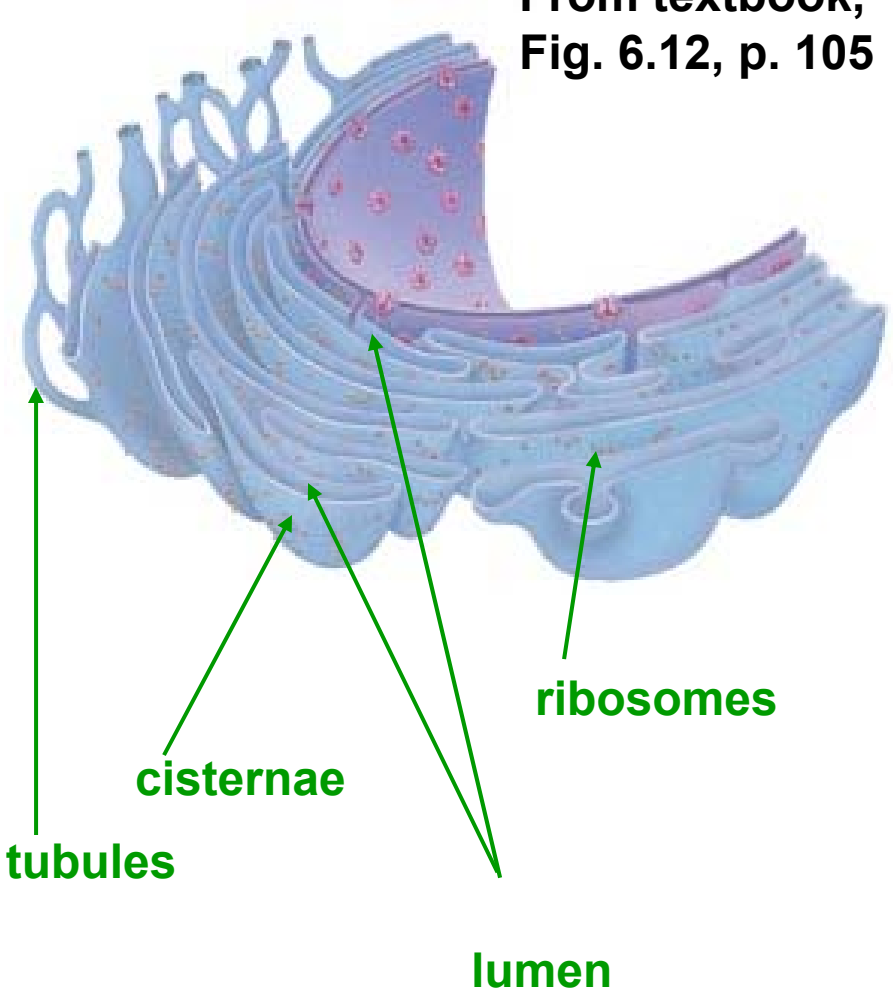
BIO 311C
Spring 2010

You are responsible for all reading assignments, even when the reading material goes beyond the lecture information.

Lecture 5 – Friday 29 Jan. 2010

Rough Endoplasmic Reticulum (r.e.r.)

From textbook,
Fig. 6.12, p. 105



The membrane of endoplasmic reticulum is continuous with the outer membrane of the nuclear envelope.

The lumen of the endoplasmic reticulum is continuous with the intermembrane space of the nuclear envelope.

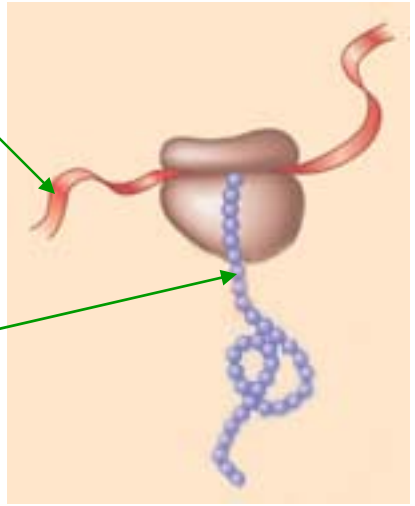
Rough e.r. does not appear smooth in electron micrographs as do most membranes, because of ribosomes that are attached to the cytoplasmic surface of its membranes.

