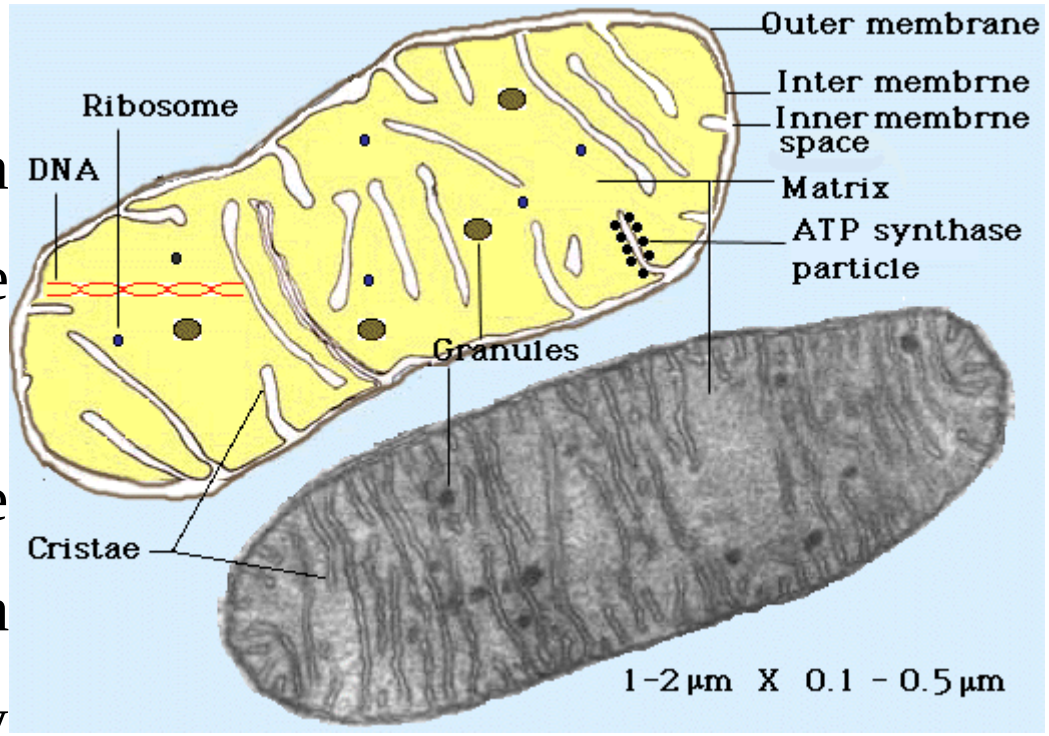
Mitochondria, endoplasmic reticulum, Golgi apparatus, lysosoma, vesicular transport

Mitochondria

Mitochodria have originated from a symbiosis: a nucleated cell engulfed an aerobic prokaryote.

The internated cell came to rely on the protective environment of the host cell.

The host cell came to rely on the prokaryote for energy production which used oxygen to create energy and became critical to eukaryotic evolution.

