland cells secrete ***hormones;*** the plas cells secrete ***antibodies;*** Nerve cells secr ***neurosecretions.***

Secretion is done by the Golgi complex. Golgi complex functions as a transporting channel from the site of synthesis to the outside.

The product is synthesized on the ribosomes attached to the endoplasmic reticulum. The product flows into the endoplasmic reticulum in the form of dilute solution. The endoplasmic reticulum buds off small vesicles containing the product. These vesicles fuse with the cisternae of Golgi complex. The product is transported to the cisternae of Golgi complex. In the cisternae the product is ***concentrated***. The cisternae release ***secretory vesicles***. The secretory vesicle is loaded with the product. The product is released out of the cell by ***exocytosis***.




*Secretion by Golgi complex.*


Exocytosis
cell membrane
transport vesicle
released
soluble proteins
constitutive
secretion
unregulated
membrane fusion
soluble
proteins
cell membrane
proteins
secretory vesicle
secreted proteins
regulated
secretion
regulated
membrane fusion
secretory
proteins
receptor
signal transduction
ligand
Golgi apparatus

### 6. Concentration and Storage of Secretory Products

The Golgi cisternae have the ability to concentrate the secretory products by losing water through the membrane.

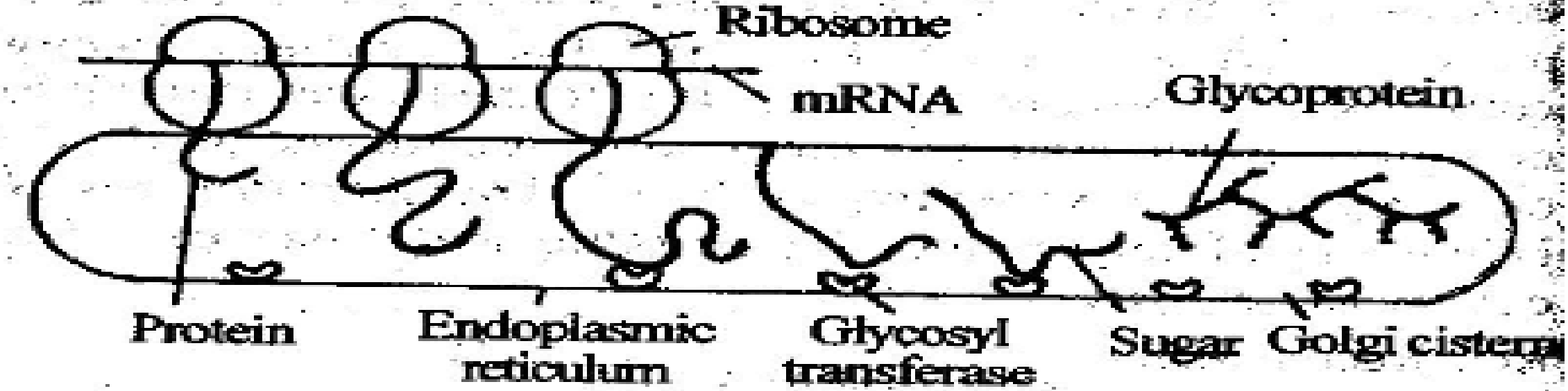
The secretory vesicles can store the secretory product until the product is demanded.

### 7. Glycosylation

Glycosylation is the formation of linkages with carbohydrate units. Glycosylation produces complex carbohydrates such as glycoproteins, mucopolysaccharides, glycolipids, glycogen, etc.

The glycosylation occurs in endoplasmic reticulum and Golgi complex. They contain an enzyme called ***glycosyl transferase***. This enzyme brings about glycosylation.

The protein is synthesized in the ribosomes attached to endoplasmic reticulum. It is transported to the cisternae of Golgi complex through the endoplasmic reticulum. The Golgi complex also receives simple sugar molecules through the blood streams. The glycosyl transferase links sugar molecules to proteins to produce *glycoprotein.*




*Glycosylation of proteins.*

The cisternae liberate secretory vesicles containing glycoprotein.

### 8. Sulphation

Golgi complex is involved in the metabolism of sulphate.

The goblet cells of intestine secrete ***mucigen.*** Mucigen is a ***mucopolysaccharide***. It is made up of protein, sugar and sulphate. The Golgi complex adds sulphate to the glycoprotein to produce mucigen. Addition of sulphate is catalysed by an enzyme called ***sulphotransferase*** present in the Golgi complex

### 9. Lipid packaging and secretion

The intestinal cells use their Golgi apparatus for the absorption of monoglycerides and fatty acids.

The endoplasmic reticulum synthesizes triglycerides from monoglycerides and fatty acids. The Golgi complex concentrates and transports the lipids synthesized in the endoplasmic reticulum to the plasma membrane and intercellular space.