A cisterna (plural cisternae) is a flattened membrane enclosing a space.

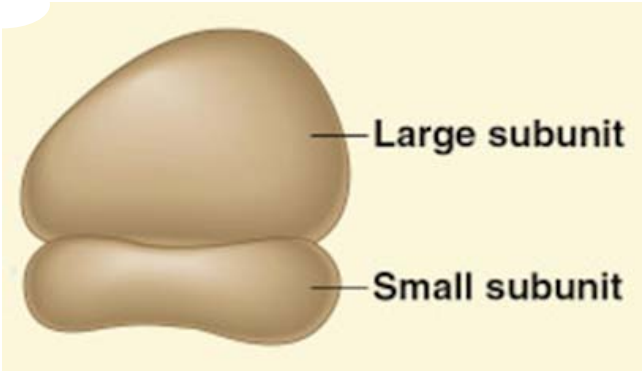
*

The Ribosome is the Site of Synthesis of Polypeptide Chains

Proteins are polypeptide chains that have coiled and folded into a functional unit.



Polypeptide chain being produced on a ribosome



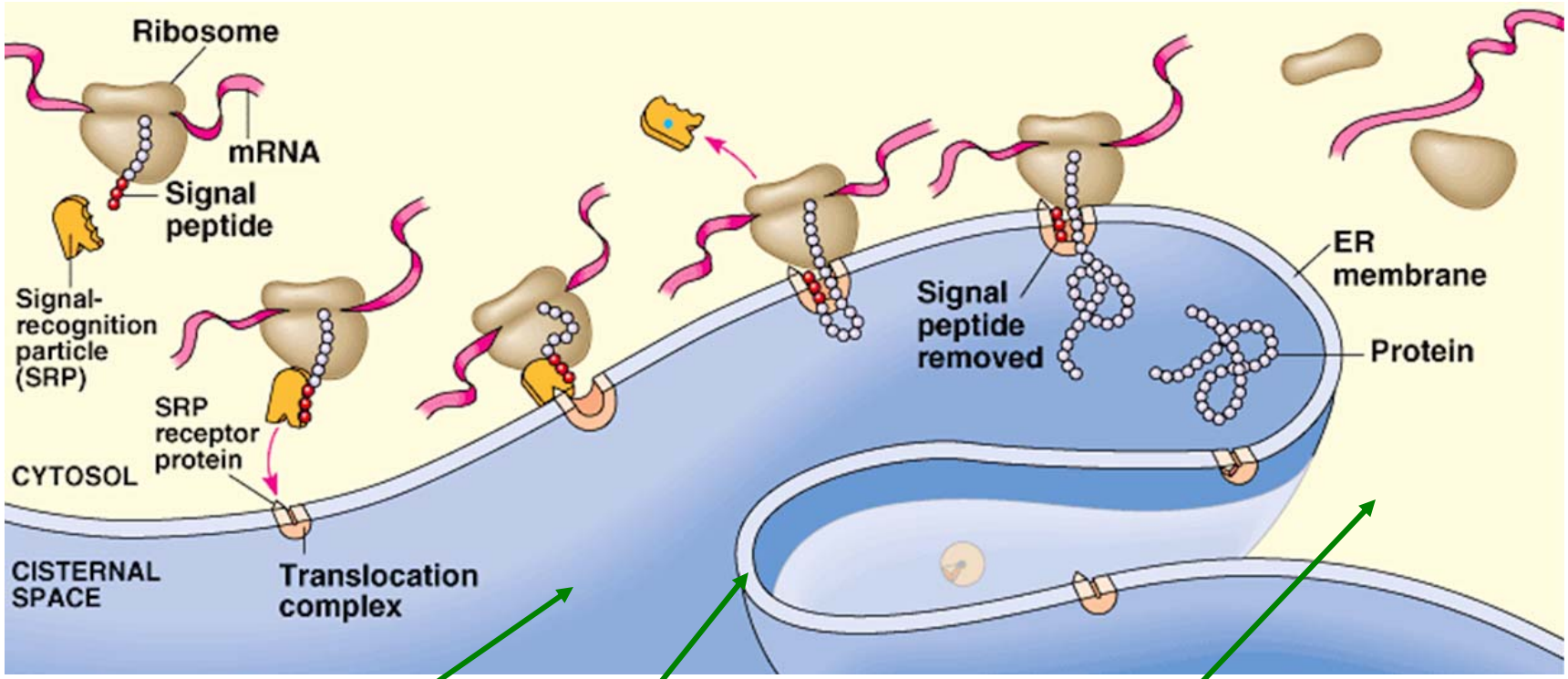
Ribosome

The polypeptide chain grows in length, one amino acid at a time, as the mRNA slides along