

Cell Structure & Function

Cell Theory

- Cells are fundamental to biology
- Cells are the basic living units within organisms (all chemical rxns. of life take place within cells)
- All organisms are made of cells
 - Single-celled organisms (bacteria/protists)
 - Multicellular organisms (plants/animals/fungi)

Cell Structure & Function

Basic Aspects of Cell Structure & Function

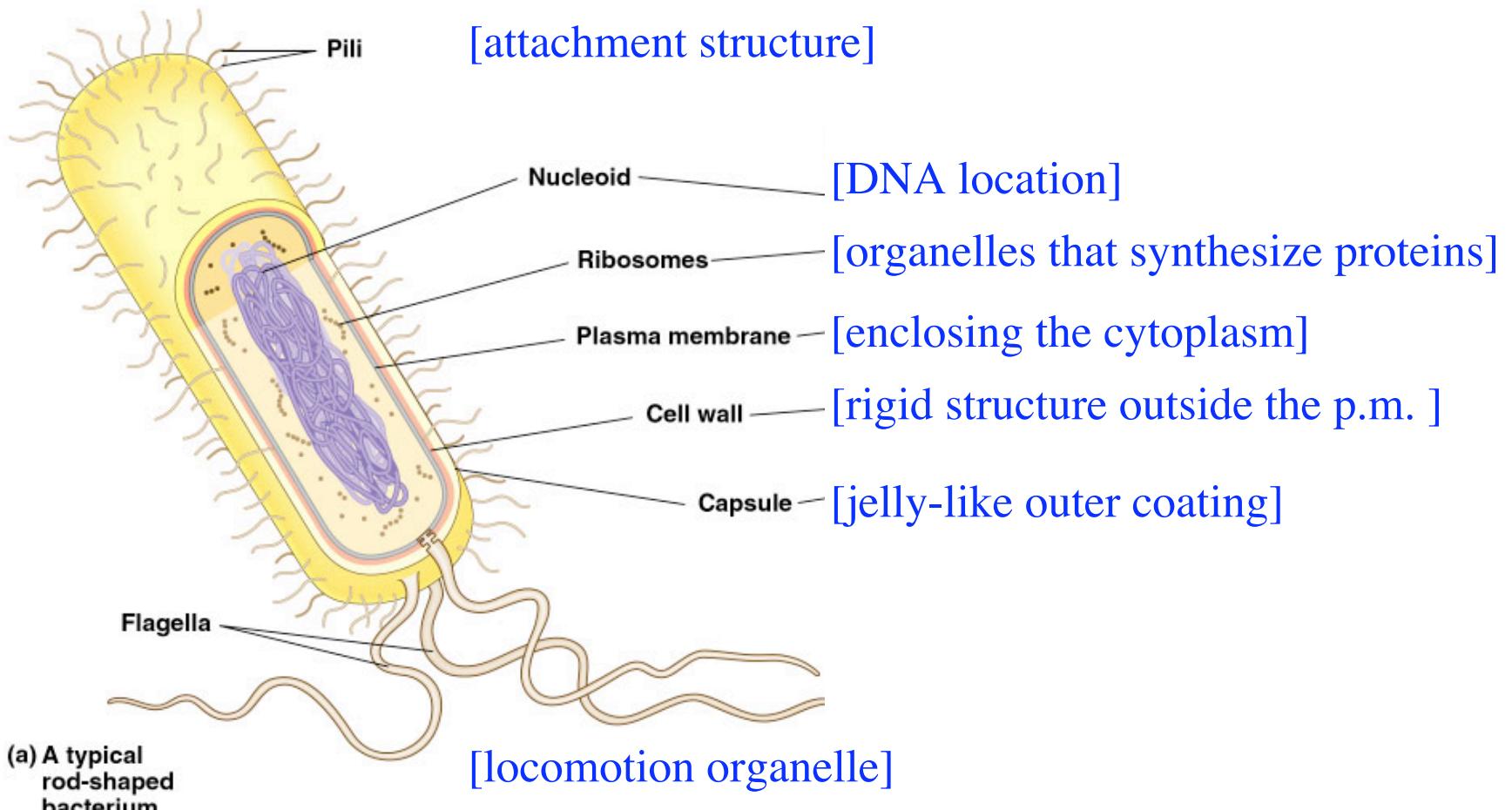
- Plasma membrane
 - Lipid bilayer
 - Proteins
- DNA-containing region
- Cytoplasm
- Eukaryotic v. Prokaryotic cells

Prokaryotic v. Eukaryotic Cells

Two major classes of cells

- Prokaryotic cells (*pro-*, “before”)
 - Cell lacks a “true” nucleus
 - DNA is coiled in a nucleoid region
 - Cells lack nuclear membrane

Prokaryotic v. Eukaryotic Cells



Prokaryotic v. Eukaryotic Cells

- **Eukaryotic cells (eu-, “true”)**

- Nucleus

- contains most of the cells nuclear material, DNA
 - usually the largest organelle

- Bordered by a membranous envelope

Prokaryotic v. Eukaryotic Cells

Plant v. Animal Cells

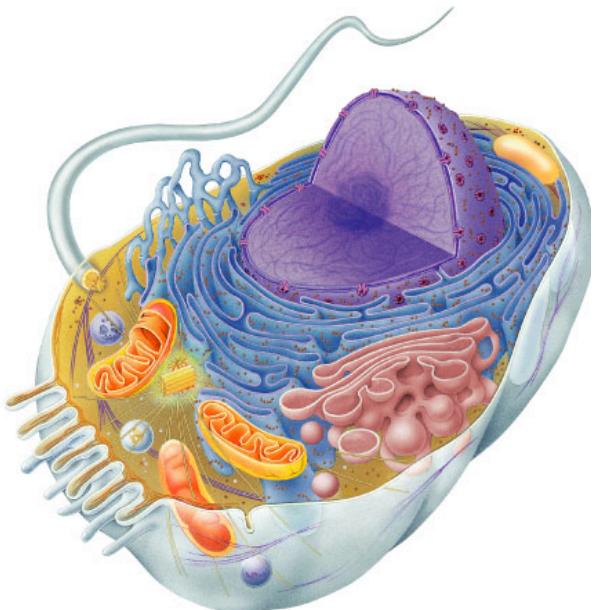
- Both contain
 - Plasma membrane
(functions as a selective barrier)
 - Nucleus (gene-containing organelle)
 - Cytoplasm (region between nucleus and p.m.)
 - Consists of organelles in a fluid (cytosol)

