# ULTRASTRUCTURE AND FUNCTION OF GOLGI APPARATUS

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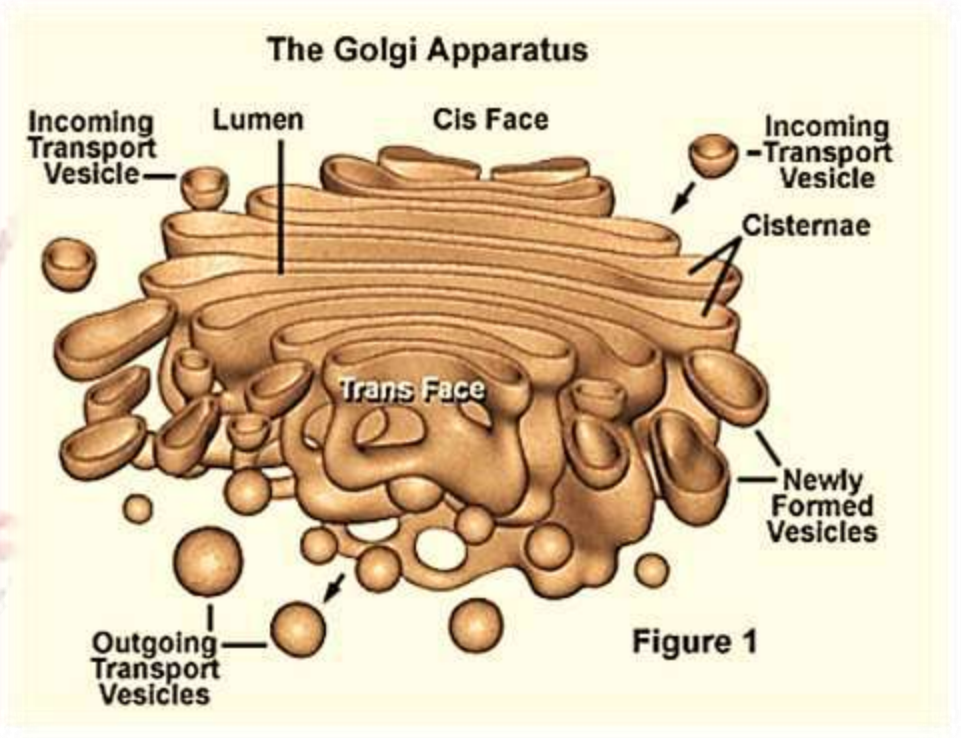
# Introduction

- The Golgi apparatus or the Golgi body or Golgi complex, lipochondrion, Barker's body, Dalton Complex, Apparato Reticulare or simply Golgi is a sub-cellular organelle present in most of the eukaryotic cells.
- It was first described by Italian Histologist Camillo Golgi in the nerve cells of Barn Owl and cat in 1898, while Dalton and Felix (1954) described its electron microscopic structure.
- It is composite structure of many independent units called dictyosomes or Golgi body or Golgi stacks which are variable in number – from one in simple alga like micromaonas to 2500 in rhizoidal cell of aquatic alga chara (largest alga).
- Each Golgi stack has variable number of cisternae which may be simply 4 and 8 to as many as sixty cisternae in some protist.
- This collection of cisternae is broken down into *cis*, *medial*, and *trans* compartments, making up two main networks: the *cis* Golgi network (CGN) and the *trans* Golgi network (TGN).
- It is found in most of the eukaryotic cells except RBCs, egg cells, embryonic cells.
- Its main function is collection, storage, condensation, modification and packaging of various materials into secretary vesicles.

# Structure

- It is extremely dynamic and pleomorphic structure
- A Golgi complex has two faces – *Cis* Face & *Trans* face.
- *Cis* face is always facing towards nucleus while the *trans* face is facing towards PM.
- It has zone of clear cytoplasm known as zone of exclusion.
- Golgi stacks are actually Golgi cisternae which looks like deflated balloons.
- A liver cell may have up to 50 cisternae.
- It constitutes about 2% of total cell volume.
- In plant cells, 10-20 individual stacks found scattered in the cytoplasm.



