TOPIC:GOLGI BODIES

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AUTHOR: DR.NIRMAL KUMARI

General History of Golgi Bodies

Camillo Golgi in 1898 discovered the Golgi apparatus in the nerve cells of barn owl and cat by metallic impregnation method. After it's discoverer's name, the Golgi apparatus has been variously named as **Golgisome**, **Golgi material**, **Golgi membranes**, **Golgi body**, etc.

Structure of Golgi Bodies:-

Golgi bodies varies in size and form in different types of cells, but they have similar organization in all kinds of cells. For example, it is well developed in secretory and nerve cells, but is rather small in muscle cells. Golgi bodies are compiled as a central stack (pile) of flattened sacs or cisternae and many peripheral tubules and vesicles.

Cisternae- The cisternae vary in number from 3 to 7 in most animal cells and from 10 to 24 in plant cells. They are usually equally spaced in pile so that they are nearly parallel to one another, having 200-300Å wide inter-cisternal spaces containing a layer of parallel fibers called inter-cisternal elements. These support the cisternae and maintain regular spacing between them. The cisternae may be flat, but are often curved, having a distinct polarity with a convex face towards the cell membrane and concave face towards the

nucleus. They are free of ribosomes and have swollen ends. They look like the smooth endoplasmic reticulum and are continuous with it at certain places. This suggests that the Golgi apparatus is derived from the smooth endoplasmic reticulum. A cisterna is about 0.5-1 μm in diameter and its cavity is about 100Å wide. It is fenestrated at the margin as here it passes into tubules. All the cisternae have a continuous lumen filled with a fluid.

Tubules- Short tubules arise from the periphery of the cisternae. Some of these enlarge at their ends to form vesicles.

Vesicles- The vesicles lie near the ends and concave surface of the Golgi complex. They are pinched off from the tubules of the cisternae. They are of three types: transitional, smooth or secretary and coated vesicles.

Transitional Vesicles: These are the small outgrowths formed from the transitional ER. They migrate to, converge and coalesce to cis face of Golgi, where they form new cisternae.

Smooth Vesicles: These have smooth surface and contain secretions of the cell and so they are also called secretary vesicles. They arise from the ends of the cisternae tubules.

Coated vesicles: These have rough surface and they also arise from the cisternae tubules. They play a role in intracellular traffic of secretary protein molecules.

The Golgi complex has 3 functional regions: **cis region** that lies nearest the ER, **medial region** in the middle, and **Tran's region** with trans Golgi reticulum nearest to the plasma membrane. These regions have different enzymes which introduce different modifications to secretary and membrane proteins

passing through them. The principal modification is glycosylation, i.e., addition of sugars to proteins, forming glycoproteins. Glycosylation starts in the ER and is completed in the Golgi complex. Modification of proteins in the Golgi apparatus also involves addition of lipids, forming lipoproteins (liposylation), and even the addition of other groups (Fig. 4.6).