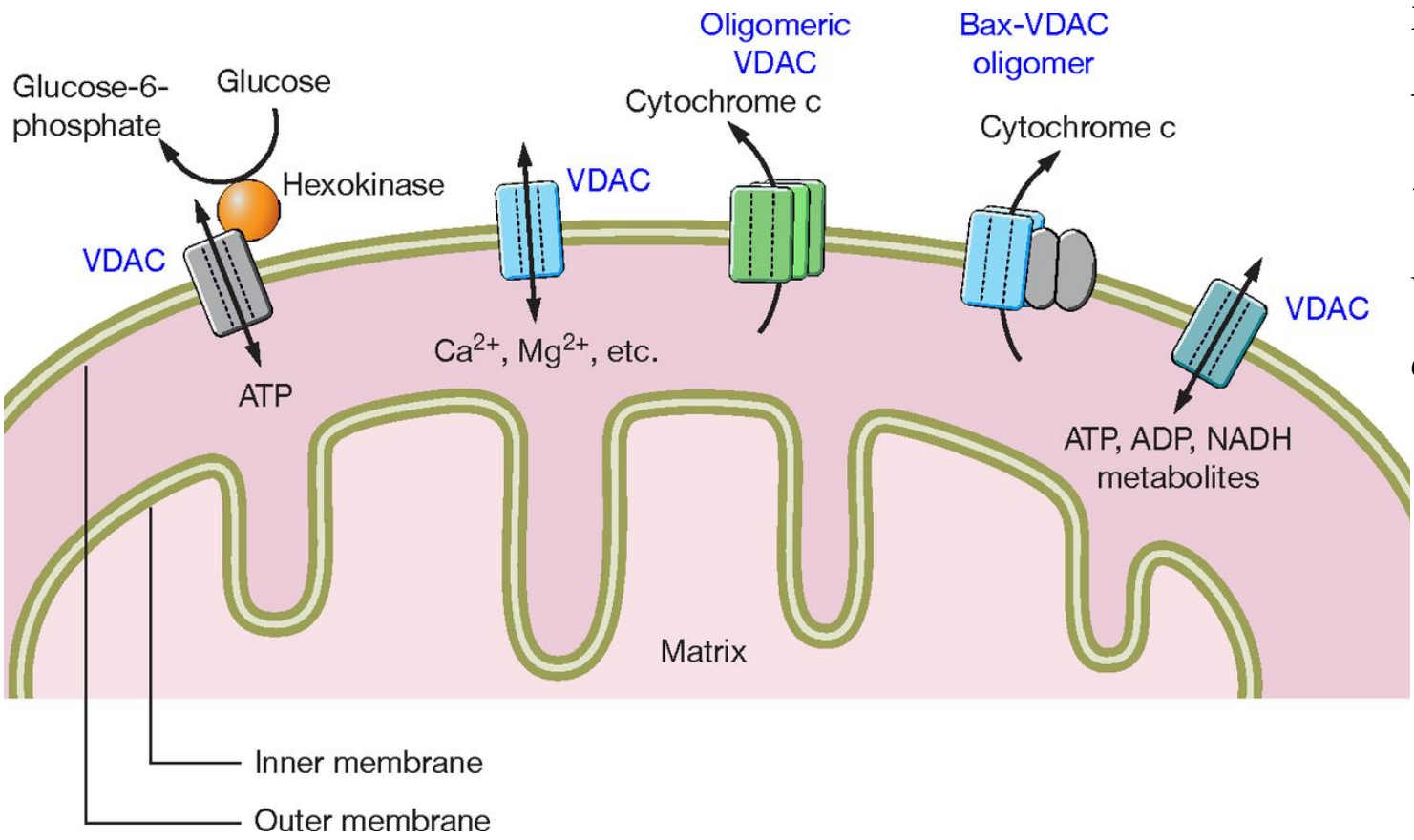


Functions of mitochondrial membranes and spaces

Outer mitochondrial membrane:

protein-based pores: allow the passage of ions and small proteins.

These channels are important for energy supply by the mitochondria and have a major impact on the fate of the entire cell as well.



VDAC:

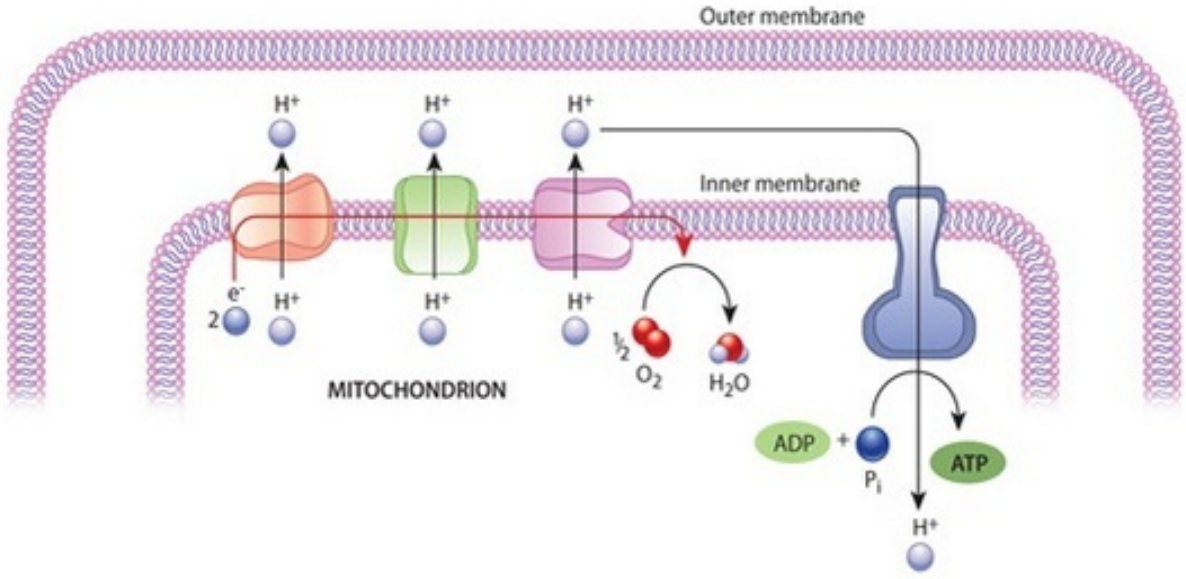
voltage-dependent anion channel

Intermembrane space:

Between the inner and outer membranes.

Inner mitochondrial membrane:

Restricted permeability, like the plasma membrane of a cell.

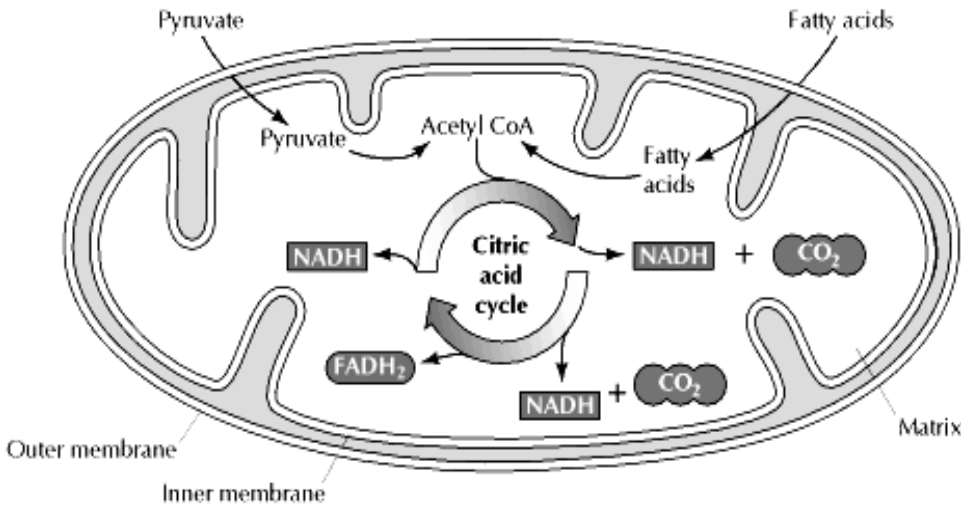


Proteins of the electron transport for oxidative phosphorylation and ATP synthesis.

