MSc I Sem – Life Sciences

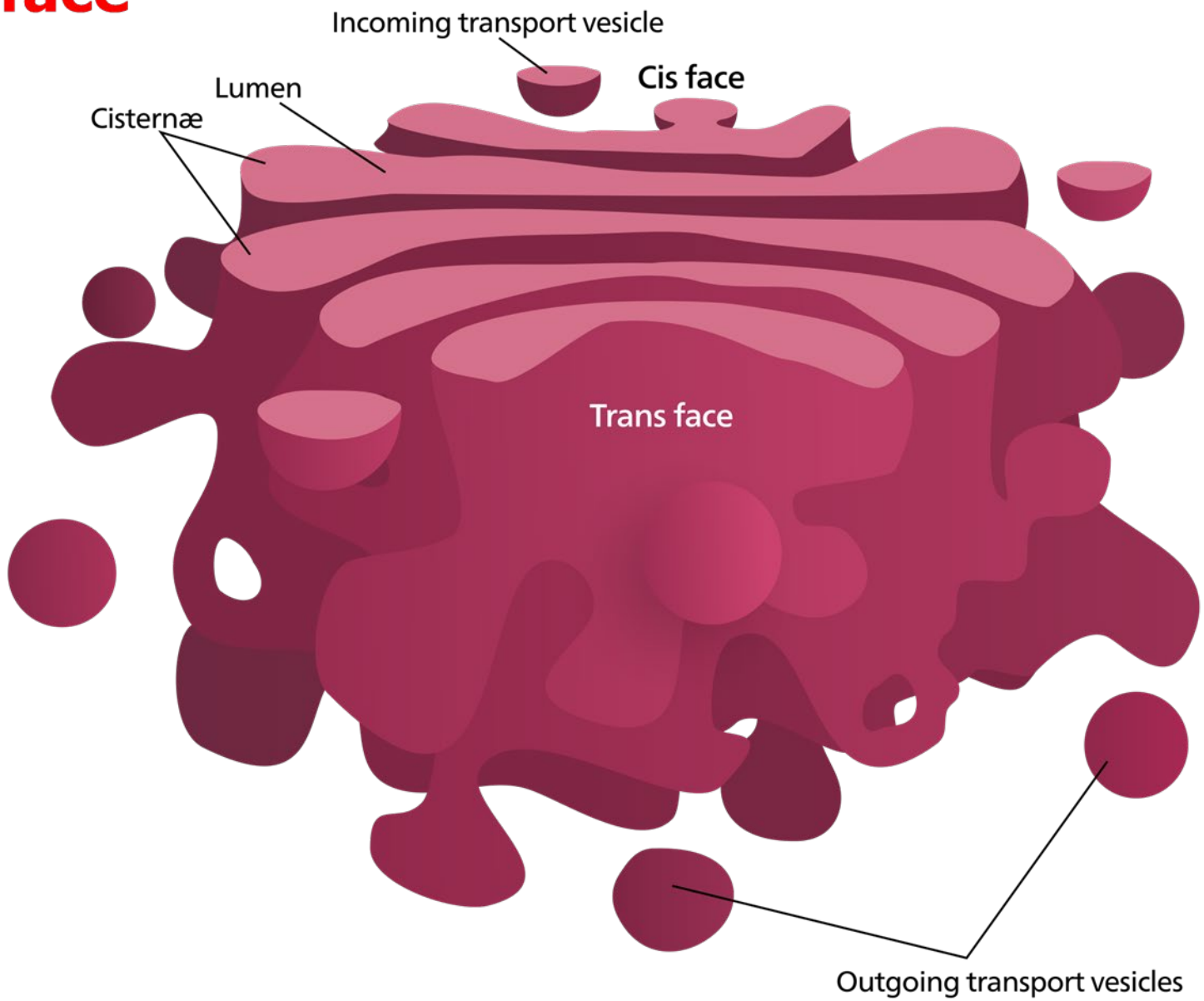
Course – Cell Biology

Golgi Complex

Golgi apparatus

- Golgi complex, Golgi body, Golgi network, or simply the Golgi is an organelle found in most eukaryotic cells.
- First identified in 1897 by Camillo Golgi and named after him in 1898.
- Nobel prize in 1906
- Part of the cellular endomembrane system
- The Golgi apparatus packages proteins inside the cell before they are sent to their destination
- It is particularly important in the processing of proteins for secretion.