# Structure

- Each Golgi stack is about 1 - 5μm in diameter. Under EM, a Golgi body seen to consists of a stack of 3-10 cisternae with a complex irregular network of tubules, vesicles and vacuoles on the outer edges just like ER.
- The adjacent cisternae are separated by an intercisternal space of 10-30nm.
- The intercisternal space contains protein cross-links that hold the cisternae together.
- The cisternae may be flat, but often curved to give a definite polarity to the Golgi body.
- Many small Golgi vesicles having 20-80μm in diameter are found associated with the Golgi body.
- The transitional vesicles or transport vesicles pinched off from the rough ER and fuse with the *cis* face of the Golgi to transport proteins and lipids between the cisternae and the tubule.
- The secretary vesicles that derive from TGN carry glycoproteins, glycolipids and polysaccharides to different destinations in the cell or outside the cell.
- The coated vesicles are covered by a basketlike network of protein complex consists of clathrin triskelions.
- The larger secretary vesicles are called Golgian vacuoles. Some of them function as lysosomes.

# Structure

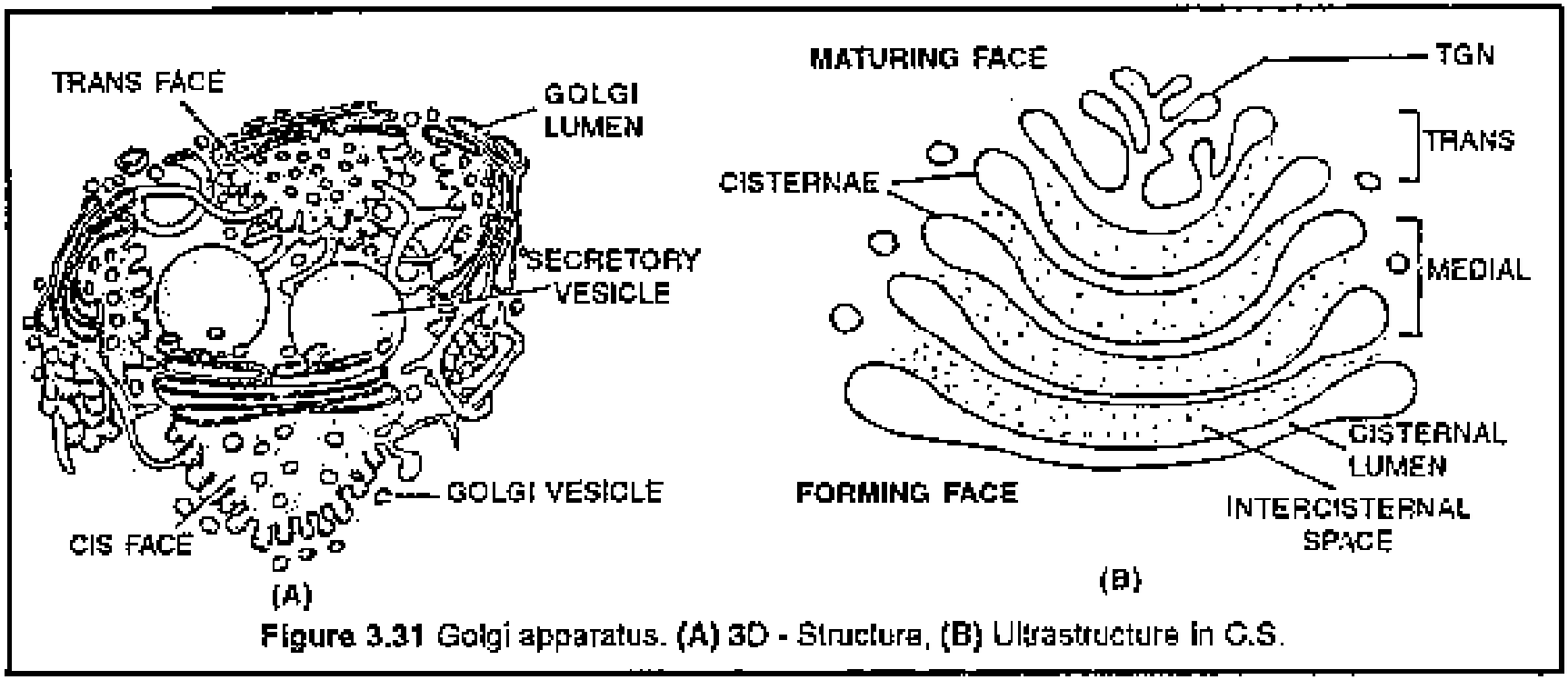
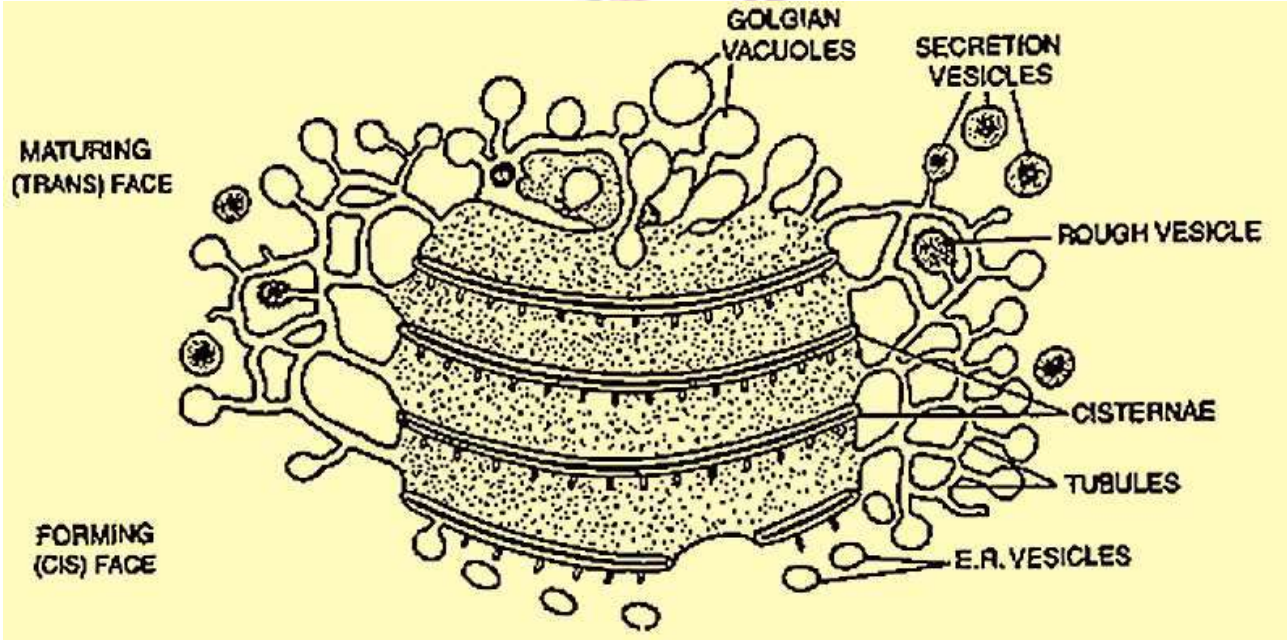