Prokaryotic v. Eukaryotic Cells

Plant v. Animal Cells

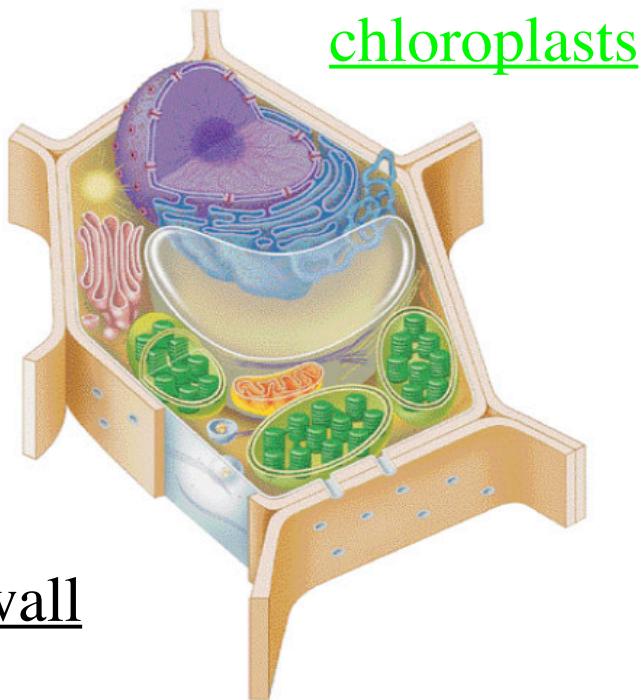
- Organelles
 - Bordered by internal membranes
 - Compartmentalizes the functions of a cell
 - Maintains organelle's unique environment
 - Most organelles are found in both plant and animal cells

Plant v. Animal Cells



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Cell wall



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Eukaryotic Cells

Major Cellular Components

- Nucleus
- Ribosomes
- Endoplasmic reticulum
- Mitochondria
- Chloroplasts (plants)
- Cytoskeleton

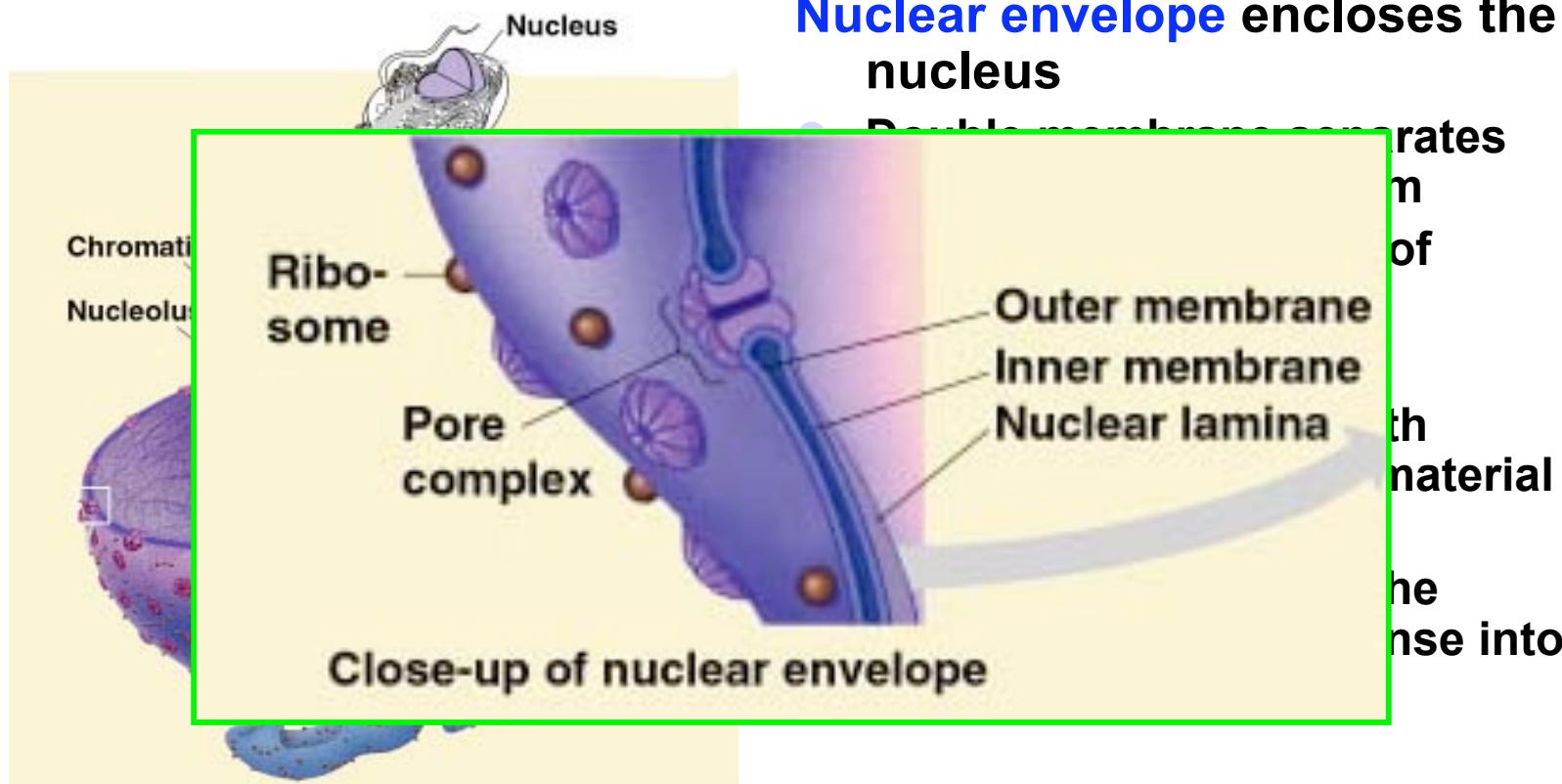
Eukaryotic Cells

Genetic control of the cell

- **Nucleus**

- Contains most of the genes (inherited DNA molecules) of the cell
 - Genes - portion of DNA that codes for proteins
 - Protein synthesis occurs at the ribosome