ER face


Incoming transport vesicle
Cis face
Lumen
Cisternæ
Trans face
Outgoing transport vesicles

Structure

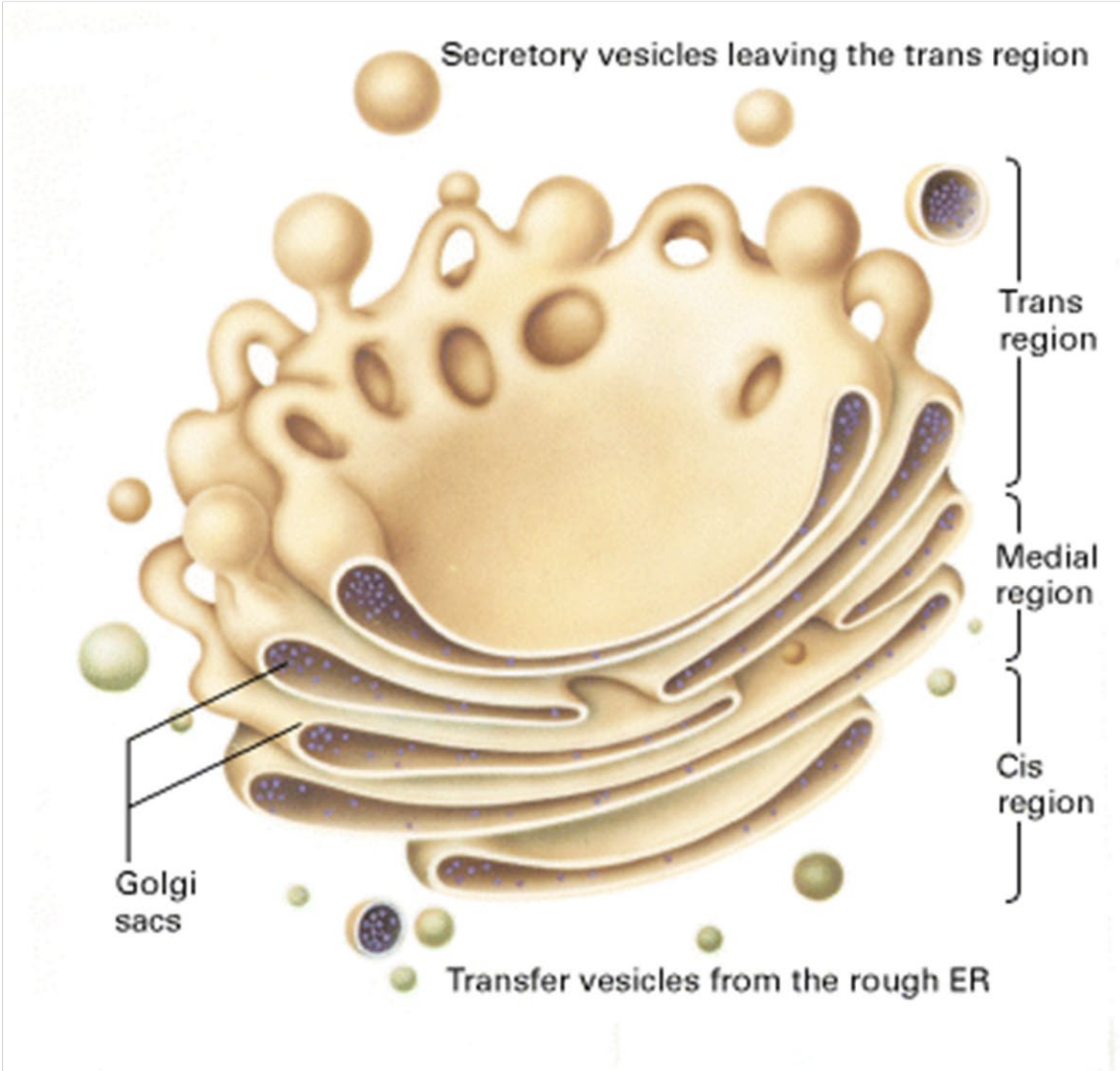
•Golgi is composed of stacks of membrane-bound structures known as cisternae.
•An individual stack is sometimes called a dictyosome especially in plant cells.
•A mammalian cell typically contains 40 to 100 stacks.
•A stack contains usually 4-8 cisternae but variable in prganisms.
•Each cisterna comprises a flat, membrane enclosed disc that includes special Golgi enzymes which modify or help to modify cargo proteins that travel through it.