the ribosome. It then folds into a 3-dimensional shape that converts it into a functional protein.

*

Insertion of Polypeptide Chains into the Endoplasmic Reticulum

From textbook Fig. 17.21, p. 343



lumen

membrane of rough e.r.

cytoplasmic matrix

*

Endoplasmic reticulum (e.r.)

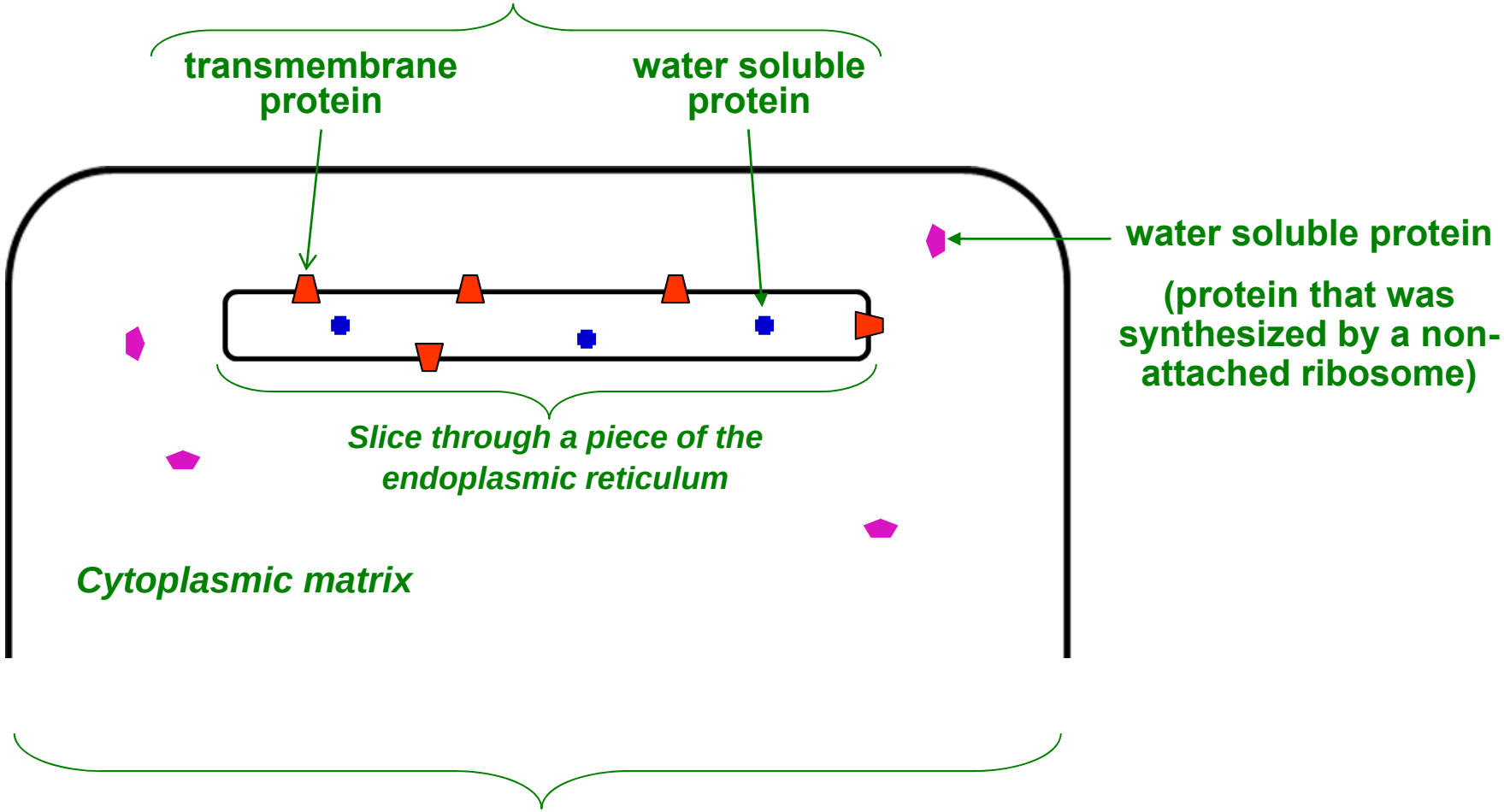
Ribosomes that are attached to the endoplasmic reticulum and the outer surface of the plasma membrane are used to synthesize:

