

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

CYTOLOGY



MID – Lecture 3

Golgi Apparatus

وَإِن تَتَوَلَّوْا يَسْتَبَدِلْ قَوْمًا غَيْرَكُمْ ثُمَّ لَا يَكُونُوا أَمْثَلَكُمْ

اللهم استعملنا ولا تستبدلنا

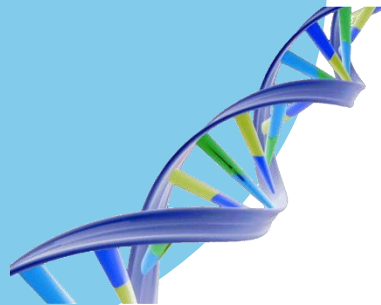
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Lecture 2: Golgi apparatus and vesicular transport

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School of Medicine

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سُبْحَانَ اللَّهِ
الْحَمْدُ لِلَّهِ
عَالَمُ الْإِلَهِاتِ
اللَّهُ أَكْبَرُ

Functions of the Golgi apparatus

- Further protein processing and modification
- Further protein sorting
- Synthesis of glycolipids and sphingomyelin

A quick comparison

ER	Golgi
<u>Synthesis of:</u> -Membrane glycerophospholipids -Sphingolipids like ceramide -Steroids	<u>Synthesis of:</u> -Glycolipids and sphingomyelin

ER → synthesizes ceramide , the lipid precursor

Golgi → completes glycolipids and sphingomyelin synthesis by adding sugar ,phosphocholine ,or other groups to ceramide

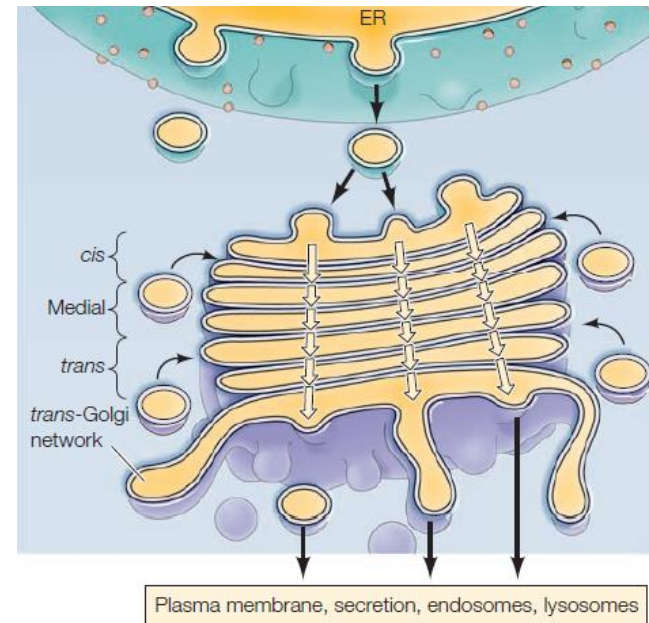
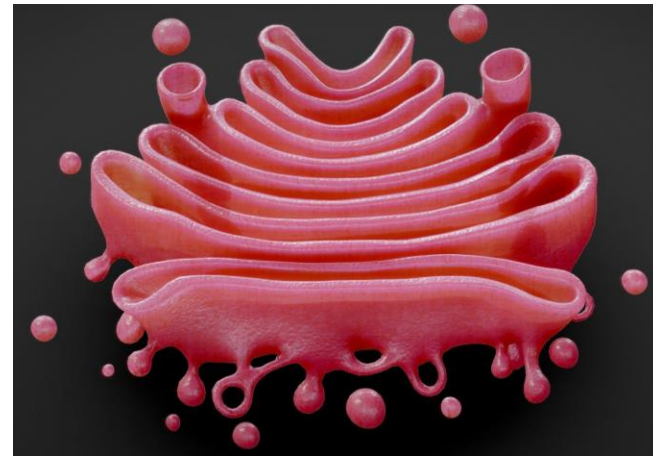
In other words , further modification for ceramides occurs in golgi in order to produce -synthesize- glycolipids and sphingomyelin

Any questions right now 😞!!!?