- The cisternae stacks structure is polarized into sub-compartments
  - cis Golgi
  - cis Golgi network (CGN)
  - medial Golgi
  - trans Golgi
  - trans Golgi network(TGN)

- Vesicles from the endoplasmic reticulum fuse with the network and subsequently progress through the stack to the TGN, where they are packaged and sent to their destination.
- The cisternae also carry structural proteins important for their maintenance as flattened membranes which stack upon each other.

- **Saccles**
- **Tubules**
- **Vesicles**

- Front end : cis face (towards plasma membrane)
- Back end : trans face (towards ER)



Golgi Apparatus – Major Functions

- **transport**
- **sorting**
- **transformation**
- **membrane wrapping**

- The basic function of the Golgi apparatus is the transport of proteins within the cell.
- It functions in the collection, packaging, and distribution of material.
- The Golgi apparatus is integral in modifying, sorting, and packaging these macromolecules for cell secretion (exocytosis) or use within the cell.

- **The Golgi receives materials for transportation through the <u>cis face</u>**
- **<u>Modification</u> of proteins in <u>vesicle</u> form**
- **Transport to the <u>trans face</u>**

Golgi Apparatus – Other Functions

- It primarily modifies proteins delivered from the rough endoplasmic reticulum but is also involved in the transport of lipids around the cell, and the creation of lysosomes.
- Glycosylation (addition of carbohydrates) and phosphorylation (addition of phosphates) takes place by the enzymes within the cisternae.
- The Golgi plays an important role in the synthesis of proteoglycans, which are molecules present in the extracellular matrix of animals.
- It also synthesizes carbohydrate such as glycosaminoglycans (GAGs), long unbranched polysaccharides.
- Another task of the Golgi involves the sulfation of certain molecules passing through its lumen via sulfotranferases. Sulfation is generally performed in the trans-Golgi network.
- The level of sulfation is very important to the proteoglycans' signalling abilities as well as giving the proteoglycan its overall negative charge.
- The Golgi has a putative role in apoptosis, with several Bcl-2 family members localised there, as well as to the mitochondria.

CGN – incoming from ER

- the peptides arrive from the ER in vesicles
- they are N-glycosilated
- no sorting in the ER

Bidirectional transport of proteins:

- soluble, *endogenous proteins of the ER* recycled in transport vesicles

- **retention signal** is required

- sorting and transport of **lysosomal enzymes**

Sorting and modification of lysosomal enzymes

Mannose-6-phosphate (M-6-P) signaling:

- based on the recognition of lysosomal hydrolases
- recognition of the "*signal patches*" (proper 3D combination of amino acids) is required
- main working enzyme: GlcNAc-phosphotransferase

Phosphorylation of the mannoses:

- promotes the sorting of these enzymes
- prevents the further modifications

Glycosilation in the Golgi

Modifications on the *N-glycosilation* pattern

- **cis-Golgi**:
  mannose-type oligosaccharides
  complex oligosaccharides

- **TGN**:
  substitution with **sialic acids** - negatively charged

O-glycosilation:

- takes place mainly in the *medial- and trans-Golgi*
- sidechains of Ser and Thr are glycosilated

Other modifications

- glucose-amino-glycane (GAG) chains
- sulphatation (proteoglycanes, Tyr res. of peptides) - TGN
- proteolytic modifications - secretion vesicle

Main transport pathways from TGN

- endosomal-lysosomal compartment
  via transport vesicles - **M-6-P receptors**

- surface membrane - secretion
  constitutive secretion - transports **lipids** and **peptide**
  components of the surface membrane and the extracellular matrix

- exocytosis
  regulated secretion

Posttranslational Modification - Glycosylation of synthesized proteins in the ER

- Nearly all proteins become glycosylated – glycoproteins
- Glycosylation helps in interaction with other macromolecules
- Glycosylation takes place by addition of highly specific oligosaccharides
- Glycosylation is performed by glycosyltransferase enzyme
- It transfers monosaccharides from nucleotide sugars such as GDP-mannose or UDP-N-acetylglucosamine

DOLICHOL (Dolichol Phosphate):

- Lipid carrier molecules, embedded in the ER membrane
- Sugars/oligosaccharides are added to dolichols
- Then flipped inside lumen by flippase enzyme