- **some water-soluble proteins that are deposited in the intermembrane space;**
- **some water-insoluble proteins that become integral components of the membrane.**

*

Compartmentalization of Proteins by Eukaryotic Cells

proteins that were synthesized by ribosomes attached to endoplasmic reticulum or the outer membrane of the nuclear envelope.



*

Functions of the Rough Endoplasmic Reticulum

Insertion of proteins into the fabric of the e.r. membrane or into the lumen for:

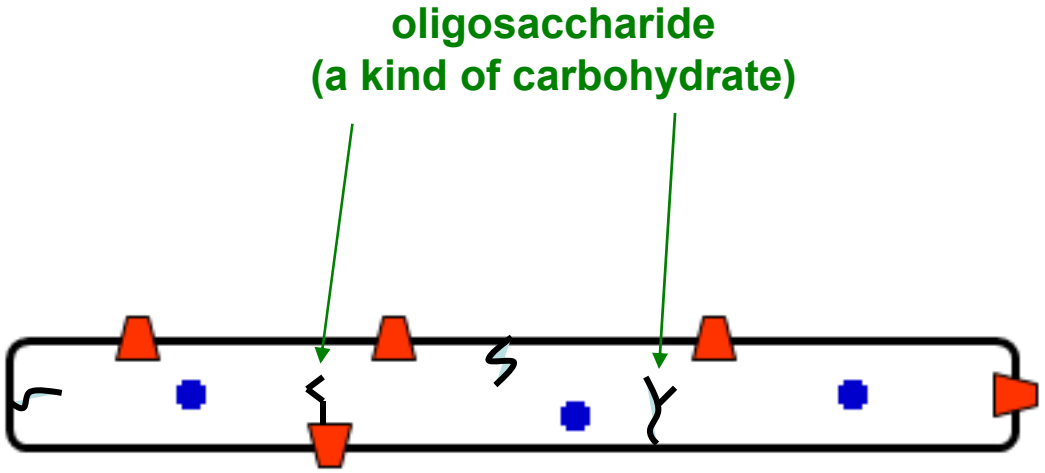
- **constructing new membrane,**
- **processing (chemical modification),**
- **transport to other membrane-bounded organelles,**
- **transport out of the cell.**

Synthesis of lipids and their insertion into the e.r. membrane.

Attachment of small carbohydrates called oligosaccharides to the lumen surface of the e.r. membrane.

The e.r. membrane constantly expands as proteins and lipids are synthesized and inserted into the e.r. membrane.