Golgi apparatus is a dynamic structure

Structure of the Golgi

- The Golgi apparatus consists of a stack of flattened sacs (cisternae) of four regions: *cis*, medial, and *trans* compartments and the *trans*-Golgi network.
- Proteins are carried through the Golgi apparatus in the *cis-to-trans* direction.
- Transport vesicles carry the Golgi proteins back to earlier compartments for reuse.
From *trans* back to *cis* region



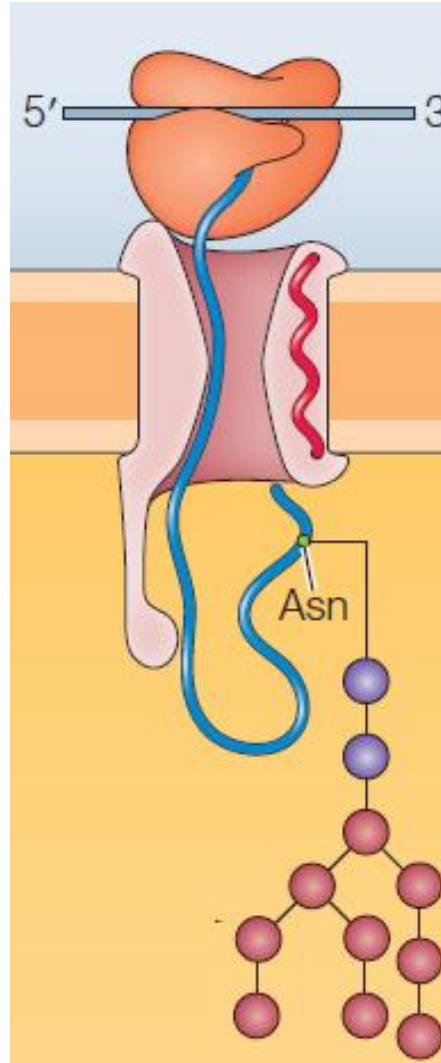
- After cyramide synthesis in the ER , cyramide goes to golgi , where a sugar or phosphocholine is added to it making a glycolipid or sphingomyelin

Processing of *N*-linked oligosaccharides in Golgi

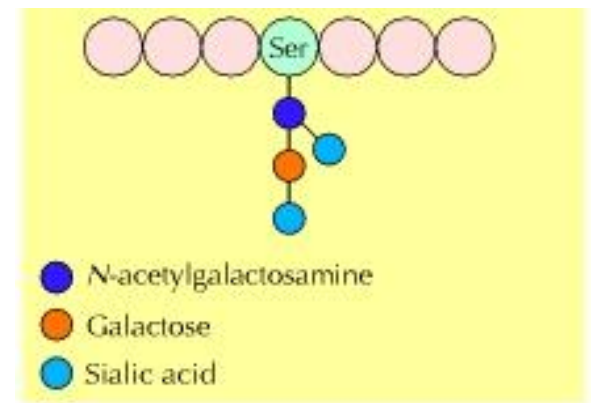


The *N*-linked oligosaccharides, which are added to asparagine residues of glycoproteins and transported from the ER, are further modified enzymatically in different compartments of the Golgi.

N-linked glycosylation starts in the ER and continues in golgi apparatus
While *O*-linked glycosylation starts in golgi apparatus



*Proteins can also be modified by the addition of carbohydrates to the hydroxyl side chains of serine and threonine residues, hence called *O*-linked sugars.*