Asparagine-linked (N-linked) precursor oligosaccharide

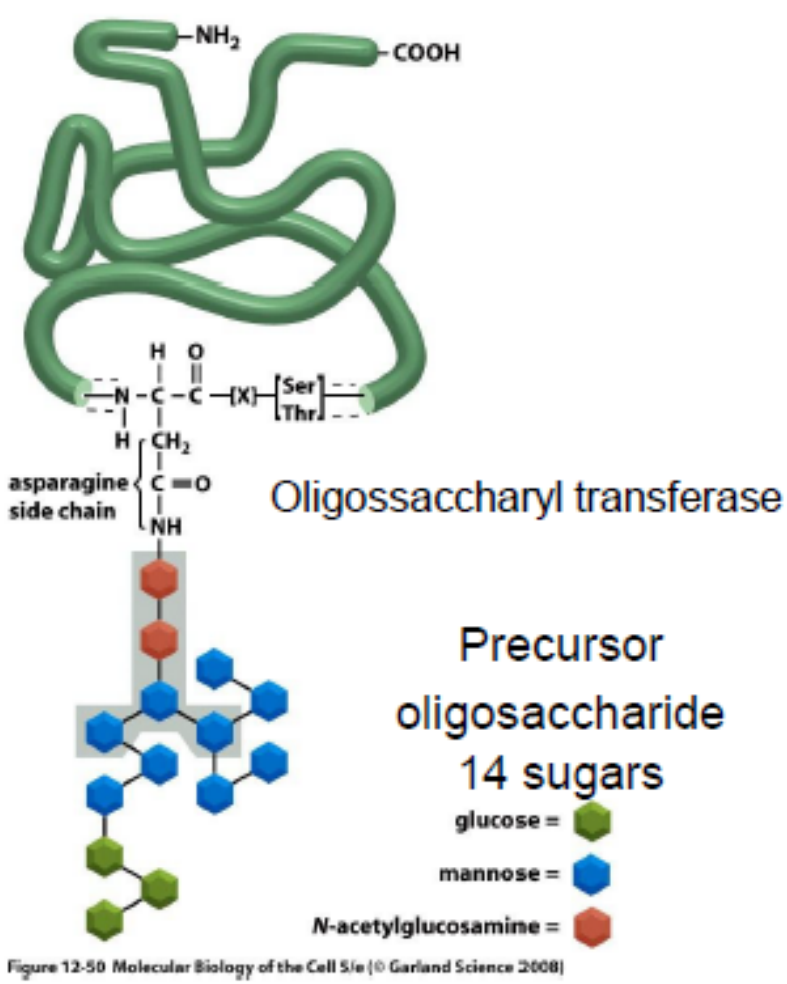


Figure 12-50 Molecular Biology of the Cell 5/e (© Garland Science 2008)

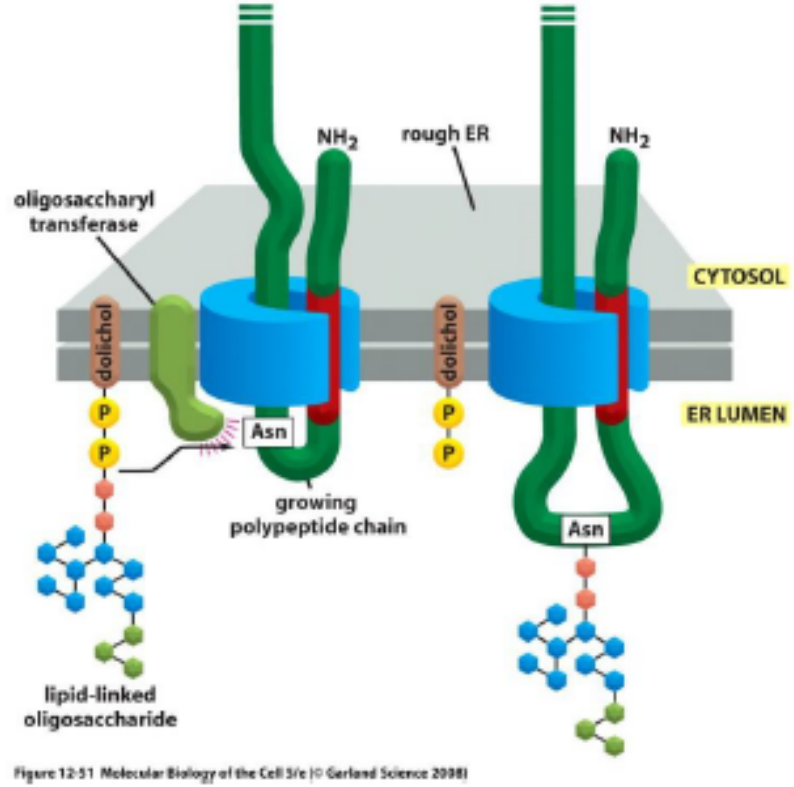


Figure 12-51 Molecular Biology of the Cell 5/e (© Garland Science 2008)