**Figure 3.31** Golgi apparatus. (A) 3D - Structure, (B) Ultrastructure in C.S.

*Maturing faces are thicker (7-8 µm)*
*Forming face are thinner (~ 4 µm).*

# Components of Golgi body

- Golgi body or Golgi apparatus is composed of four distinct components which are cisternae, tubules, vesicles and Golgian vacuoles.



# Components of Golgi body – Cisternae

- The Golgian cisternae (Golgian saccules) is comparable to that of Endoplasmic reticulum.
- The membranes of cisternae are smooth but of variable thickness.
- Intracisternal lumen is of about 60-90 Angstrom, while intercisternal space is 100-300 Angstrom wide.
- Intracisternal space contains a fluid substance or matrix, while intercisternal space contains thin layer of clear cytoplasm having parallel fibrils.
- The cisternae are frequently curved to give a definite polarity to the Golgi apparatus – one face of the apparatus is convex while the other is concave. The convex side is called forming face (=formative, cis-face).
- The forming face receives (transitional) vesicles from endoplasmic reticulum.
- The contents of transitional vesicles pass through various cisternae with the help of coated vesicles and intercisternal connectives.
- The contents of transitional vesicles ultimately reach the maturing face where they are budded off as secretion, coated or Golgian vesicles or vacuoles.