Mitochondrial matrix:

Citric acid cycle produces the electrons.

During electron transport, the participating protein complexes push protons from the matrix out to the intermembrane space. This creates a concentration gradient of protons that ATP synthesise, uses to power synthesis of the energy carrier molecule ATP.



Mithocondrial genom:

genes include rRNA, tRNA genes, genes that encode proteins involved in electron transport and ATP synthesis.

Mitochondrial proteins are mainly synthesised from nuclear genes: enzymes required for the citric acid cycle, proteins involved in DNA replication and transcription, and ribosomal proteins.

The protein complexes of the respiratory chain are a mixture of mitochondrial proteins and proteins encoded by nuclear genes.

Newly synthesised, unfolded proteins are transported from the cytoplasm via the two membranes into the matrix, where folding ensues.

Reproduction:

These organelles replicate by dividing in two.

They are constantly dividing, fusing, and changing shape: a single mitochondrion may contain multiple copies of its genome at any given time.

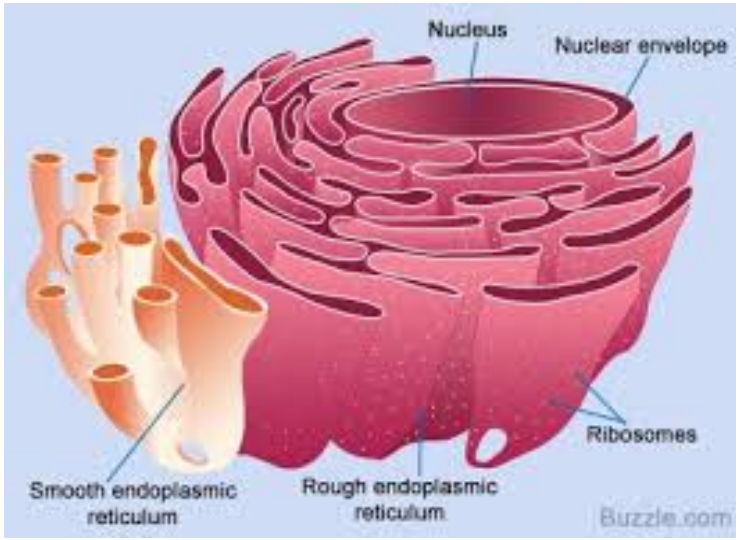
They multiply when a the energy needs of a cell increase: repeatedly stimulating a muscle cell will spur the production of more mitochondria in that cell. Cells with an increased need for energy contain greater numbers of these organelles than cells with lower energy needs.

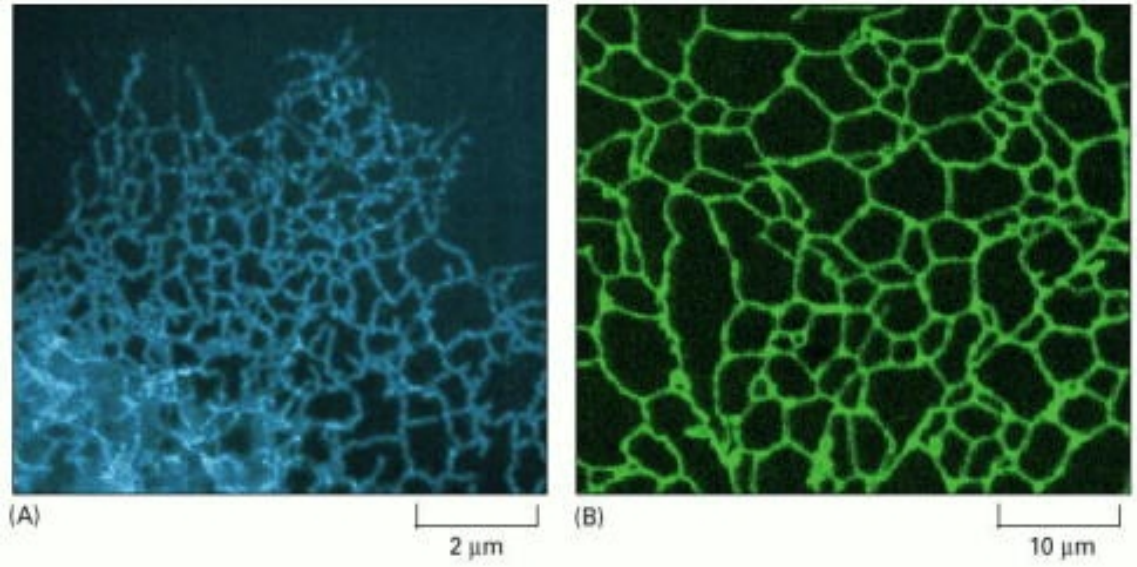
Endoplasmic reticulum:

Typically constitutes more than half of the total membrane of an average animal cell (exceptions: spermium, adipose cells)

The ER is organized into a netlike labyrinth of branching tubules and flattened sacs extending throughout the cytosol.