Nucleus

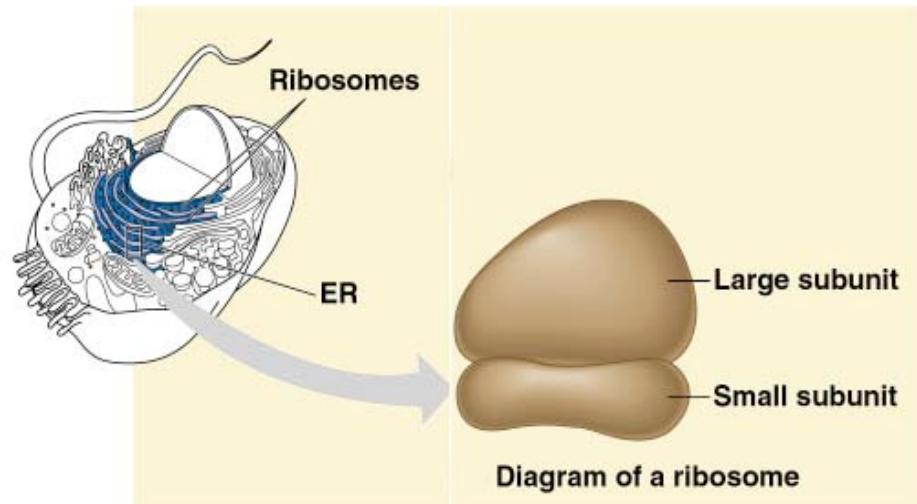


Nucleolus

- Synthesis of rDNA --> ribosomal subunits --> ribosome

Ribosomes

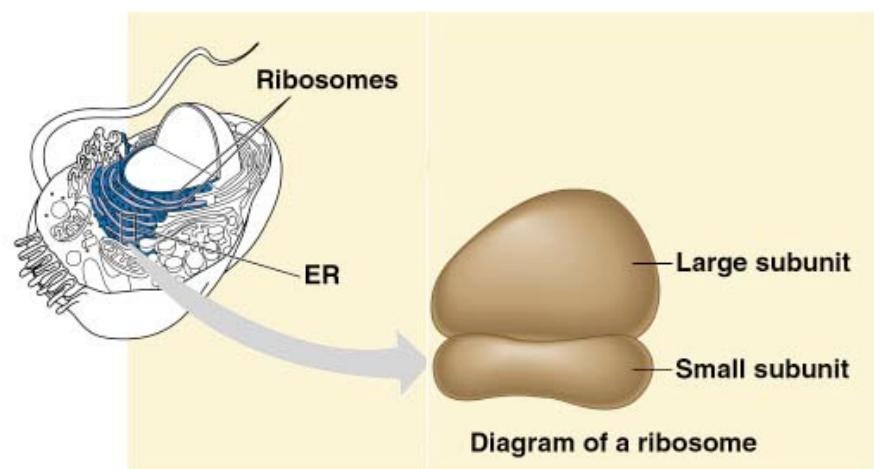
- Sites of protein synthesis
- Composed of 2 subunits
- Size
 - Prokaryotes (70S)
 - Eukaryotes (80s)
 - Except ribosomes of mitochondria and chloroplasts (70S)



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Ribosomes

- Particles made from rDNA and cytoplasmic proteins
- Either suspended in the cytosol
 - Enzyme production
 - Proteins in cytosol
- Attached to the endoplasmic reticulum (ER)
 - Synthesize membrane proteins and secreted proteins



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Eukaryotic Cells

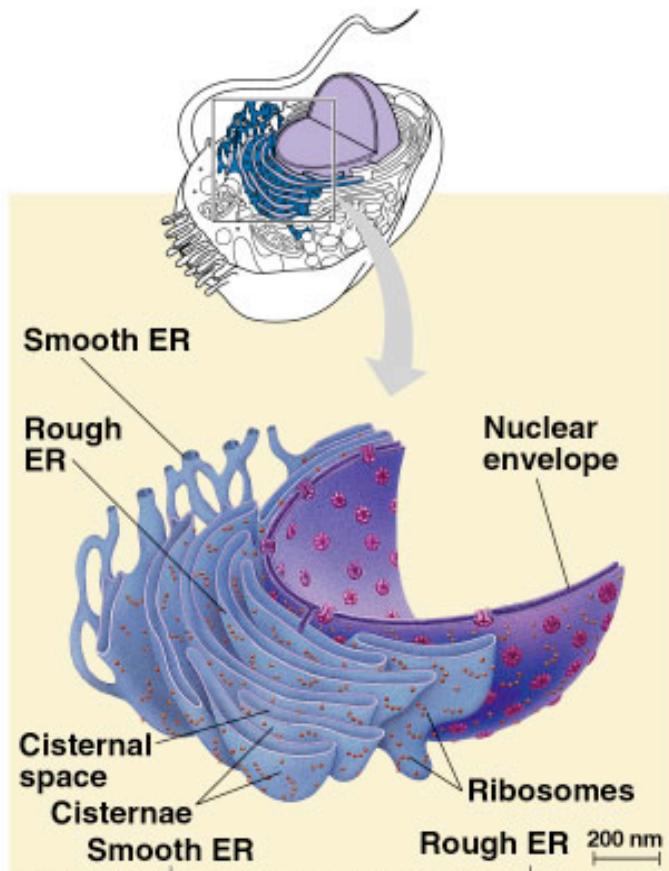
Endomembrane system

- Responsible for the manufacture and distribution of cellular products
- This system includes the:
 - Endoplasmic reticulum (ER)
 - Golgi apparatus
 - Lysosomes
 - Vacuoles

Endoplasmic reticulum

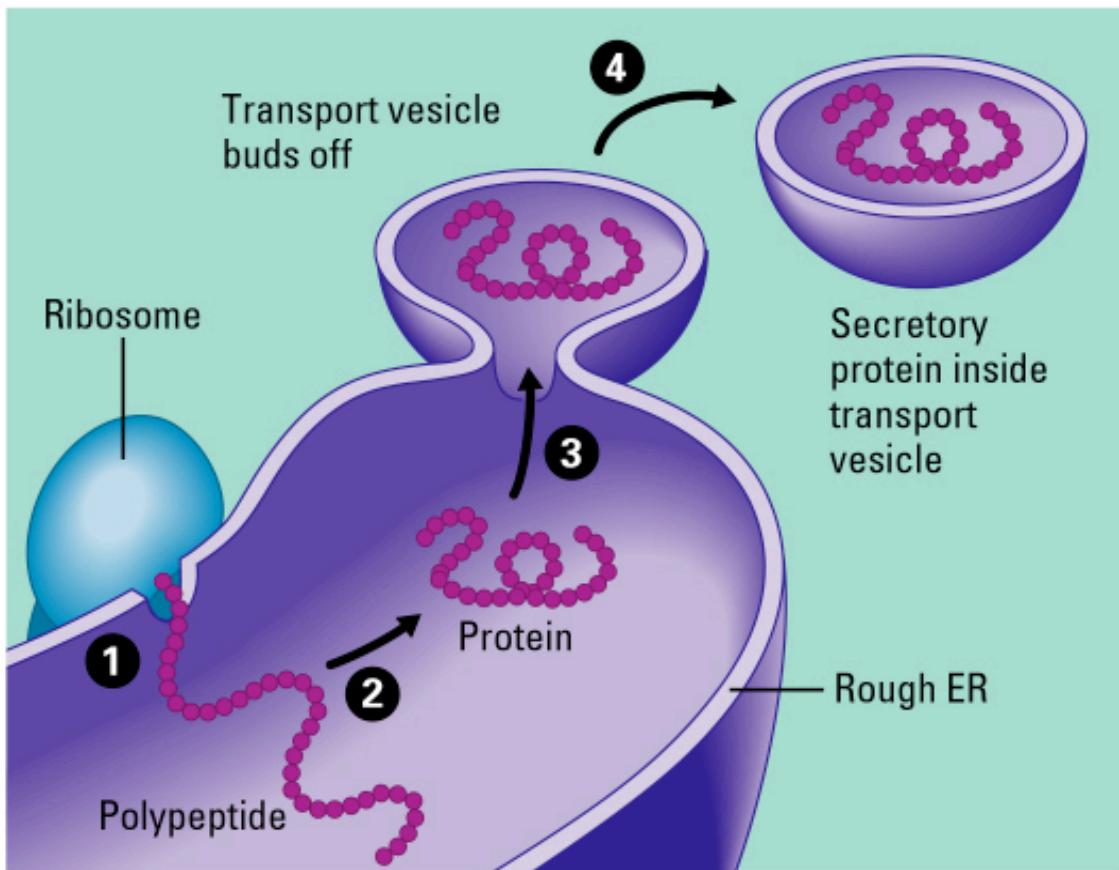
- *Reticulum*, “little net”
- Consists of a physically connected network of membranous tubules and sacs
- ER membrane separates the internal compartment from the cytosol
- 2 distinct regions
 - Rough ER
 - Smooth ER