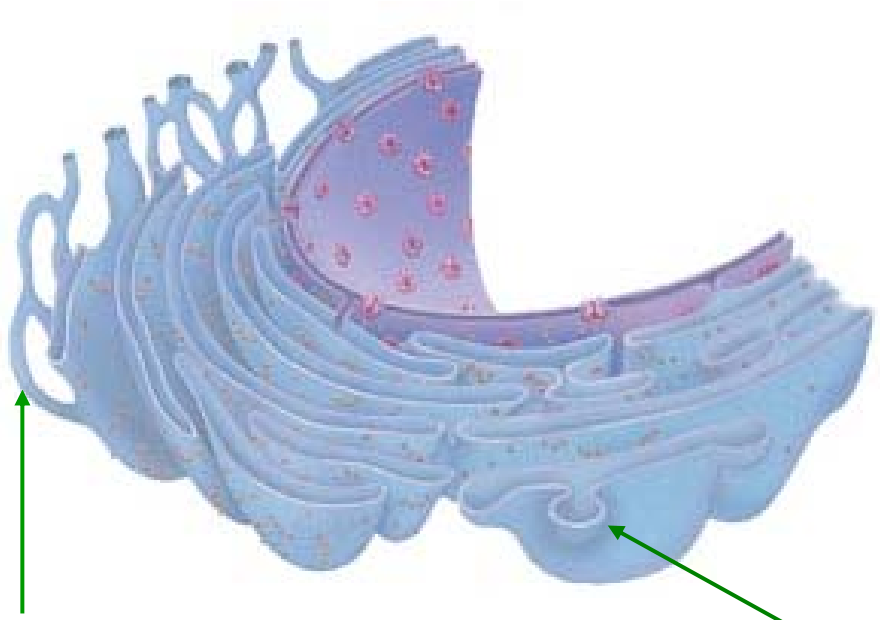
*



Oligosaccharides are attached to only the inner (luminal) face of the endoplasmic reticulum.

*

Smooth Endoplasmic Reticulum (s.e.r.)



s.e.r. (tubules)

vesicle that is forming from endoplasmic reticulum = transitional e.r.

The s.e.r. in some cells occurs only as slight extensions of the r.e.r. that are in the process of forming vesicles. Those small extensions are then called “transitional endoplasmic reticulum”.

*

Functions of the Smooth Endoplasmic Reticulum

Processing (chemically modifying) previously synthesized membrane and lumen proteins