Lipid and Polysaccharide Metabolism in the Golgi

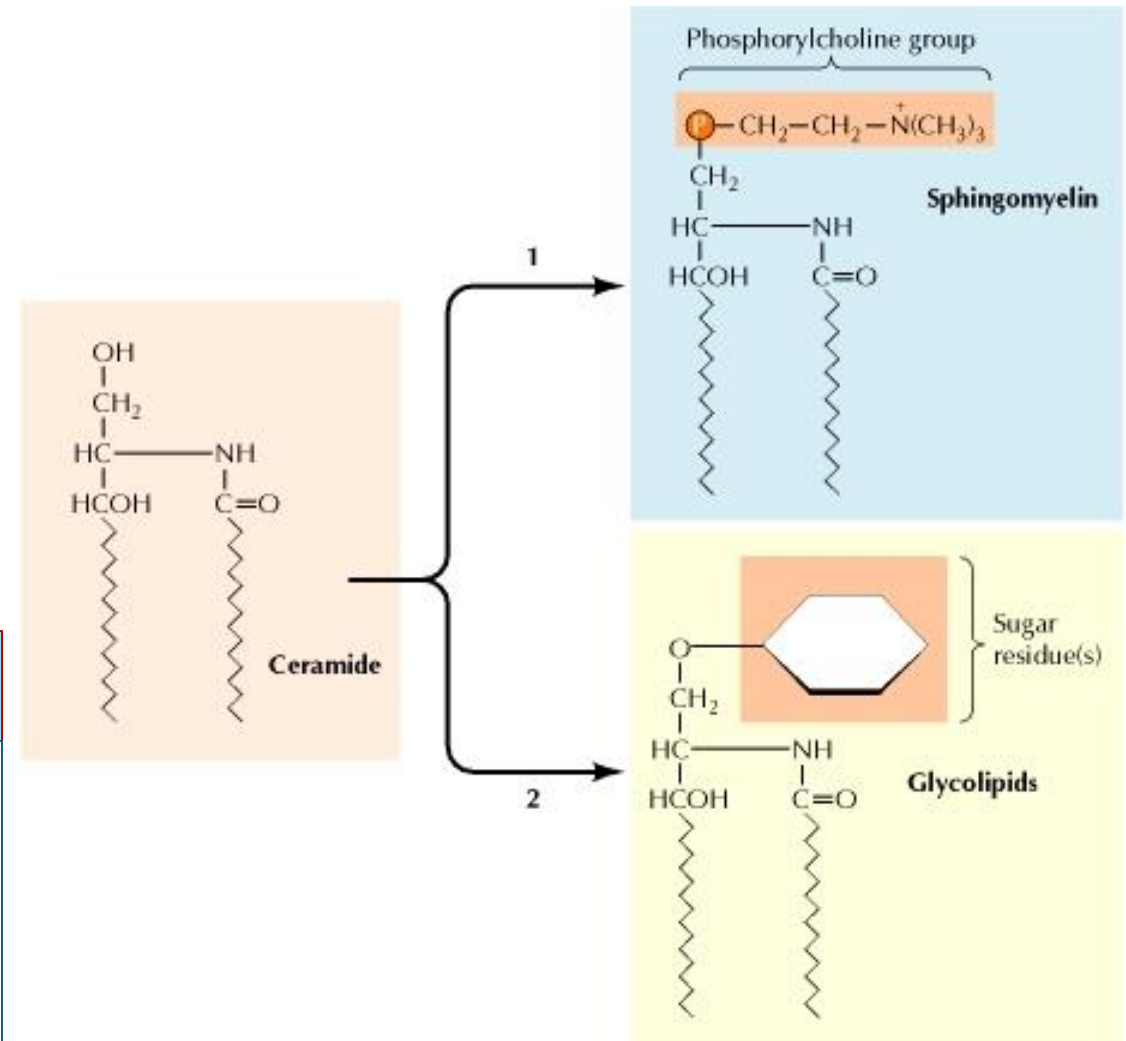
- Ceramide is converted either to sphingomyelin (a phospholipid) or to glycolipids in the Golgi apparatus.