Most proteins in the ER are added to the asparagine-linked (N-linked) precursor oligosaccharide

Synthesis starts in the cytosol and ends in lumen

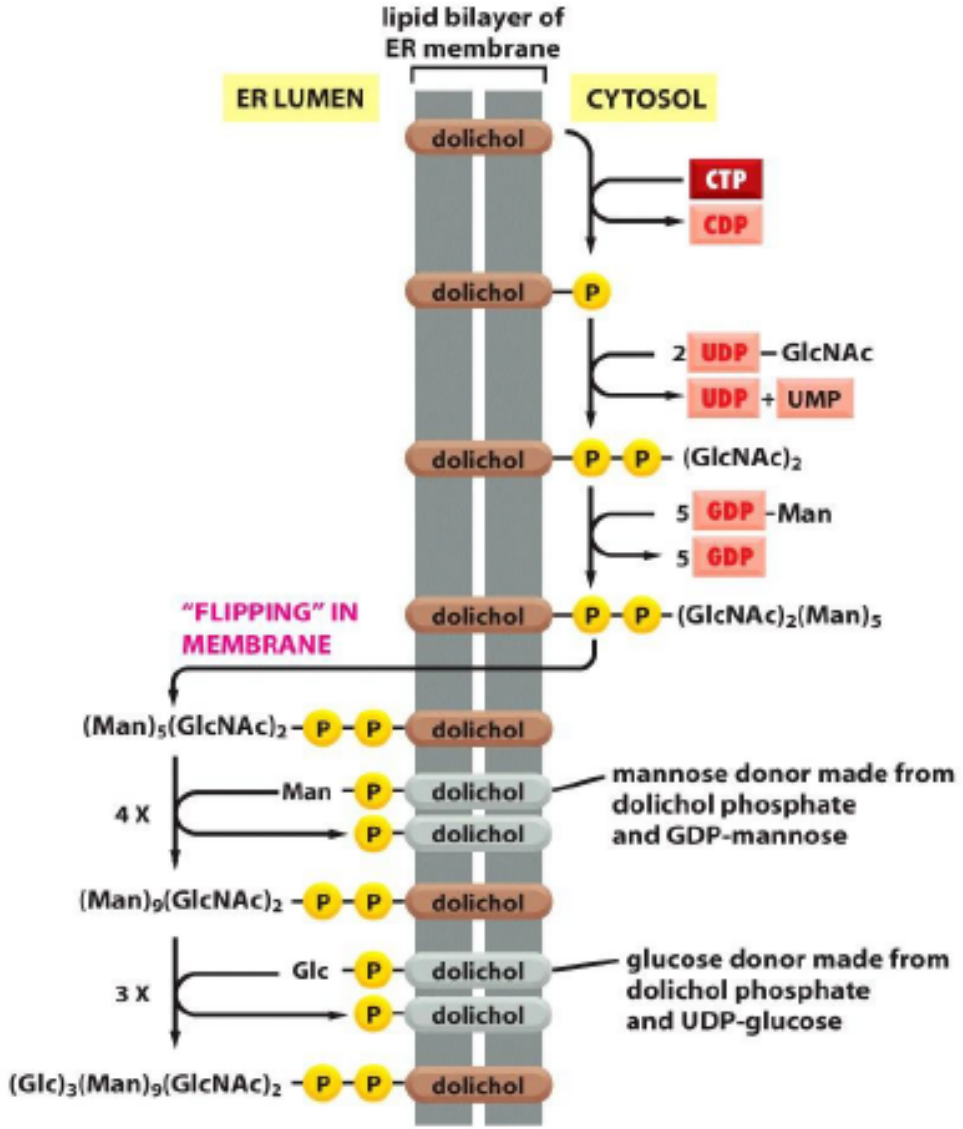


Figure 12-52 Molecular Biology of the Cell 5/e (© Garland Science 2008)

- Synthesis starts in the cytosol and ends in lumen
- Lipid intermediate is flipped across the bilayer by a transporter
- Oligosacchides are used as tags to mark the state of protein folding
- Improperly folded proteins are exported from the ER and degraded in the cytosol