Continued synthesis and incorporation of lipids into the e.r. membrane

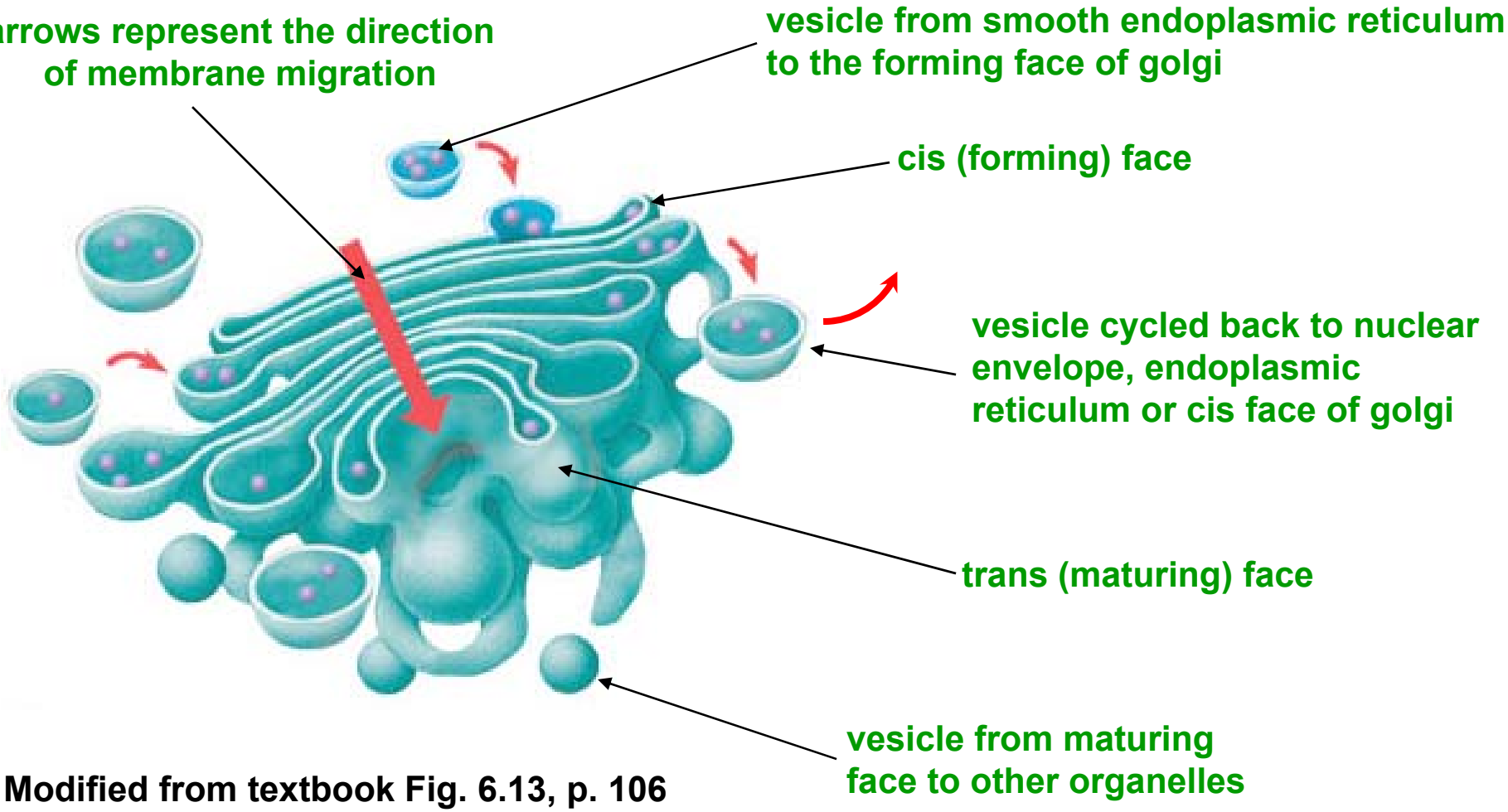
Detoxification of some kinds of toxic organic molecules (such as those with benzene rings) by chemically modifying them

Continued attachment of oligosaccharides (small carbohydrates) to the lumen surface of membrane proteins and lipids

Processing of the carbohydrates that were previously attached to the lumen surface of membrane proteins and lipids

*

A Golgi Body

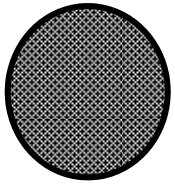


Modified from textbook Fig. 6.13, p. 106

*

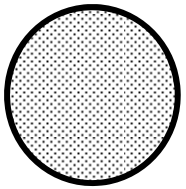
Terminology Cell Biologists use to Describe Types of Membrane Structures in Eukaryotic Cells

A vesicle is a spherical cellular organelle surrounded by a single membrane that contains enzymes and performs metabolic functions. A lumen is separated from the cytoplasmic matrix by the vesicle membrane.



vesicle
(active metabolism)

A vacuole is a spherical cellular organelle surrounded by a single membrane that contains few if any enzymes and does not perform many metabolic functions. A lumen is separated from the cytoplasmic matrix by the vacuolar membrane.