The ER membrane forms a continuous sheet enclosing a single internal space, the *ER cisternal space.*



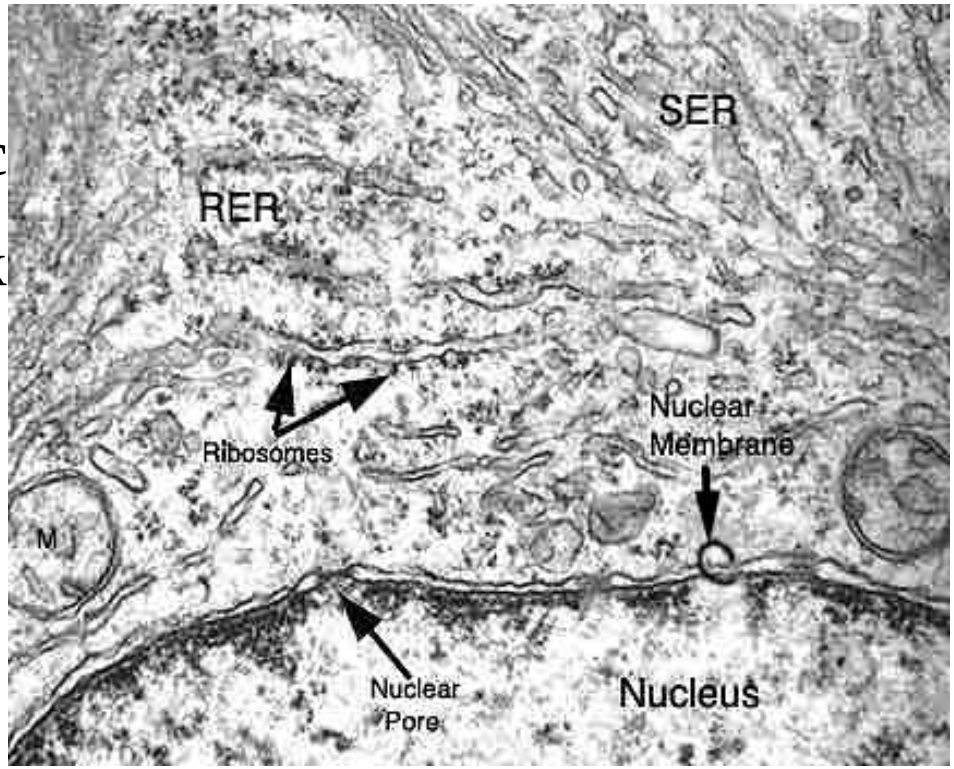


Central role in protein and lipid biosynthesis.

In most eucaryotic cells sequester Ca^{2+} from the cytosol.

RER (rough endoplasmic reticulum): Membrane-bound Ribosomes Define the Rough ER

SER (smooth endoplasmic reticulum): Regions of ER that lack bound ribosomes



Functions:

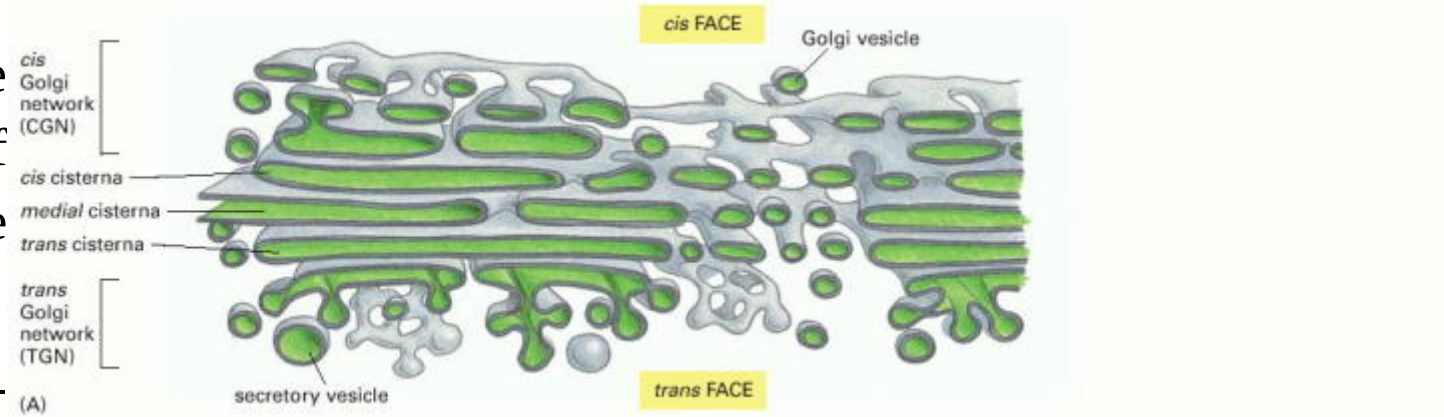
The membrane of the RER is the site of production of all the transmembrane proteins and lipids for most of the cell's organelles (the ER itself, Golgi apparatus, lysosomes, endosomes, secretory vesicles, plasmamembrane).