Ceramide is synthesized in the ER

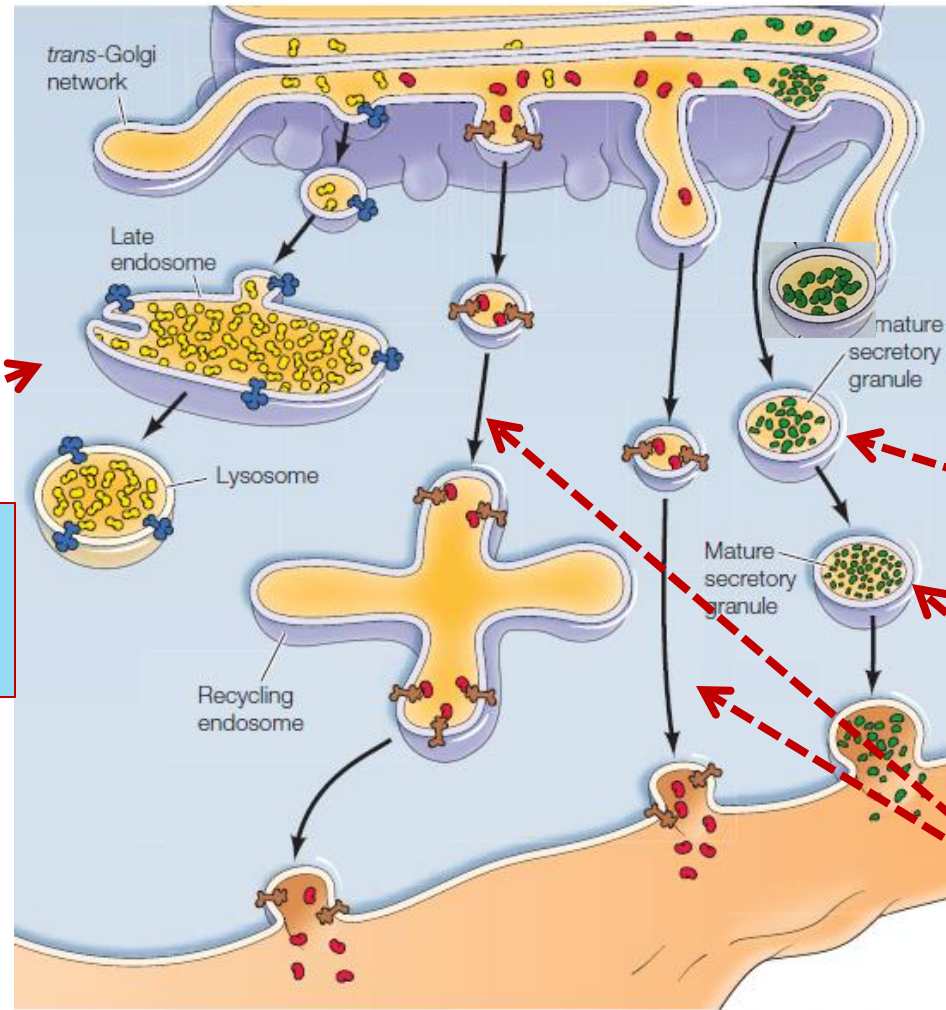
-EXTRA-

Remember

- Sphingomyelin is the only sphingophospholipid
- Glycolipids are 3 types :
Globosides , cerebrosides and gangliosides



Protein Sorting and export



Proteins can be targeted to late endosomes, which develop into lysosomes

In contrast to the ER, all of the proteins retained within the Golgi complex are associated with the Golgi membrane rather than being soluble proteins within the lumen

Protein processing in Immature secretory vesicles

Regulated secretion after signaling from specialized vesicles

Continuous, unregulated secretion

- Exporting proteins from golgi to cell surface can occur via many routes :
 - Direct transport from trans-golgi network to the plasma membrane via vesicles which leads to continuous secretion *unregulated *from the cell
 - Vesicle remains in the cytosol waiting for a specific signal to come to fuse with the plasma membrane and release its contents *regulated secretion*

For example, the digestive enzymes produced by pancreatic acinar cells are stored in mature secretory granules until the presence of food in the stomach and small intestine triggers their secretion .

Another example , vesicles containing neurotransmitters remain in the cytosol waiting for calcium ions to enter the cell and bind to proteins on the vesicular membrane allowing these vesicles to interact with the plasma membrane and release their content outside the cell

-What about lysosomal proteins ?

