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B.Sc HONS Part-III Paper-VI
Topic: Describe the structure and function of Golgi complex
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Q. 9. Describe the structure and functions of Golgi complex.

Ans. The first electron micrograph to clearly reveal the structure of the Golgi complex were by Dalton and I Helix (1954). These workers described the Golgi complex in the epididymis of the rate as consisting of three components, flatten dsacs cisternae, large vacuoles and small grannules. The following description of the Golgi complex is a composite one based on the work of several authors.

Electron microscope observations of thin sectiona reveal the presence of three membranous components. 1. flattened sacs or cisternae. 2. small tubules and vesicles and 3. large vacuoles filled with an amorphous or granular substance. These membranous structures are charactorized by the absence of ribosomes, i.e. they are smooth membranes.

1. The cisternae or lamellae are the most constant elements of the Golgi complex. They consists of flattened parallel sacs piled one upon the other to form stacks.

The number or cisternae in a stack varies from species to species, and sometimes from one developmental stage to another. In most animal and plant cells there are 3 to 8 cisternae in stack. Other cell types may have as many at 25 to 30 cisternae.

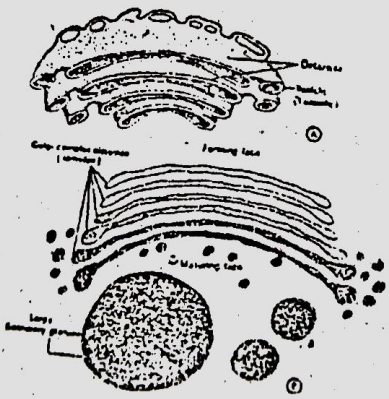

Fig. The Golgi-complex (A) Stereoscopicview. (B) Section.

Mollenhauer and Whaley (1963) suggested that in certain plant cells the Golgi complex is polarized and has a "forming face" and a "maturing face". The forming or proximal face is on the outer side while the maturing or distal face is on the opposite side. It is believed that the smooth membranes of the ER bud off vesicles, which then become arranged on the forming face of the stack. It is also possible that a lamella of the ER may be converted into a Golgi lamella by loss of ribosomes. On the other sides is the maturing or secreting face where the lamellae but off secretory visicles. This new lamallae are formed on the forming face and mature lamellea are lost on the maturing face. Chemical analysis shows

the composition of the Golgi complex membranes is intermediate between those of the ER and the plasmalemma. The membranes at the forming face to the Golgi complex are similar to the ER membranes and those of the maturing face to the plasmalemma. The membranes of the Golgi complex are in dynamic equilibrium. They are continually receiving lamellea through budding of vesicles from the smooth Er, and losing membrances through formation of secetory vesicles.

In a section the cisternae unit appears as a pair of parallel membranes continuous at the ends. The two membranes enclose a thin cavity about 150 A° across. The cavities of the cisternae on the maturing face are generally wider. The cisternal units are usually placed 200-300 A° apart. There is usually a difference in the size of the cisternae at the forming and maturing faces. The cisternae may be flat, but are more usually slightly curved. This gives the whole stack convex and concave faces.

In a number of cases the cisternae show variation from the spical from. In goblet cells, at a certain stage of maturity, the cisternae are all transformed in to mucigen granules which almost fill up the cell (Neutra and Leblond, 1966). In the multifid gland of the snail the stack breaks up into small vesicles during certain stages of development. The stack-like form is again reorganized from the vesicle in the secreting phase (Outracth, 1972).

Fenestration : The membranes of the cisternae may sometimes be fenestrated, i.e. may have small pores. The pores may be confined to the periphery or may occupy three fourths or more of the cisternae. The cisternae are often reticulate structures and not simply flattend sacs. Reticulation of the cisternae may vary from one face of the stack to the other, or may also very with different developmental stages.

Origin of the Golgi Complex :

1. From the Plasmalemma : In the amoeba Pelomyxa illionoisensis the Golgi cisternae are described as originating from the plasmalemma vesicles (Daniels, 1964). These vesicles are formed by pinocytosis and phagocytosis of the plasmalemma.

2. From the Nuclear Envelope : In the brown algae there is a close association between the nuclear envelope and the Golgi complex. Bouch (1965) has described vesicles, similar to those on the formative face of the Golgi complex arising from the nuclear envelope.