SER: steroid synthesis, production of lipoprotein particles,

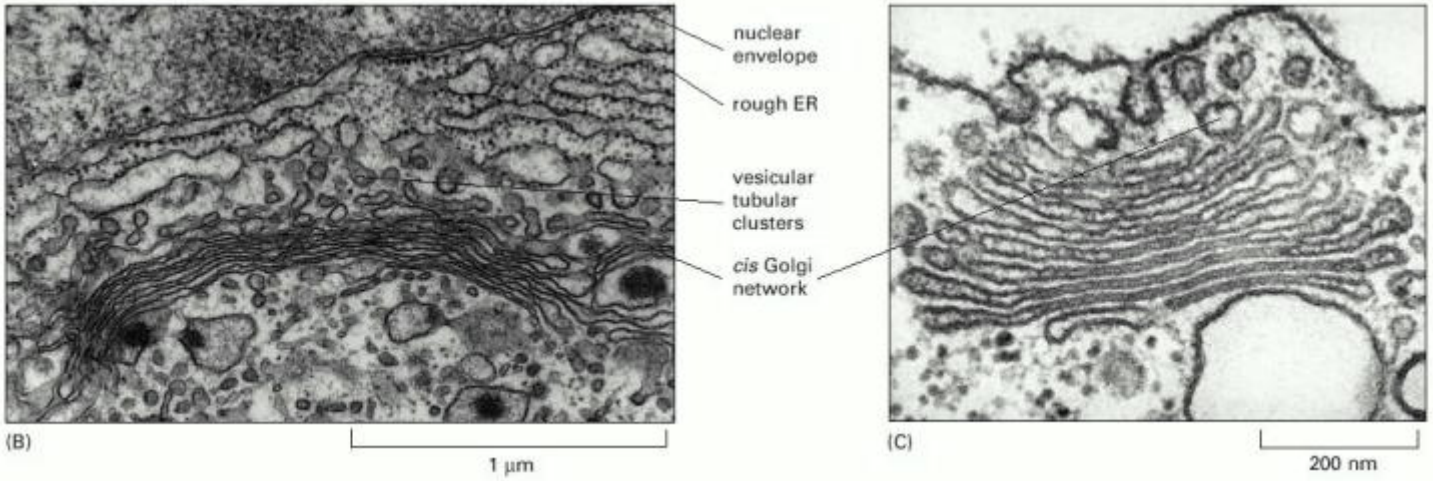
Muscle cells have an abundant specialized smooth ER, called the sarcoplasmic reticulum, which sequesters Ca^{2+} from the cytosol by means of a Ca^{2+}-ATPase that pumps in Ca^{2+} into its lumen. The release and reuptake of Ca^{2+} by the sarcoplasmic reticulum trigger the contraction and relaxation of the myofibrils during muscle contraction.

Golgi apparatus:

Its structure is made of flaps of membranes which are also called, Cisternae.



The electron microscopic studies have revealed that it consists of series of compactly grouped smooth contoured membrane limited vesicles of variable shapes and dimensions and variable number of small vacuoles



Functions:

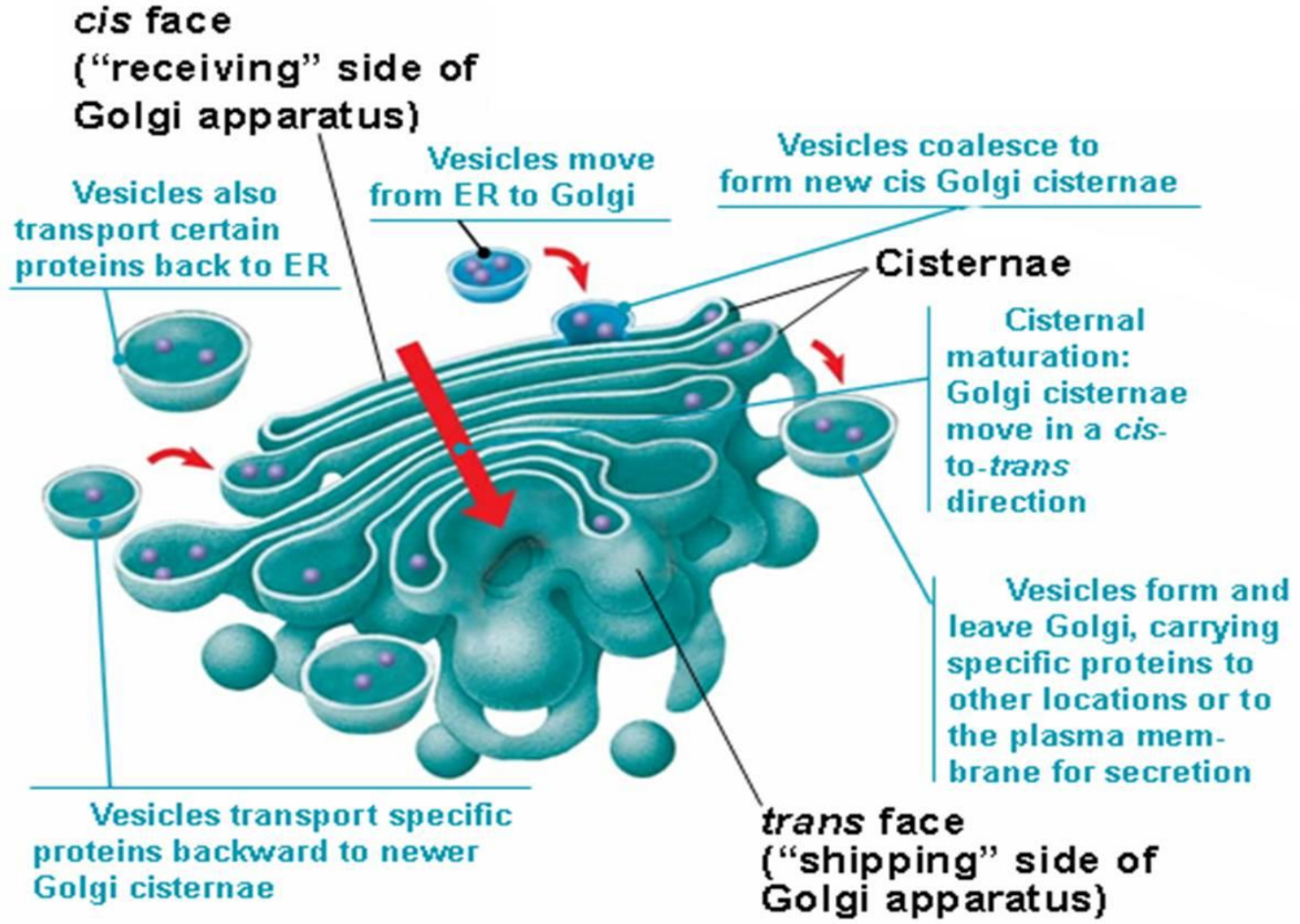
It helps the cells to transport proteins: processes the proteins that are sent from the ER.