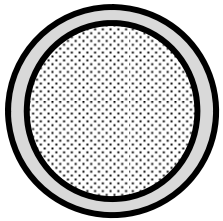


vacuole
(storage)

A cisternae is a flattened vesicle, so the lumen space is very narrow.

cisterna
(flattened)

An envelope is a pair of concentric membranes that enclose a space between the two membranes called the intermembrane space or periplasmic space.



envelope
(membrane pair)

*

Functions of the Golgi

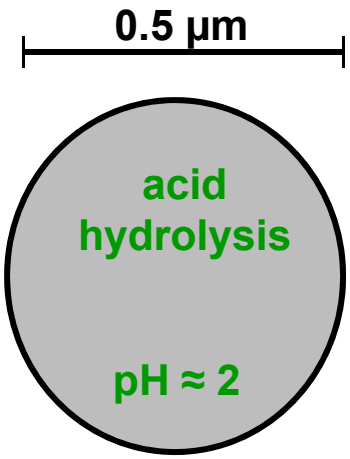
Modification of carbohydrates that were previously attached to proteins and lipids on the lumen surface of the cisternae

Packaging of luminal proteins into forms suitable for their final destination (e.g. to another membrane-bounded organelle or exported from the cell)

Sorting of components within the membrane and in the lumen so that each component can be a part of the right vesicle and targeted to its correct final destination

*

Lysosomes

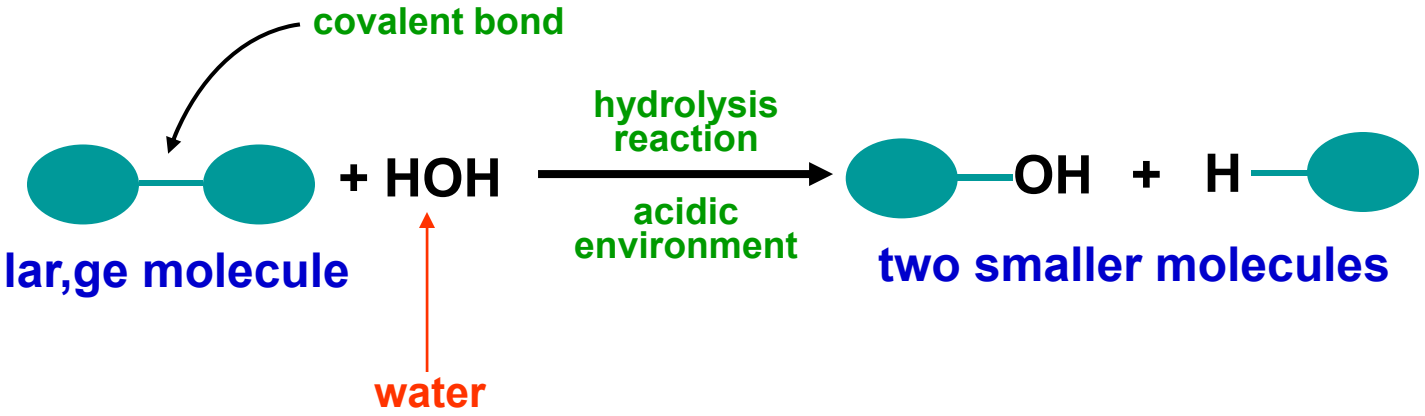


- They are vesicles, approximately 0.5 µm in diameter, that are derived from the golgi.

- The inner surface of their membrane is lined with protective carbohydrate.

- The lumen is acidic and is filled with hydrolytic enzymes that function at acid pH values (acid hydrolases).

The acid hydrolases are capable of hydrolyzing practically all large molecules found in living cells, including those from which cells are constructed.



*

The acid hydrolysis enzymes in lysosomes are so diverse in function that together they can destroy virtually every kind of large organic molecule that occurs within the cell. Thus, they are capable of destroying every structure of the cell, including membranes.