Rough ER



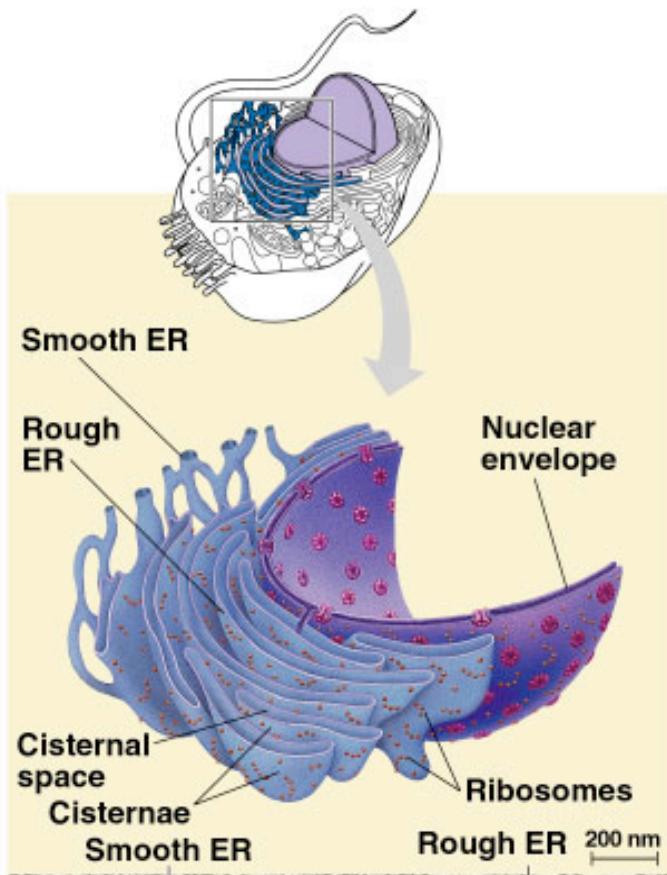
- Ribosomes on outer surface of the membrane
- Produce 2 types of proteins
 - Membrane proteins
 - Secretory proteins
- Some products are sent via **transport vesicles**
 - Membranous spheres that bud from ER

Transport vesicles



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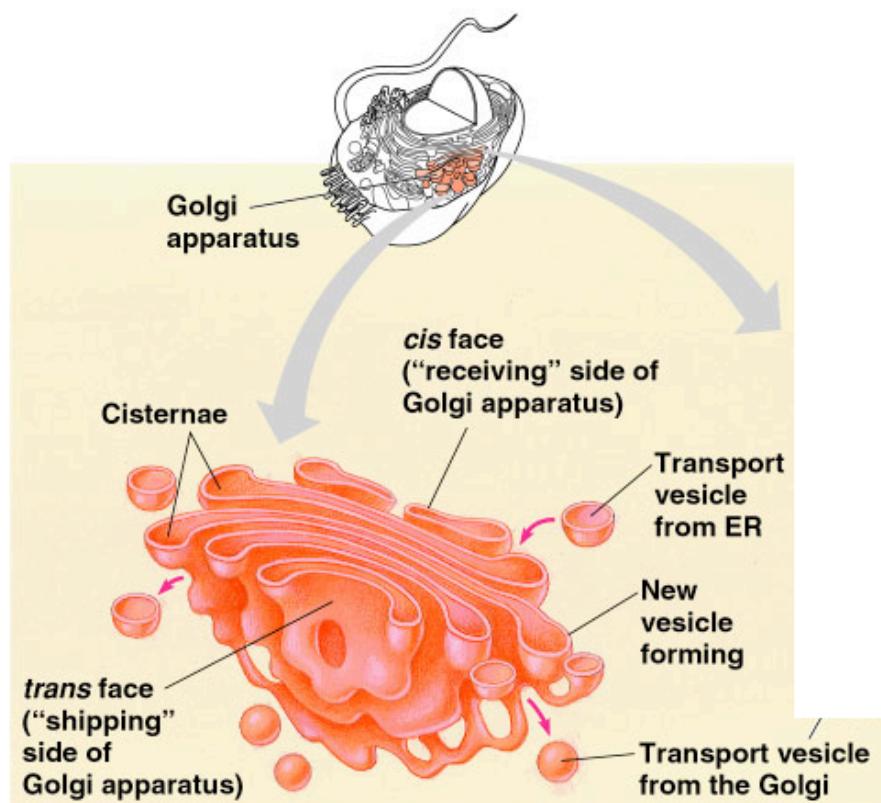
Smooth ER



- Cytoplasmic surface lacks ribosomes
- Smooth ER of various cell types functions in diverse metabolic processes
 - Synthesis of lipids (steroids)
 - Metabolism of carbohydrates (sugar regulation by the liver)
 - detoxification of drugs and poisons

Golgi Apparatus

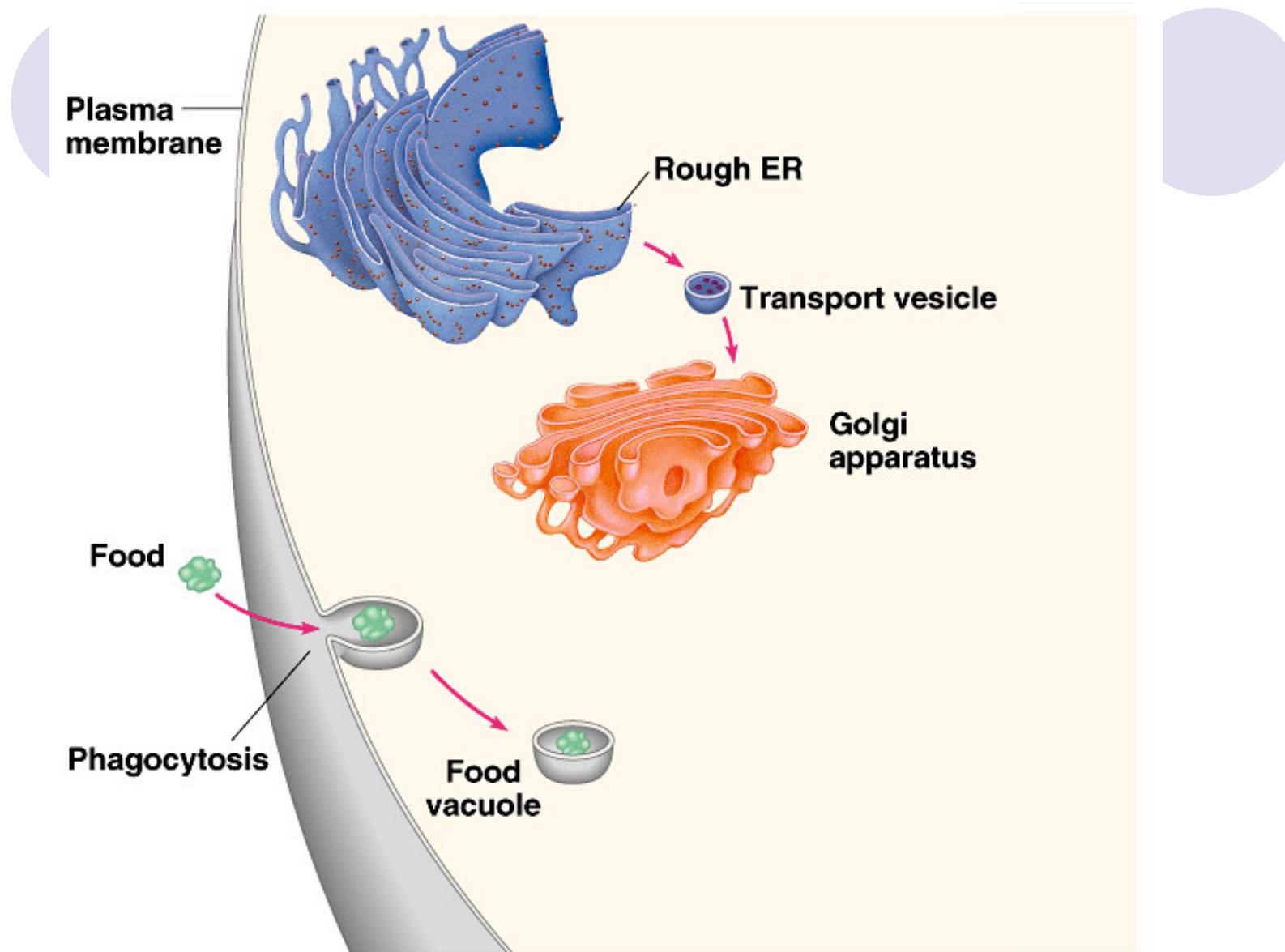
- Consists of stacks of flattened unconnected membranous sacs (unlike ER)
- Products of ER are modified, stored and then sent to other destinations:
 - Plasma membrane
 - Other organelles