It transports lipids that the cell may need.

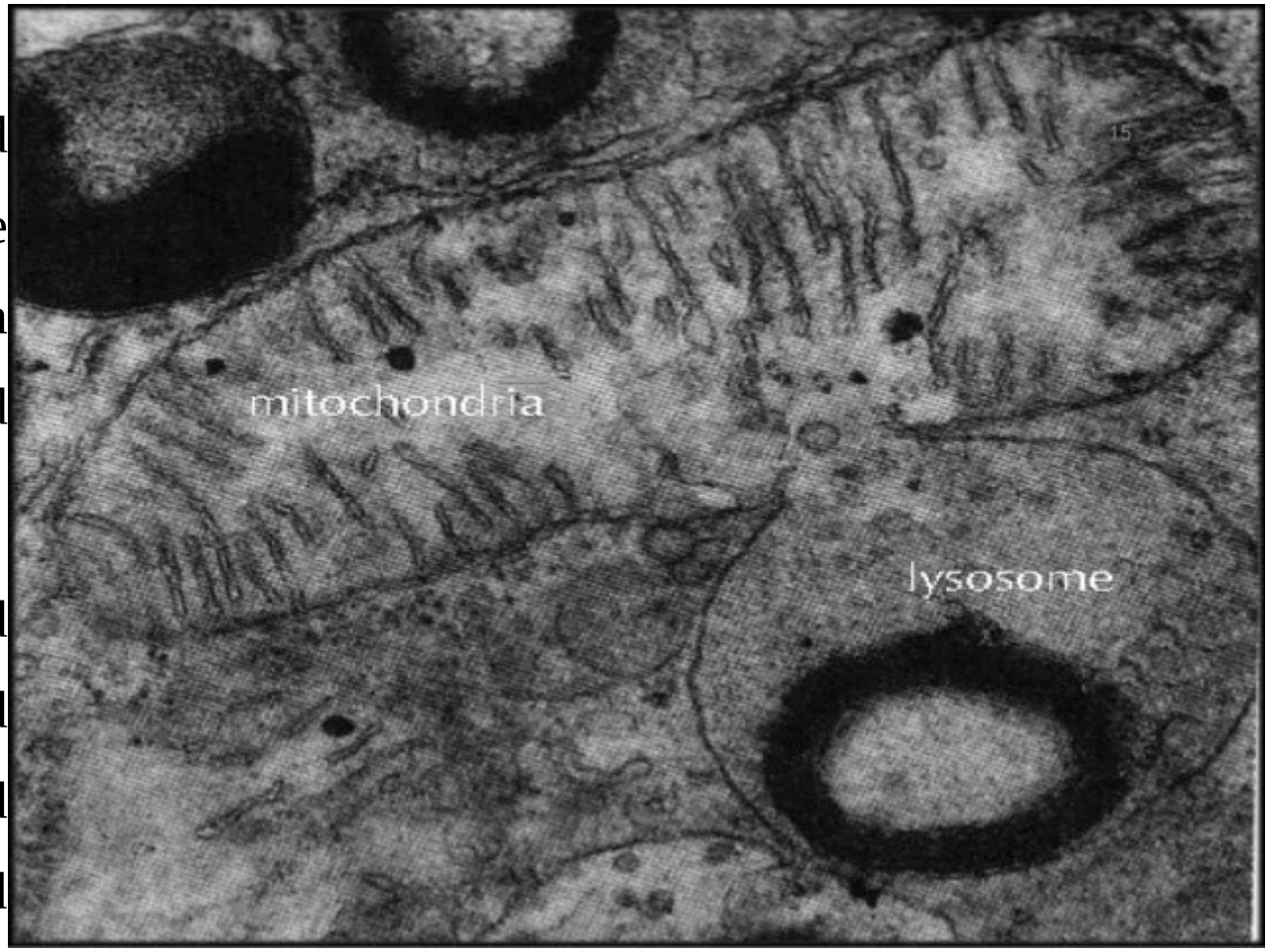
It produces glycosaminoglycans to form proteoglycans, (in connective tissue).

Its usual occurrence is in the secretory cells.

It plays a crucial role in the prevention of apoptosis.