# Components of Golgi body – Tubules

- Tubules in the Golgi apparatus form a complicated network towards the periphery and maturing face of the apparatus.
- It arises from the cisternae of Golgi body due to cisternal fenestrations.
- Tubules have a diameter of 30 – 50 nm.
- Tubules also interconnects the different cisternae and thus it represents a communication channel to synchronize function of Golgi body within the cell..

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# Components of Golgi body – Vesicles

- Vesicles are small sacs of 20-80 nm diameter.
- They are found attached to the tips of tubules at various levels in the tubular network.
- Vesicles are of two types; coated and smooth vesicles.
- The coated vesicles have a rough surface due to elaborate proteins, while the smooth vesicles have a smooth surface.
- The smooth vesicles contain secretory substances and are hence known as secretion vesicles.

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# Components of Golgi body – Golgian vacuoles

- Golgian vacuoles are basically an expanded parts of the cisternae.
- Part of Golgian cisternae become modified to form a vacuoles.
- The Golgian vacuoles develop from the concave or maturing face.
- They contain amorphous or granular substance.
- Some of the Golgian vacuoles function as lysosomes.

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# Function

- Posttranslational modification: It facilitates glycosylation (addition of carbohydrates) of proteins synthesized in the rough endoplasmic reticulum (RER).
- Modification of molecules: It facilitates liposylation (formation of lipoprotein), sulphation (addition of sulphates) and phosphorylation (addition of phophates).
- Secretion: It is the major function of Golgi apparatus, which help in collection, storage, condensation, modification and packaging of various materials into secretory vesicles. The secretory vesicles release the contents to the exterior through exocytosis, e.g., secretion of mucilage by root cap cells, secretion of hormones, gum, wax, cell wall material, ground matrix of connective tissue, etc.
- Membrane transformation: It helps in the transformation of one type of membrane (e.g. that of ER) into other types (e.g., selectively permeable plasma membrane, differentiated membrane of lysosome, etc.).
- Structural maintenance: It helps in the formation of cell plate, cell wall and plasma membrane during cell division.
- Lysosomes: It helps in the formation of primary lysosomes, sperm acrosome, nematocysts in coelenterates and root hairs.
- Hormone synthesis: It is the site of production of hormones in the secretory cells of endocrine glands,

# Function

- Synthesis of complex carbohydrates: Most of the complex carbohydrates except glycogen and starch, such as pectic compounds, mucopolysaccharides, hyaluronic acid, chondroitin sulphate, hemicellulose, etc., are synthesized.
- Synthesis of special simple carbohydrates: Special simple carbohydrates, such as sialic acid and galactose are formed in the Golgi complex.
- Matrix: Matrix of connective tissue is formed by Golgi complex of its cells.
- Fat transport: Fatty acids and glycerol absorbed by intestinal epithelium are transferred as fat to lacteal through Golgi complex.
- Pigment synthesis: It is believed to synthesize retinal pigments in Chick embryo.
- Vitellogenesis: In oocytes of animals, Golgi apparatus functions as the centre around which yolk is deposited – a process that is known as vitellogenesis.
- Acrosome formation: Acrosome is formed by Golgi complex with the help of its vesicles.
- Root hair: Root hair is formed form their mother (root hair stem) cells by the Golgi complex.
- Hypnotoxin: Nematoblasts  hypnotoxin is formd by Golgi apparatus.
- Proteolysis: Cleavage of some precursor proteins, e.g., prohormones.

# Further readings


- Cooper G.M., Hausman R.E. The Cell – A molecular Approach. ASM Press, Washington, DC, USA.
- Iwasa J., Marshall W. Karp's Cell and Molecular Biology – Concepts and Experiments, Eighth Edition. John Willey & Sons, Inc., MA, USA.
- Kar D.K. & Halder S. 2015. Cell biology genetics and molecular biology. New Central Book Agency, Kolkata, India.
- De Matteis M.A. & Luini A. 2008. Exiting the Golgi complex. Nature Reviews Molecular Cell Biology 9: 273-284. doi:10.1038/nrm2378.
- Andreeva A.V., Kutuzov M.A., Evans D.E., Hawes C.R. 1998. The structure and function of the Golgi apparatus: a hundred years of questions. J. Exp. Bot. 49(325): 1281-1291.
- https://microbenotes.com/golgi-apparatus-structure-and-functions/