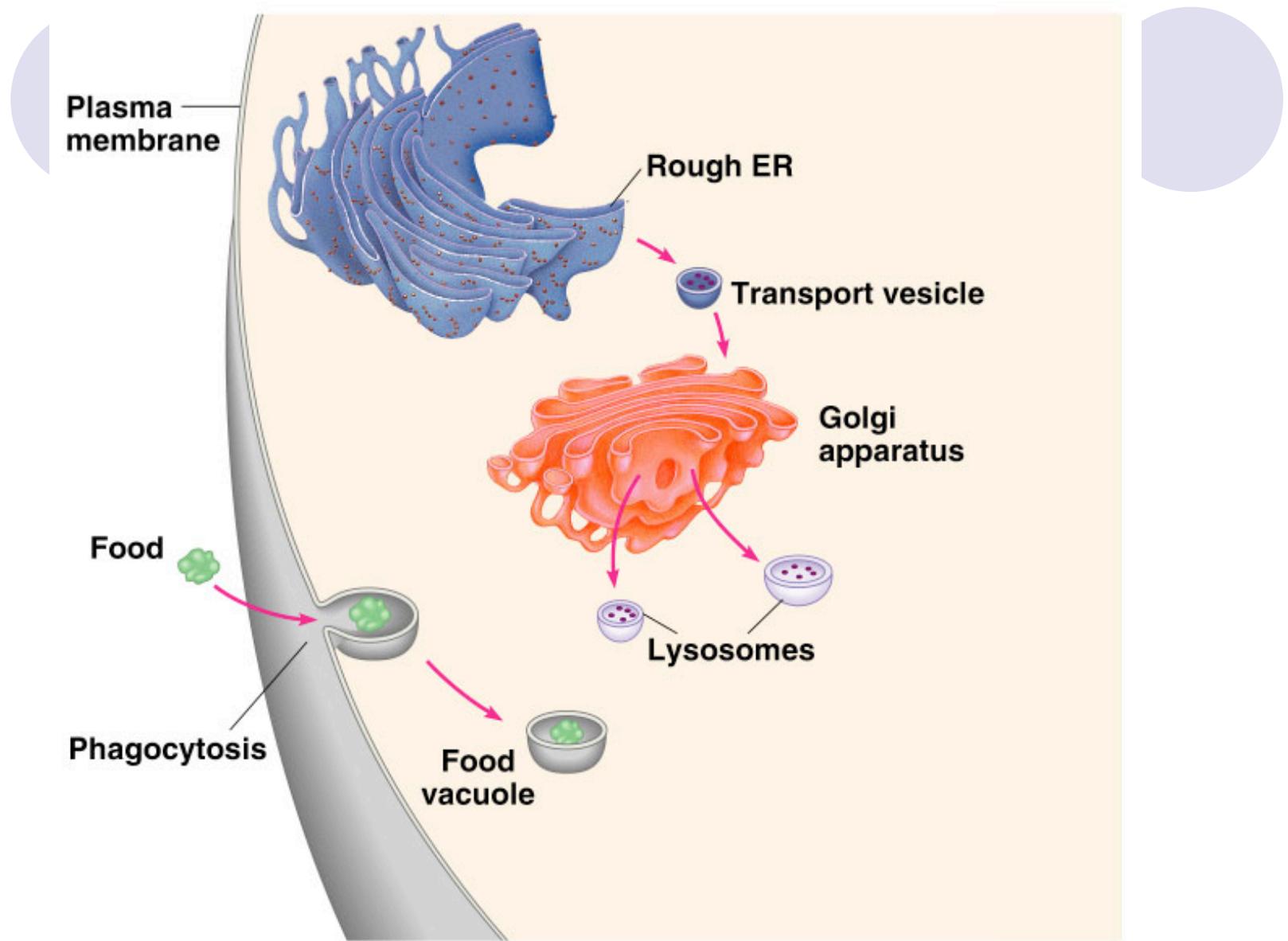
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Lysosomes