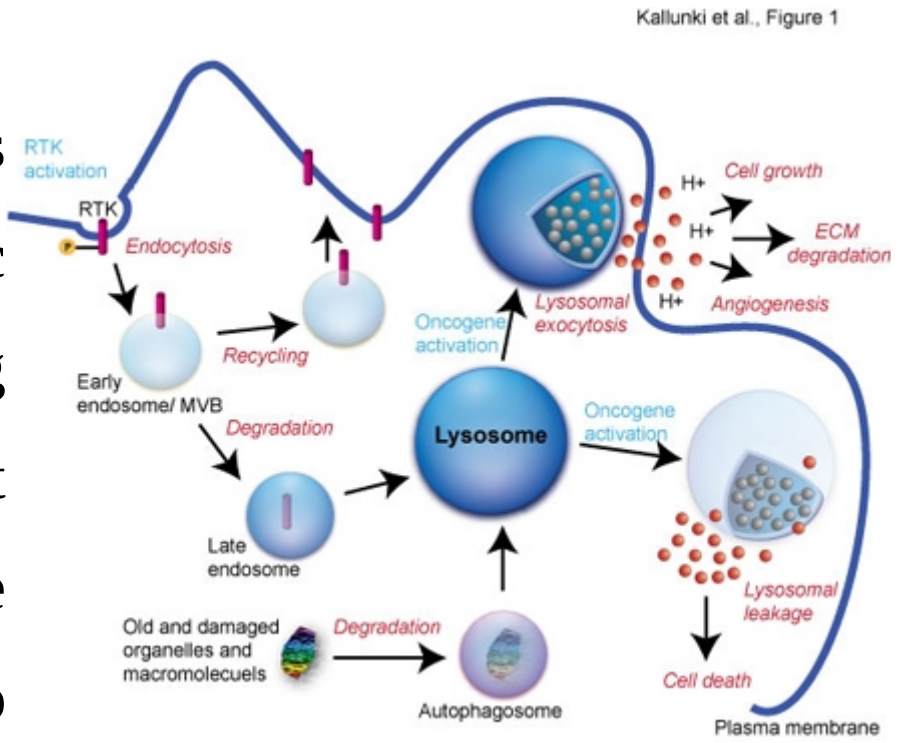
Lysosome:



Lysosomes are membrane-bound organelles containing digestive enzymes that can break down proteins, lipids, carbohydrates and nucleic acids.

Lysosomes vary in size and shape, they break down food particles, destroy bacteria and viruses that enter the cell, and recycle cellular components as organelles age. Main enzymes: hydrolytic enzymes, which are active at the acidic pH maintained by proton pumps found in lysosomal membranes.

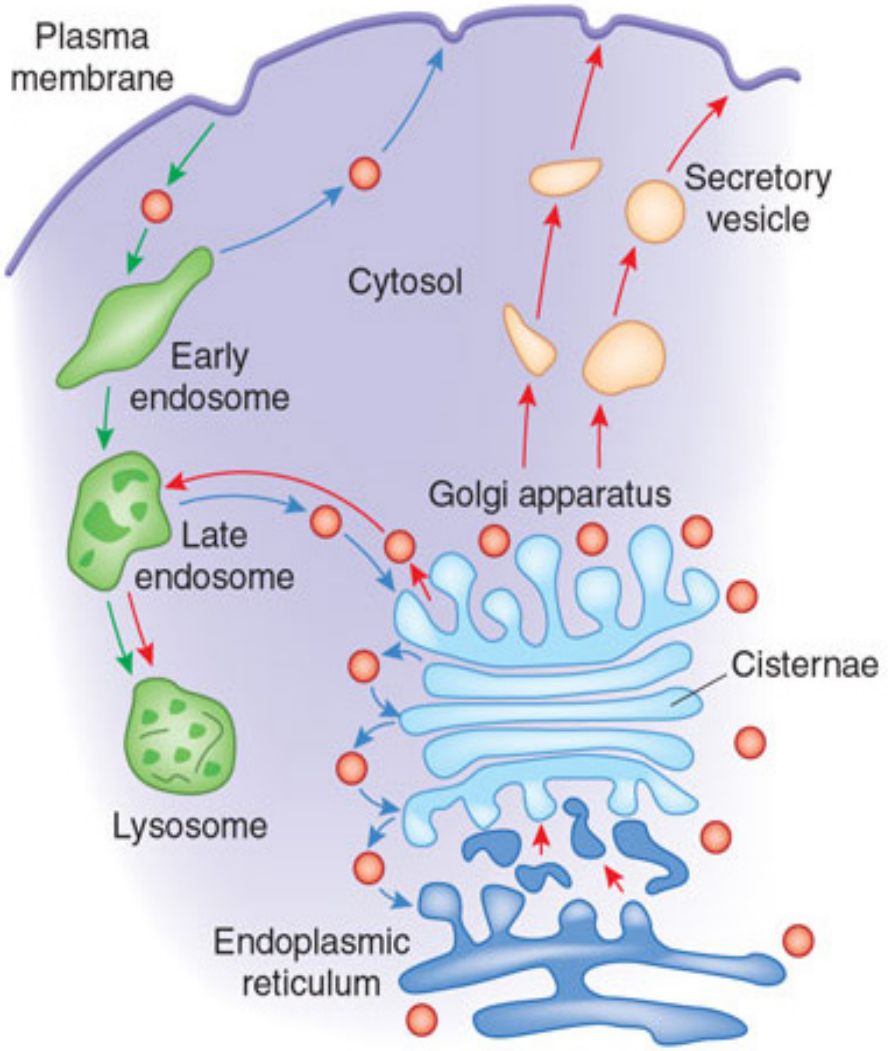
Lysosomes are formed by the fusion of vesicles that have budded off from the trans-Golgi.



The sorting system recognizes address sequences in the hydrolytic enzymes and directs them to growing lysosomes. In addition, vesicles that bud off from the plasma membrane via **endocytosis** are also sent to lysosomes, where their contents are processed. The endocytosis is a reverse vesicle trafficking, it plays an important role in nutrition and immunity as well as membrane recycling.