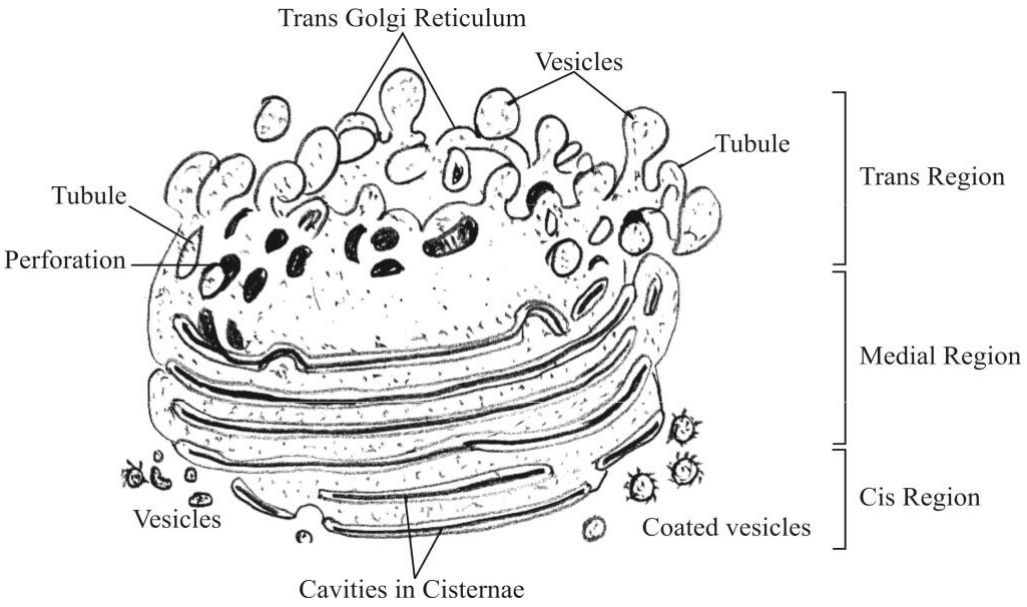

Fig. 4.6: Thee-dimensional view of Golgi apparatus

Functions of Golgi Bodies:-

Golgi apparatus is metabolically very active. Many functions have been assigned to it:

Formation of secretary vesicles- The Golgi complex processes and packages proteins and lipids coming from the ER for transport to other parts of the cell or out of the cell. Packaging involves wrapping the materials by a membrane, forming secretary vesicles. The materials so packed includes zymogen in pancreatic cells, mucus in goblet cells, lactoprotein in mammary gland cells, pigment granules in pigment cells, collagen in connective tissue cells, hormones in endocrine cells, etc.

Synthesis of carbohydrates- The Golgi apparatus synthesizes certain mucopolysaccharides from simple sugars.

Formation of Glycoproteins- The Golgi apparatus links the sugars with proteins coming from rough ER to form glycoproteins.

Formation of Lipoproteins- Lipids and proteins coming from the ER are complexed into lipoproteins in the Golgi apparatus.

Addition to Cell Membrane- The Golgi apparatus provides membrane material for the plasma membrane when the later must enlarge for the formation of pinocytotic and phagocytotic vesicles and for the formation of cleavage furrow during the division of animal cells. As the secretary vesicles discharge their contents by exocytosis, their membranes are incorporated into the cell membrane. This enlarges the cell membrane. Since, endocytosis removes segments of the cell membrane, the latter's enlargement by exocytosis is temporary, rather compensatory. The transfer of membrane from the ER via transition vesicles, Golgi complex and secretary vesicles to the plasma membrane is called **membrane flow**.

Membrane Transformation- The Golgi apparatus changes one type of membrane into another type. Membranes are gradually modified from the ER type to one with characteristics of the plasma membrane as they shift through the Golgi complex.

Formation of cell wall- In some algae, cellulose plates for cell wall is synthesized in Golgi complex. In higher plants the Golgi complex (a) synthesizes pectin and some carbohydrates

necessary for the formation of cell wall and (b) produces some secretions such as mucilage, gums, etc.

Formation of lysosomes- The Golgi complex gives rise to primary lysosomes by budding. The lysosomes may also arise from ER.

Acrosome Formation- The Golgi complex gives rise to the acrosome in a sperm.

Formation of Yolk and Cortical Granules- The Golgi complex produces yolk and cortical granules in the eggs. Formation of yolk is called vitellogenesis.

Formation of Nematocysts and Trichocysts- The Golgi apparatus gives rise to the nematocysts in Hydra and perhaps also in other coelenterates, and trichocysts in ciliates such as Paramecium.

Storage of Secretions- The Golgi complex stores cell secretions such as proteins and lipids.

Absorption of Materials- Golgi apparatus absorbs materials from the environment. For example, cells of the intestinal lining use Golgi apparatus to absorb lipids from the intestine.

Location of Enzymes- A variety of enzymes is localized in the Golgi complex to help in the cell's biochemical reactions.

Importance of Golgi Bodies:-

The Golgi apparatus is often referred to as the "traffic police" of the cell because its enzymes sort out and modify cell's secretary proteins passing through its lumen and membrane proteins in its membranes and directs them to their proper destination.

Summary:-

The ER is present in almost all eukaryotic cells except ova, embryonic cells and mature RBC. The prokaryotic cells lack ER. It comprises three types of elements: cisternae, tubules and vesicles. Various functions are performed by them, such as transport of materials, formation of desmotubule. They form supporting framework; provide surfaces for synthesis, storage and exchange of various materials. Similarly ribosomes are present in all types of cells prokaryotic as well as eukaryotic. Although they occur freely floating in the cytoplasm of prokaryotic cells, they are present free in cytoplasmic matrix and also attached to the outer surface of RER and nuclear envelop of eukaryotic cells. Each ribosome consists of two structurally and functionally distinct subunits: one large, dome shaped and the other smaller and ovoid. The subunits occur separately in the cytoplasm, and join to form ribosome only at the time of protein synthesis. The 70S ribosome is found in prokaryotic cells and in the mitochondria and plastids of the eukaryotic cells. The 80S ribosome occurs in the cytoplasm of eukaryotic cells. The ribosomes provide space and enzymes for the synthesis of proteins in the cells.