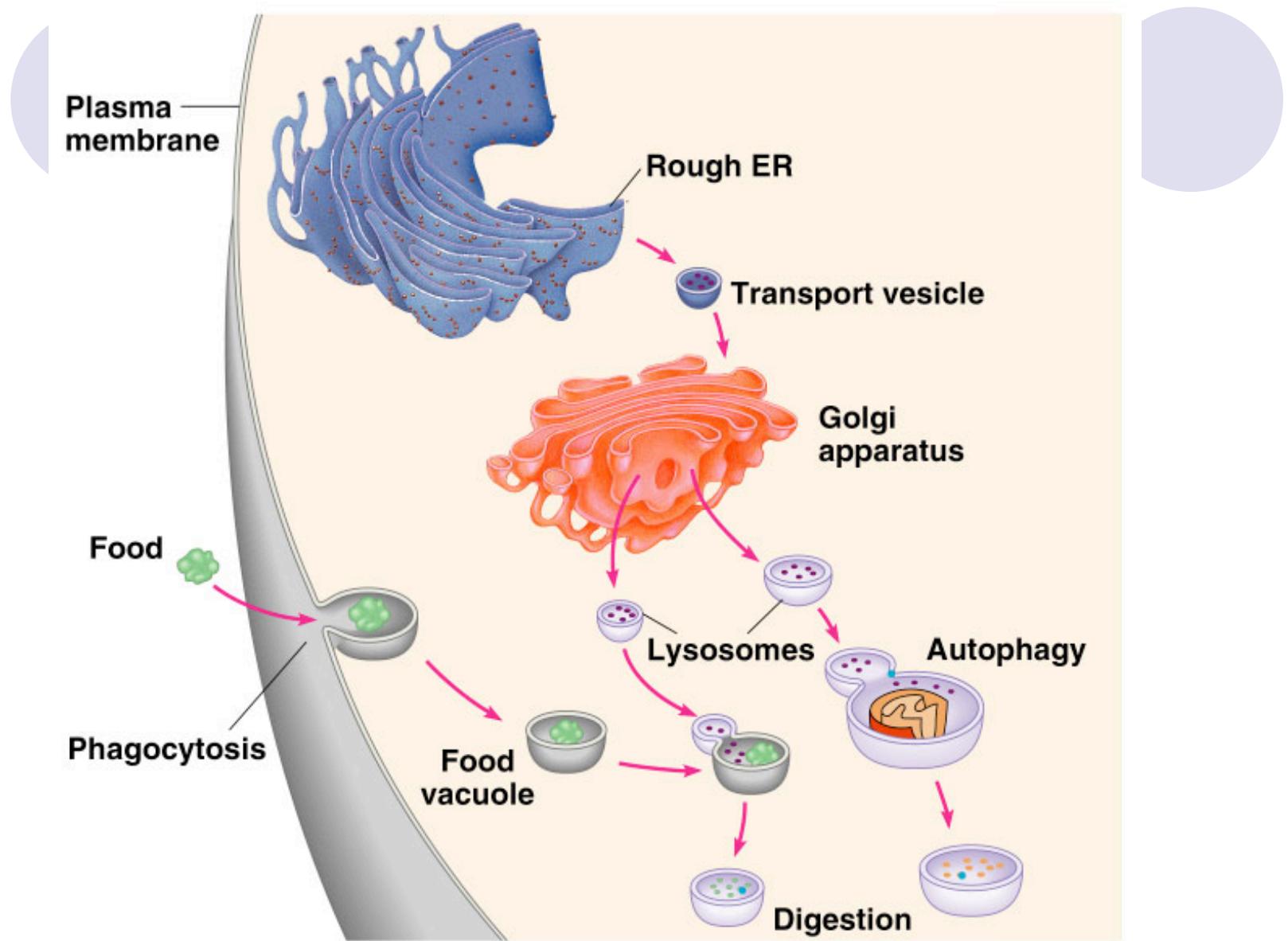
- **Membrane-bound sac of digestive enzymes**
 - Strong enzymes contained safely
 - Break down:
 - Proteins, polysaccharides, fats and nucleic acids
- **Functions:**
 - Digest food contained in food vacuoles
 - Destroy harmful bacteria
 - Recycle damaged organelles (autophagy)
 - Programmed cell destruction



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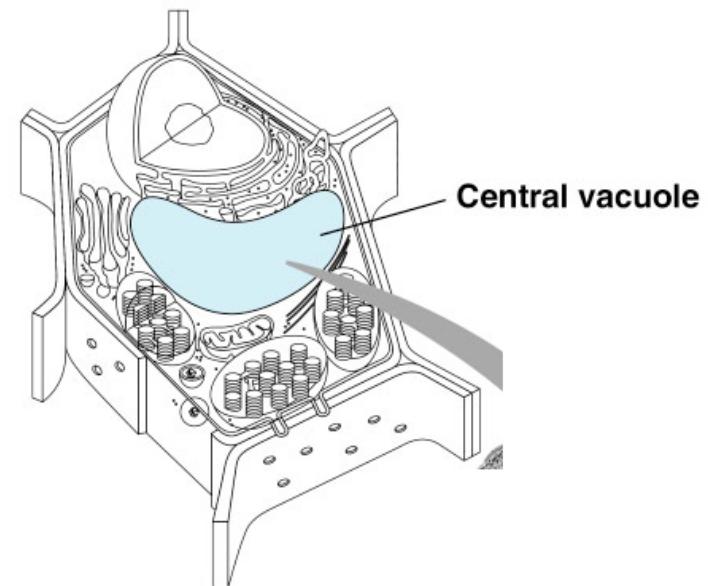
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Vacuoles

- Membrane-bound sacs within the cell
- Larger than vesicles
- 3 types
 - Food vacuoles (formed by phagocytosis)
 - Contractile vacuoles (freshwater protists)
 - Central vacuoles (plant cells)