The transport vesicle fuses with what we call a late endosome, which then matures into a lysosome

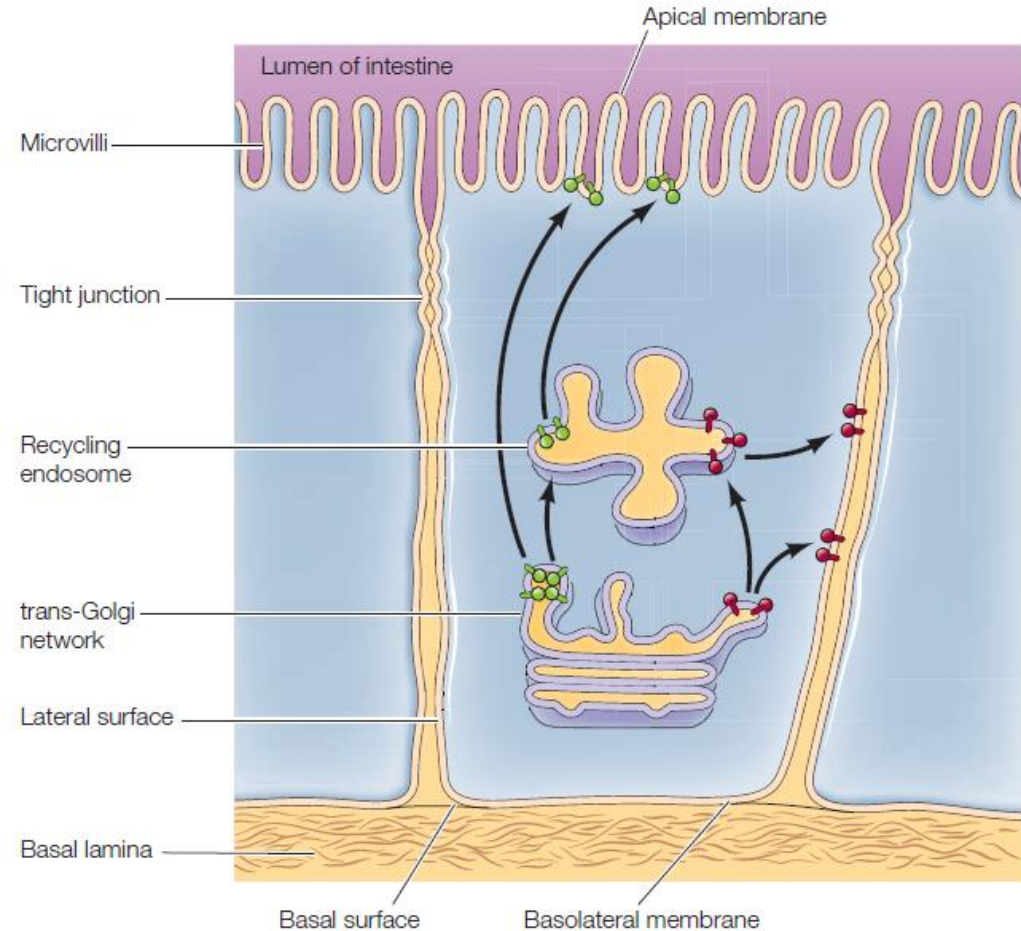


Transport to the plasma membrane of polarized cells

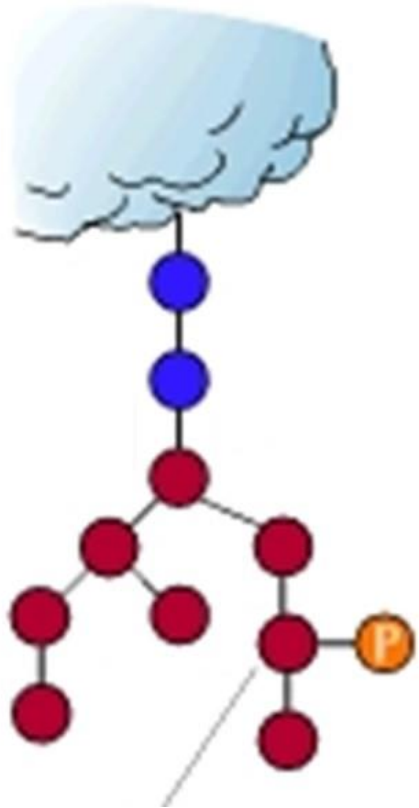
- Proteins are selectively packaged into transport vesicles from the trans-Golgi or recycling endosomes.
- Targeting is determined by special sequences (basolateral) or GPI sugar modification (apical).