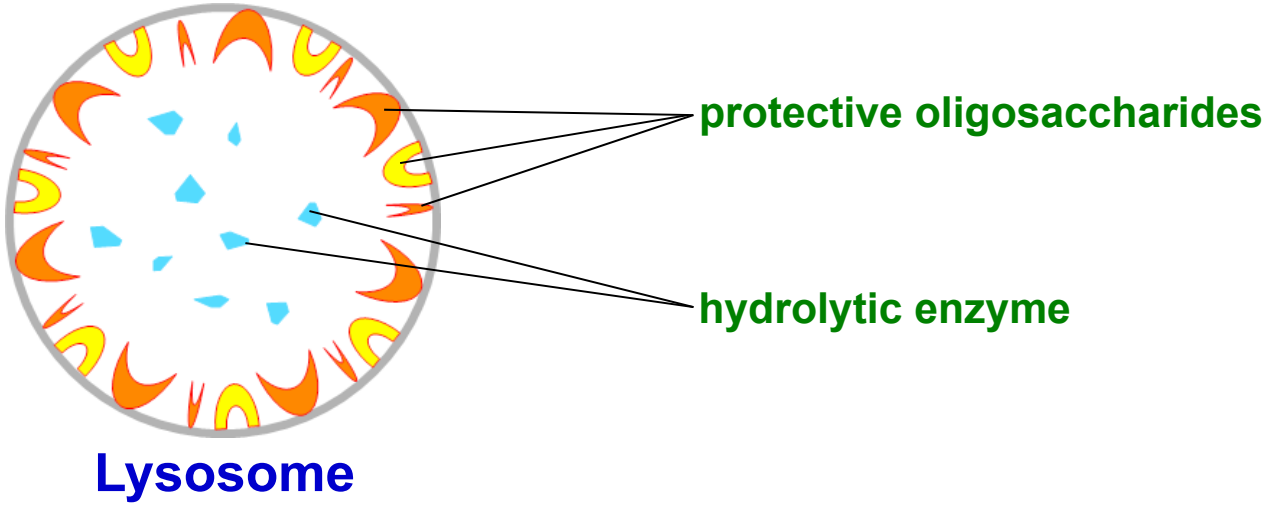
Questions for consideration:

1. **Why don't the hydrolytic enzymes contained in lysosomes destroy the lysosome membrane and escape into the cytoplasmic matrix, then destroy cell components?**

2. **Why would a cell produce an organelle of such destructive power that it could destroy the cell that contains it?**

*

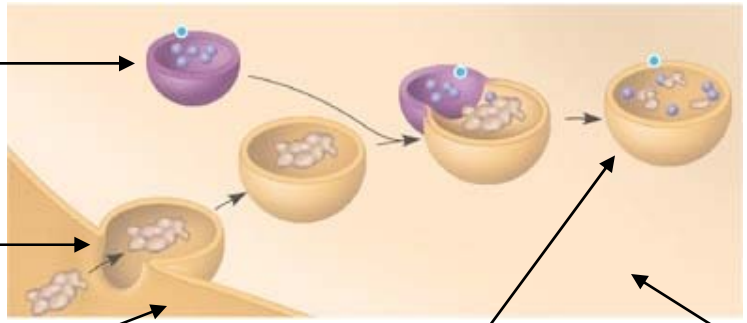
Illustration of the Protective Coating of Carbohydrate on the Inner Surface of a Lysosome



*

Examples of Lysosome Functions

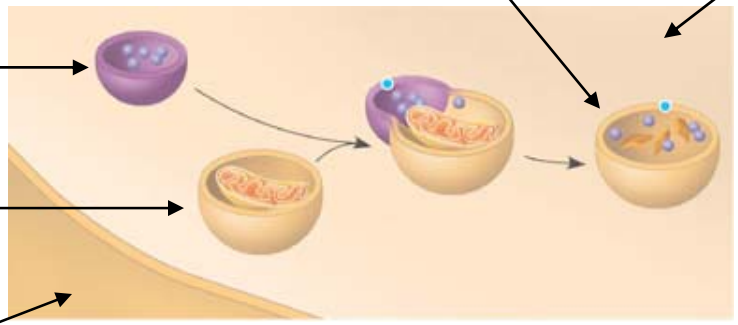
From textbook Fig. 6.14, p. 107



Ingestion of food for Intracellular digestion

secondary lysosome

Inside cell



Autophagy

*

Functions of Lysosomes

Intracellular digestion

Destruction of bacteria, other pathogens and toxins

Recycling of worn-out organelles and occlusions

Tissue development in complex multicellular organisms

Autolysis (breakdown of cellular components) after the cell dies

*