The Golgi apparatus is a system of membranes like ER. It is present in all eukaryotic cells, except a few cell types such as the mammalian RBC, sperm cells of bryophytes and pteridophytes and sieve tubes of plants. It is absent in prokaryotic cells. It is composed of cisternae, tubules and vesicles and they perform various functions like formation of secretary vesicles, carbohydrates, glycoproteins, lipoproteins etc, cell walls in plant cells, lysosomes, acrosomes in sperms, yolk and cortical granules in eggs etc. They also store secretions and absorb various materials and many enzymes are located in them.

Glossary:-

Endoplasmic reticulum: It is a network of membranous tubules within the cytoplasm of a eukaryotic cell, continuous with the nuclear membrane. It usually has ribosomes attached and is involved in protein and lipid synthesis.

Ribosome: A ribosome is a protein synthesizing machine found within all living cells that serves as the site of biological protein synthesis.

Golgi Bodies: The Golgi bodies also called Golgi complex or Golgi apparatus is a system of membranes like ER. It receives proteins and lipids from rough endoplasmic reticulum, modifies some of them and sorts, concentrates and packs them into vesicles.

Mitochondria: It is an organelle bounded by double membrane in which the biochemical processes of respiration and energy production occur.

Plastids: Plastids are double membrane organelle found in the cells of plants and algae. They are the site of manufacture and storage of important chemical compounds like pigments used in photosynthesis.

Centrosomes: It is an organelle where cell microtubules get organized. It regulates the cell division cycle, the stage which lead up to cell division. They occur only in animal cells.

Lysosomes: A lysosome is a membrane bound cell organelle found in most animal cells. They are spherical vesicles containing hydrolytic enzymes capable of breaking down all kinds of biomolecules, including proteins, nucleic acids, carbohydrates, lipids and cellular debris.

Dictyosome: In invertebrates and plant cells, Golgi complex usually consists of many isolated units called dictyosome. They are scattered throughout the cytoplasm.

Cisternae: Cisternae refer to a flattened membrane discs lying stacked upon each other like pancakes.

Tubules: These are the short structures arising from the periphery of the cisternae. Some of these enlarge at their ends to form vesicles.

Vesicles: The vesicles are the spherical structures that lie near the ends and concave surface of the Golgi complex. They are pinched off from the tubules of the cisternae.

Interstitial cells: Any cells that lie between other cells are called interstitial cells. For e.g. Leydig cells that produce testosterone are found adjacent to the seminiferous tubules of testicle.

Electrolyte: An electrolyte is a substance that produces an electrically conducting solution when dissolved in a polar solvent, such as water. The dissolved electrolyte separate into cations and anions and are dispersed uniformly through the solute.

Goblet cells: A goblet cell is a glandular, columnar epithelial cell whose function is to secrete gel-forming mucins, the major components of mucus.

Metabolism: It is the process by which body converts the food into energy. During this complex biochemical process, calories in food are combined with oxygen to release the energy for the body to function.

Oxidation: Oxidation is the loss of electrons by a molecule, atom, or ion.

Exocytosis: Exocytosis is a process by which a cell directs the contents of secretary vesicles out of the cell membrane and into the extracellular space.

Desmotubules: The desmotubule is a tube of appressed endoplasmic reticulum that runs between two adjacent cells. Some molecules are known to be transported through this channel, but it is not thought to be the main route for plasmodesmatal transport.

Dalton: Dalton is the standard unit that is used for indicating mass on an atomic or molecular scale (atomic mass). One unified atomic mass unit is approximately the mass of one nucleon (either a single proton or neutron) and is equivalent to 1 g/mol.

Sedimentation Coefficient: The sedimentation coefficient of a particle is used to characterize its behavior in sedimentation processes, notably centrifugation. It is defined as the ratio of a particle's sedimentation velocity to the acceleration that is applied to it.

Ribonuclease: Ribonuclease is a type of nuclease that catalyzes the degradation of RNA into smaller components.

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