Upon vesicle fusion with the plasma membrane, the specific site of fusion doesn't matter; because all sides of the membranes are similar ,EXCEPT for polarized cells

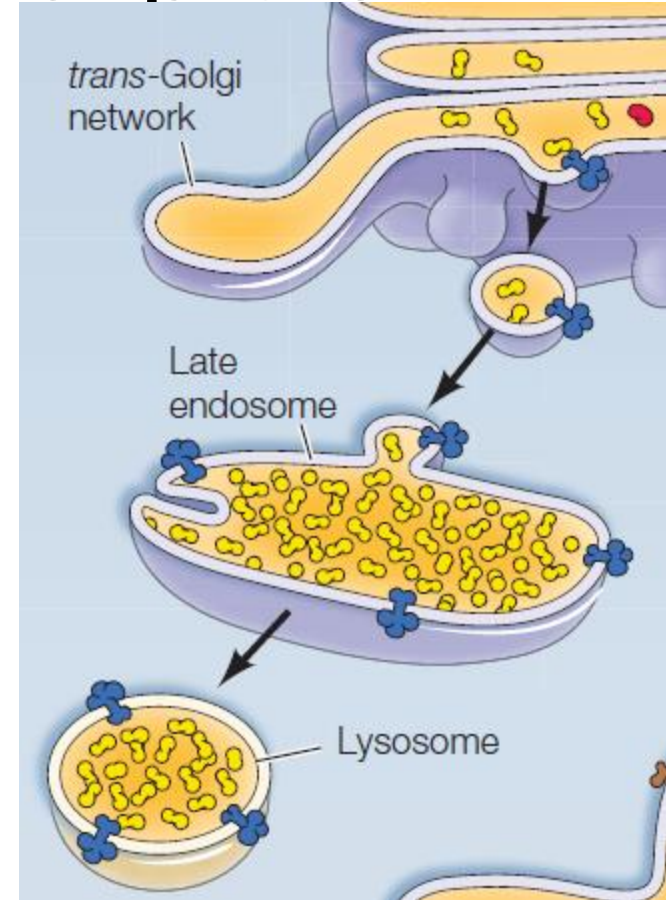
Polarized cells are cells with different apical and basolateral surfaces like intestinal cells



Processing of luminal lysosomal proteins



Protein destined to lysosomes have a signal patch (a three-dimensional structural determinant), which is recognized by modifying enzymes that add mannose-6-phosphate to the proteins.



Luminal lysosomal proteins bind to a mannose-6-phosphate receptor and are transported to late endosome, which mature into lysosomes.

- Lysosomal proteins are glycosylated proteins
- One of these sugars is mannose, which is then phosphorylated and bound to a specific receptor on golgi surface
- So a vesicle pinches out with the phosphorylated lysosomal protein inside , and fuses with the late endosome which is then matured into a lysosome



For any feedback, scan the code or click on it.



Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1	Slide3	Synthesis of Glycerophospholipids especially ceramide	Synthesis of sphingolipids like ceramide +added the box in blue
	Slide5	Transport vesicles carry proteins from cis to trans-golgi region inside golgi	The slide is removed +Added to slide: 4 Transport vesicles carry proteins from trans back to cis region
V1 → V2			

Additional Resources:

رسالة من الفريق العلمي:

The reference book
The cell –a molecular approach-8th
edition, chapter 12.2

Extra References :

<https://youtu.be/Jn-1lB5jb6I?si=Vv34g4njJZPiSGgd>

كان في جيبِ سُفيانِ الثَّوريِّ-رحمه الله- رقعةٌ ينظرُ فيها
كثيرًا ، فوَقعت منه فنظروا بها ، فاِذ بالمكتوبِ :
"سُفيان ، تذكَّر وُقوفَكَ بينَ يَدَيِ اللهِ"

اذكروا المُستضعفين من المُسلمين بِدعوةِ 