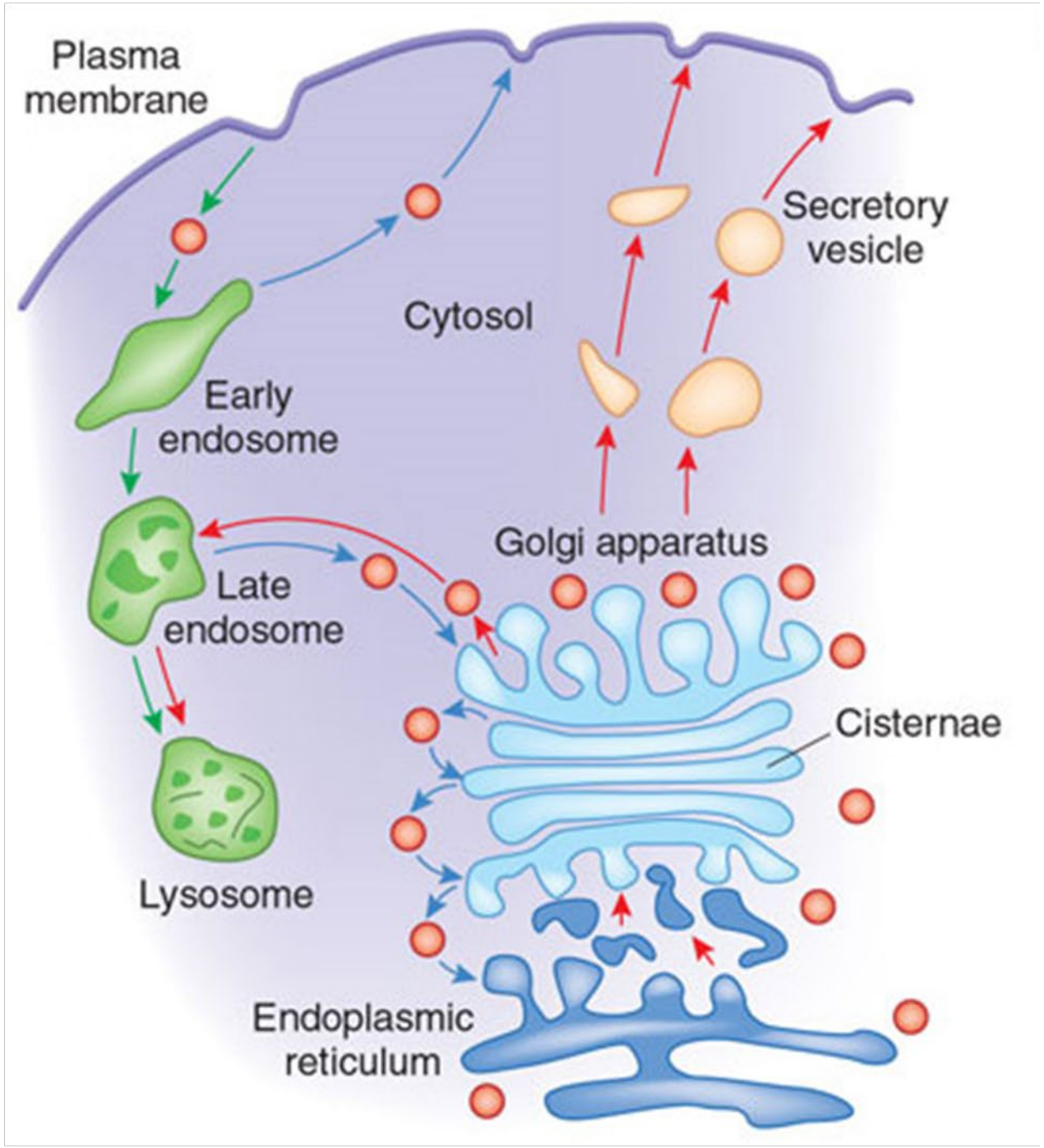
Vesicular Trafficking through Golgi and Protein Sorting

The Golgi, a curved membrane stack resembling a stack of pancakes, concentrates and packages proteins for export or storage. It also adds directions for the destination of the protein package. Proteins made within the rough ER bud off in vesicles and are transported to the Golgi where the vesicles fuse with the membrane and the components are further modified. It needs help of Endosomes.

Vesicular Trafficking Golgi

Three Pathways:

- **Endocytic:** illustrated in green arrows
- **Biosynthetic-secretory:** illustrated with red arrows
- **Retrieval**: illustrated with blue arrows



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