3. From the Annulate Lamellae : In the study of occyte maturation in the frog. Ward (1965) has described vesicles apparently derived from the annulate lamellae eventually fusing giving rise to the Golgi membranes.

4. From the Endoplasmic Reticulum : Essner and Novik off (1962) have described the formation of Golgi cisternae from the endoplasmic reticulum in certain hepatomas. Beams and Kessel (1968) have sugested that Golgi lamellae may be derived from the ER by loss of ribosomes.

It is believed that the Golgi complex arises from the granular ER, which change to smooth ER, and then becomes the Golgi cisternae. The sisternaes on the forming face are, constantly being formed by Plasma vesicles derived from the ER. The cisternae on the maturing face are believed to form secretory vesicles.

The presence of the nucleus is necessary to maintain the Golgi complex. In the absence of the nucleus the Golgi complex decreases in size and disappears. In nucleated amoebae the Golgi complex is formed within 30 minute to one hour after nuclear transplant and grows during 24 hour.

FUNCTIONS OF THE GOLGI COMPLEX

Several functions have been attributed to the Golgi complex. Most of the function are based either on indirect observation or deductions.

1. Role is Section General : There are numerous world describing secretory products in the cisternae of the Golgi complex. In the earlier works it was not clear whether secretory product were actually synthesized in the Golgi complex or whether the complex played a secondary role in secretion.

Many electron microscope studies show that during vitells genesis in oocytes. Yolk products first become visible in the cisternae of the Golgi complex. However, in these studies it is not electron whether yolk is actually synthesized the Golgi complex or only packaged there. In certain oocytes the Golgi complex appears to give rise to cortical granules (Anderson, 1966).

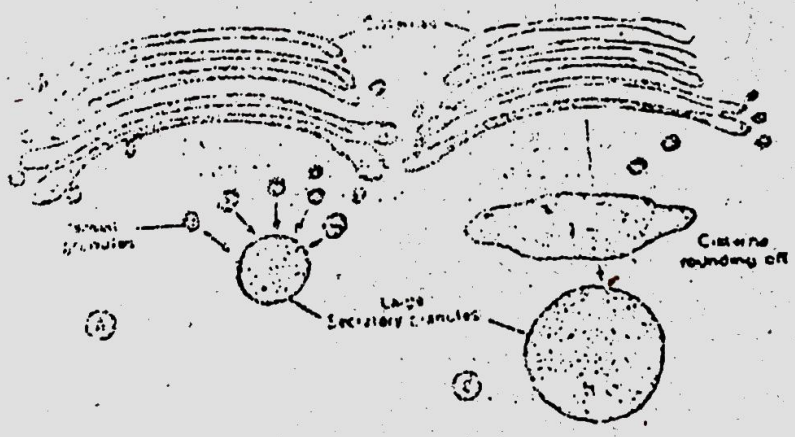

Fig. Two different modes of formation of secretory granules
(A) By fusion of secretory granules, (B) Rounding of cisternae.

In some cells, formed products appear in the expanded end of the Golgi lamellae. In others, the secretory product completed fills the cisterane. The secretory product within the Golgi lamela are very similar to the contents of the secretory granules near the Golgi complex. In some cases the ends of the Golgi cisternae most be pinched off to from small secretory granules (Fig. 2A). These may then fuse to from larger granules. In other cases the individual cisternae on the "maturing face" may be complete filled with secretory products, and then

become rounde to from secretory granules (Fig. 2B). New cisternae would then apparently be formed on the "forming face". It is possible that the lamellae of the ER may become Golgi lamellae by loss of ribosome.

2. Role in Protein Secretion : In pancreatic exocrine cells the distribution of secretory proteins (digestive enzymes) has been inveisgated by Siekevitz, Paladectal (1962). (1) Proteins are formed on the ribosomes artached to the ER. (2) These nascent proteins are then transfered into the ER. (3) From here thay go to the Golgi complex. There is morphological evidence that ER may bud off vesicles which travel towards the Golgi complex. The vesicles may then fuse with the membrances of the Golgi cisterane and release their contents into the latter. (4) In the Golgi complex the proteins are concentrated (possibly by water withdrawal) and transformed into zymogen granules. The zymogen of the granules consists of enzyme precursors of the pancreastic juice. The membrane of the Golgi vacuole becomes the limiting membrane of the zymogen granule. (5) The zymogen granules released from the Golgi complex migrate to the surface of the