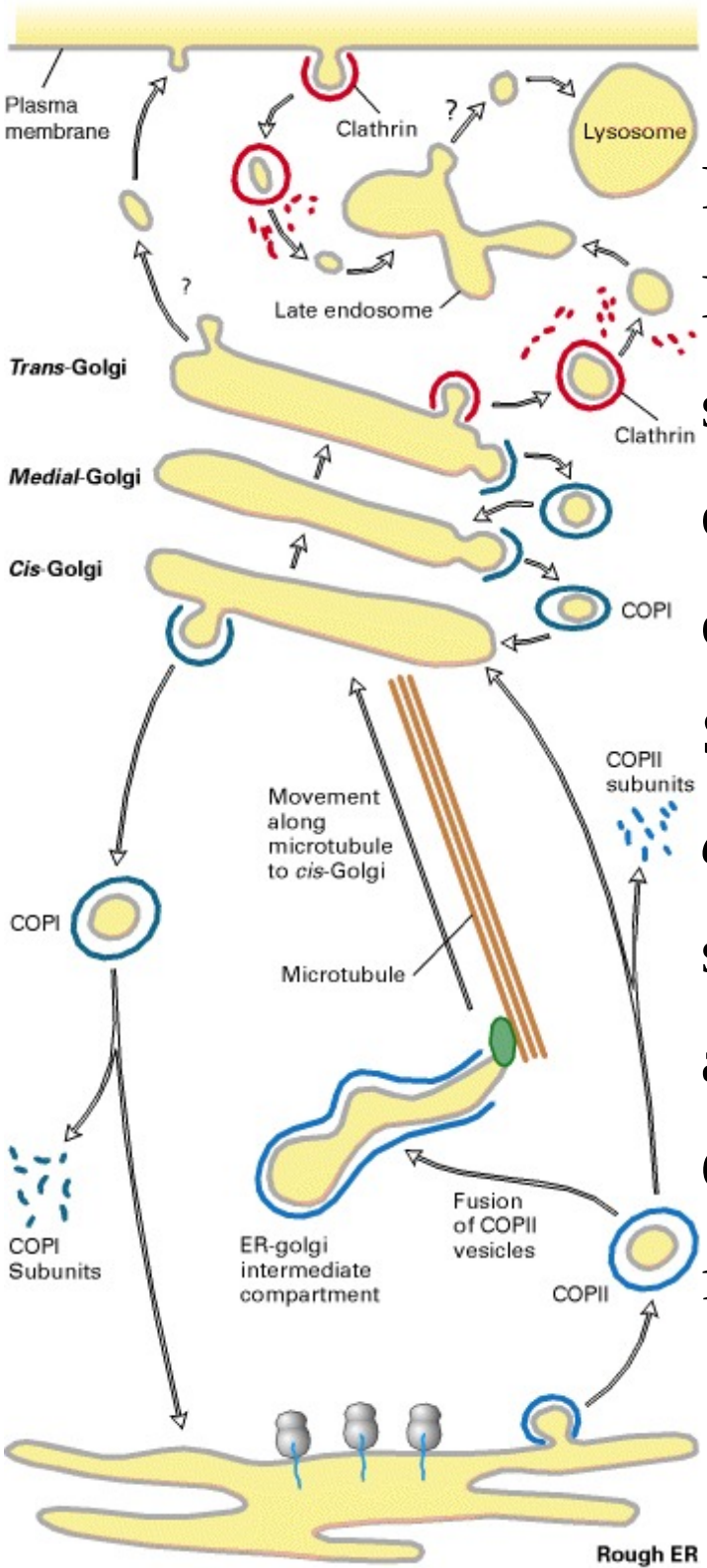
Vesicular transport:

Vesicular transport is the predominant mechanism for exchange of proteins and lipids between membrane-bound organelles in eukaryotic cells. The vesicles bud from the membrane of a particular "parent" organelle and fuse with the membrane of a particular "target" (destination) organelle.



Crucial issues concerning vesicular traffic within cells:

- What is the mechanism by which transport vesicles are formed?
- What is the molecular signal on a particular transport vesicle that causes it to bind only to a particular type of organellar membrane?
- What is the mechanism by which the membranes of a transport vesicle and the destination organelle fuse with each other?



Protein coat: COP I, COP II, clathrin

During formation of the vesicles, the coat subunit proteins polymerize around the outside of a budding vesicle helping the vesicle to pinch off from the parent organelle.

Some coat-protein subunits or associated *adapter proteins* select which membrane and soluble proteins will enter the transport vesicles as *cargo proteins*.

GTP-binding proteins regulate the rate of vesicle formation.

COP I vesicles mediate retrograde transport within the Golgi and from the Golgi back to the ER.

COP II vesicles mediate transport from the ER to the Golgi.

Clathryn vesicles mediate transport from the plasma membrane and *trans*-Golgi to endosomes.

Once vesicles have budded off, the coat is depolymerized, releasing the coat proteins for reuse.

Fusion of all vesicles with their target membranes exhibits common features: fusion occurs after the coats have depolymerized, involves a conserved set of proteins (SNARE SNAP) that mediates targeting of vesicles to the appropriate fusion partner and triggers the fusion process itself.

Uncoating exposes specific V-SNARE proteins on the surface of the vesicle. V-SNARE binds to a T-SNARE protein complexed with SNAP25 on the membrane of the target vesicle.