Eukaryotic Cell

Genetic control

- Nucleus
- Ribosomes

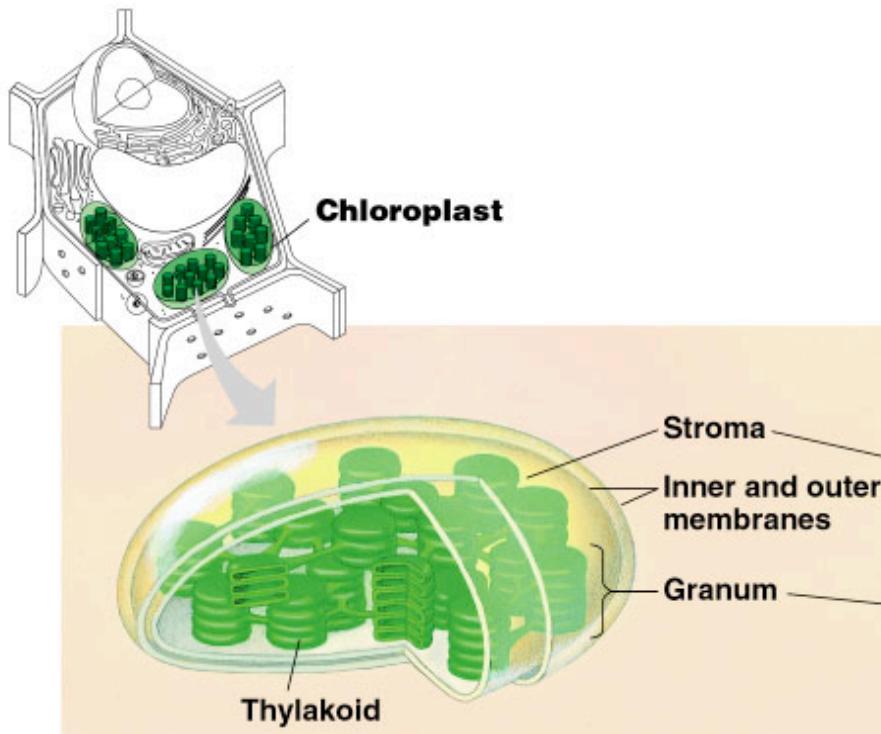
Endomembrane System

- Endoplasmic reticulum (ER)
- Golgi apparatus
- Lysosomes
- Vacuoles

Energy-converting Organelles

- Chloroplasts
- Mitochondria

Chloroplasts



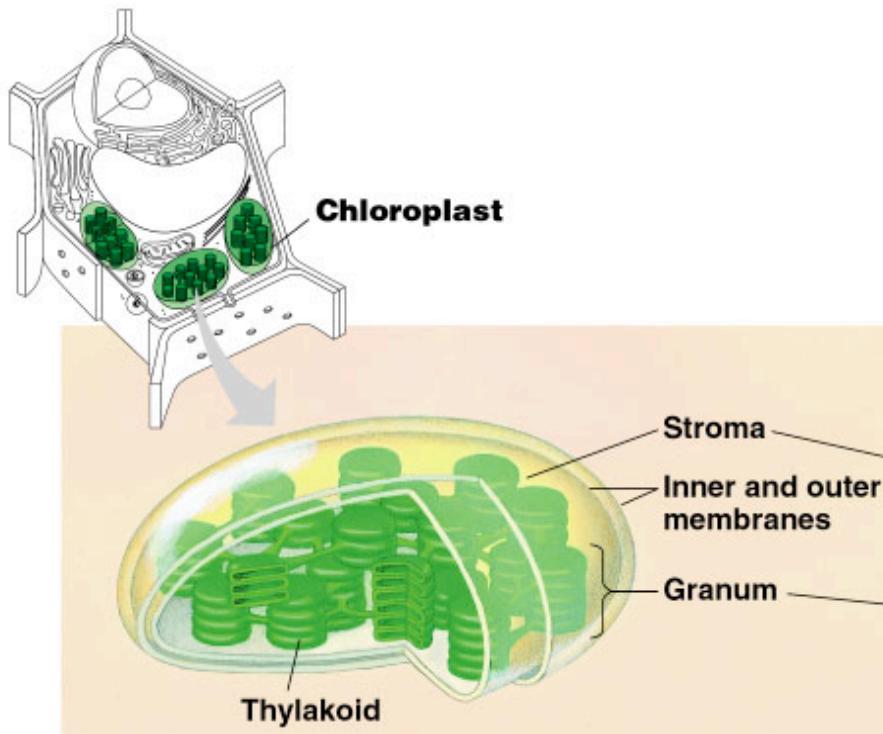
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Organelles of plants and some protists that perform photosynthesis

- Process of converting:

Light energy
↓
usable chemical energy

Chloroplasts



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Structure

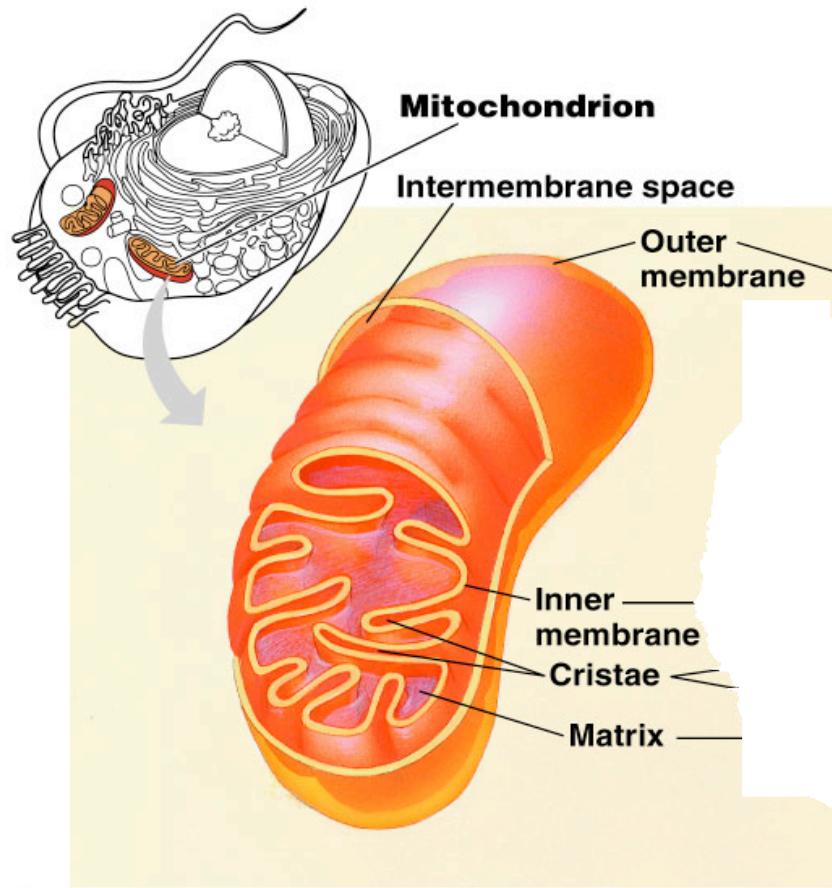
- double-membrane separates it from rest of cell
- Thylakoid disks
 - chlorophyll
 - trap light energy
- Stroma
 - Fluid outside the thylakoids
 - Contains chloroplast DNA and ribosomes

Mitochondria

- Found in nearly all eukaryotic and prokaryotic cells
- Site of cellular respiration:

Energy from sugar

Converted to ATP

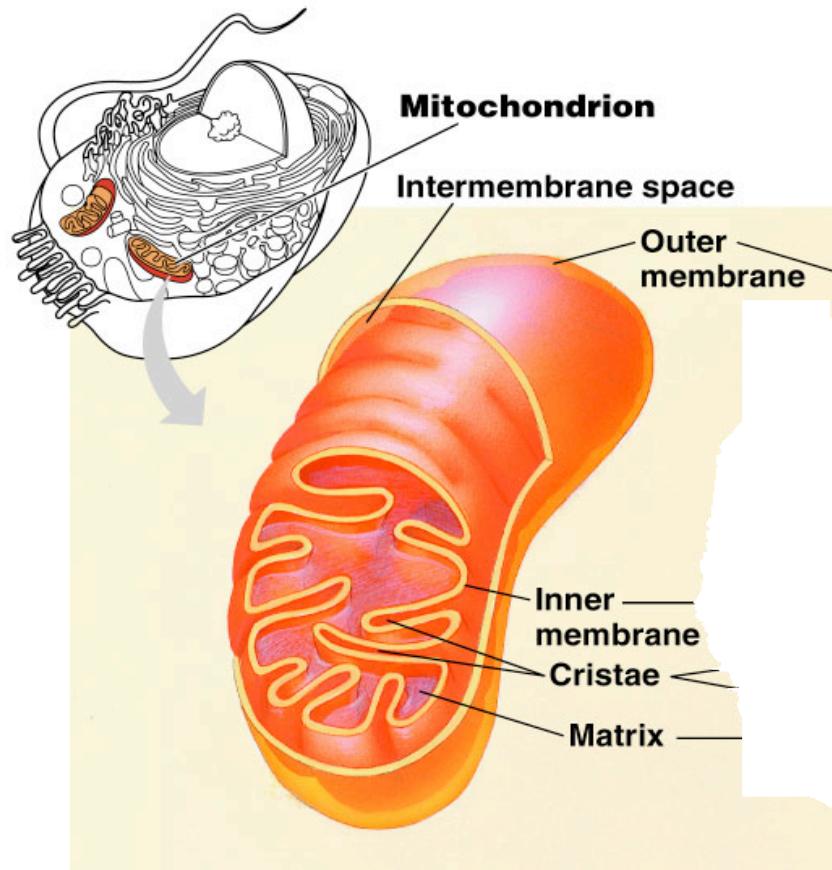


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Mitochondria

Structure

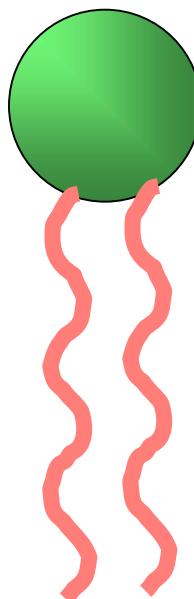
- Enclosed by a double-membrane
 - Outer membrane is smooth
 - Inner membrane is convoluted
 - Infoldings called **cristae**
 - Increase of surface area
- **Mitochondrial matrix**
 - Contains enzymes, mitochondrial DNA and ribosomes



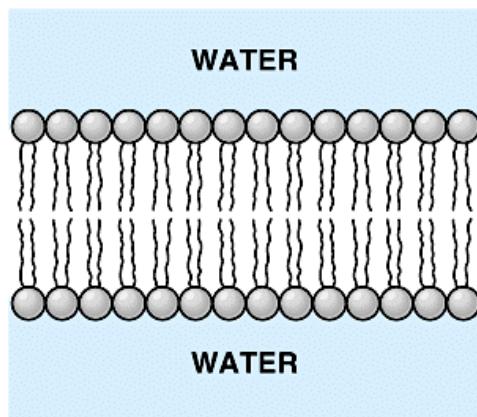
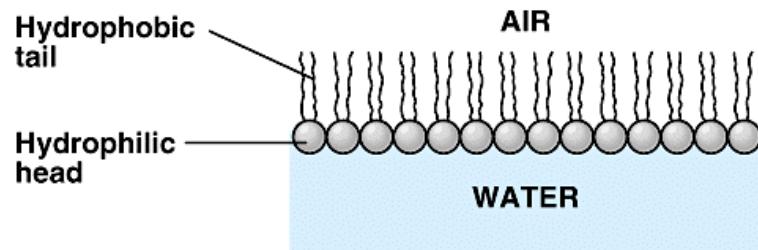
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Membrane Structure

- Composed of mostly proteins and lipids (but carbohydrates are also important)
- Most abundant lipids in most membranes are **phospholipids**
 - **Amphipathic** structure
 - **Phosphate group**
 - Hydrophilic (likes water) because it has an electrical charge
 - **Two fatty acids**
 - Hydrophobic (fears water) - no charge



Membrane Structure



Cell membranes are
phospholipid bilayers

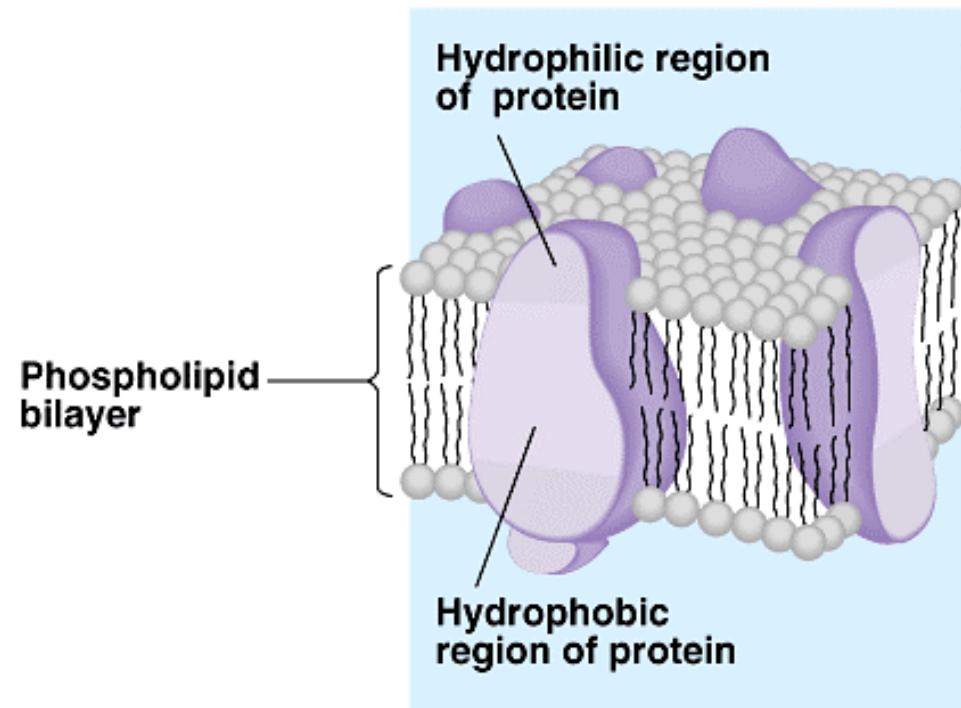
Stable boundary between 2 aqueous compartments

- Hydrophobic tails are sheltered from the water
- Hydrophilic heads exposed

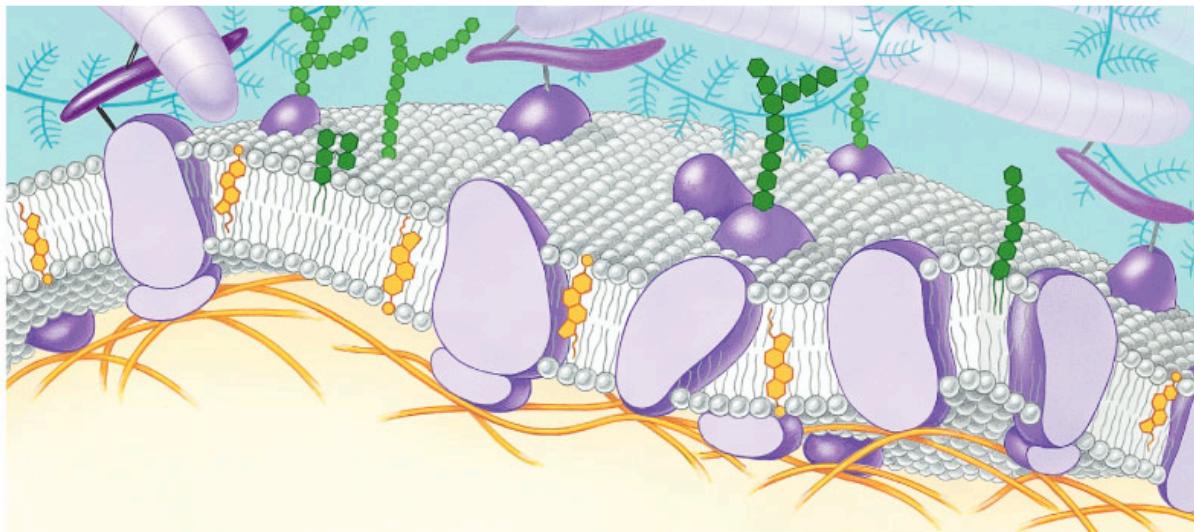
Membrane Structure

Membrane proteins

- Some bound to the surface only
- Some span the phospholipid bilayer (transmembrane proteins)



Fluid Mosaic Model



Membrane is a mosaic of protein molecules bobbing in a fluid bilayer of phospholipids

Prokaryote v. Eukaryote

Properties	Prokaryote	Eukaryote
Phylogenetic group	Bacteria, Archaea	Algae, fungi, protists, plants, animals
Size	Small (< 2 um)	Larger (2 - 100um)
Nuclear membrane	Absent	Present
Nucleolus	Absent	Present
Internal membranes	Relatively simple	Complex (ex. ER, golgi apparatus)
Ribosomes	70S in size	80S (mitochondria/chloroplast 70S)
Cell walls	Present (in most)	Absent
Endospores	Present (in some)	Absent