



# 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

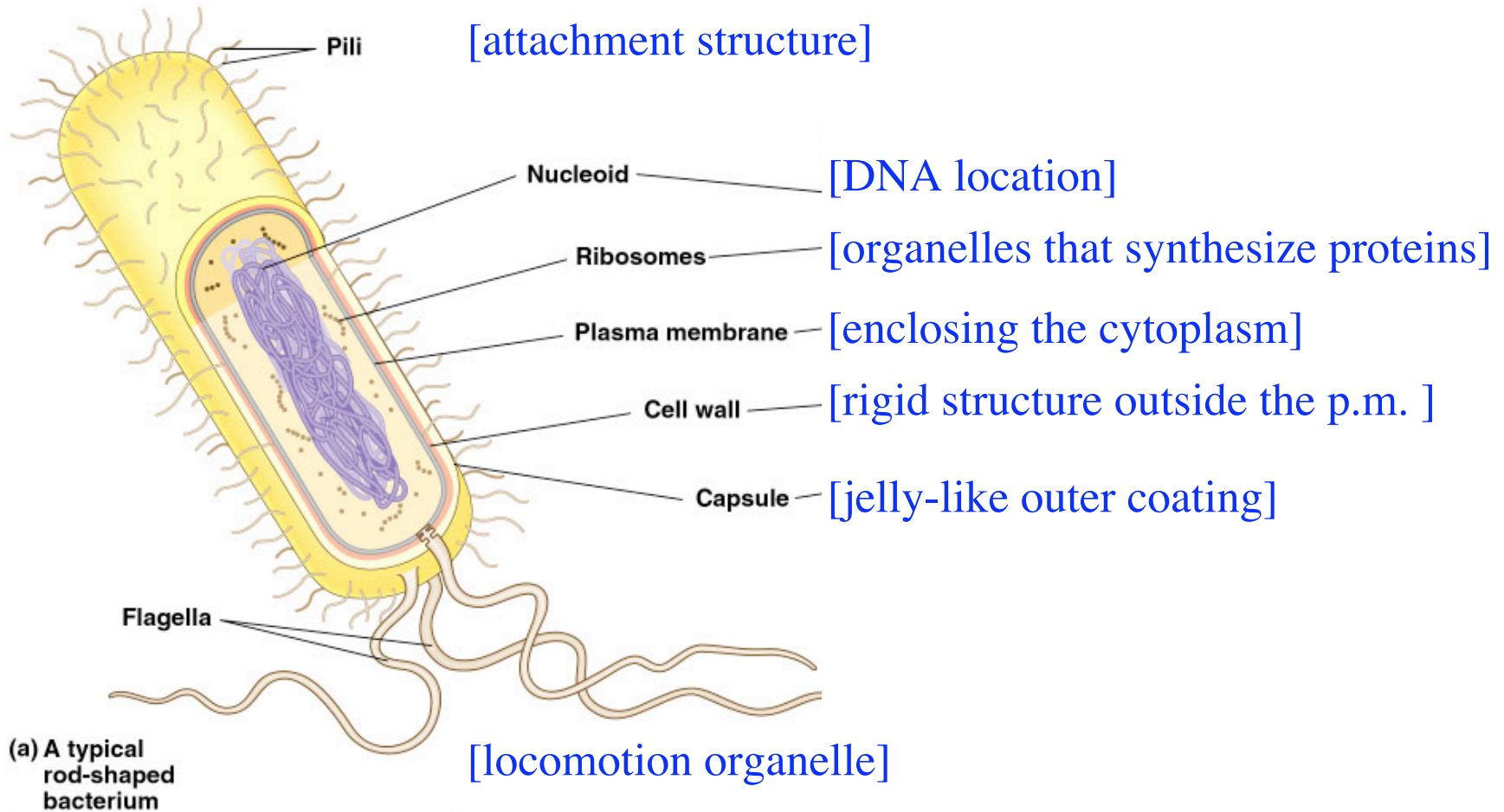
# Prokaryotic v. Eukaryotic Cells



## 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

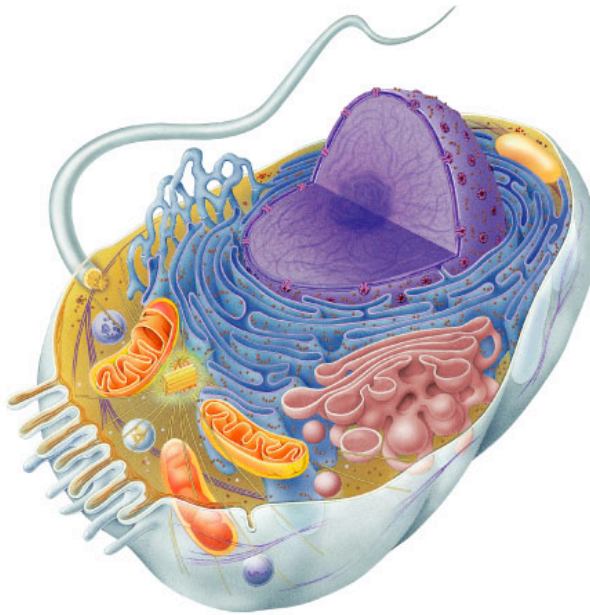
- Organelles

- Bordered by internal membranes

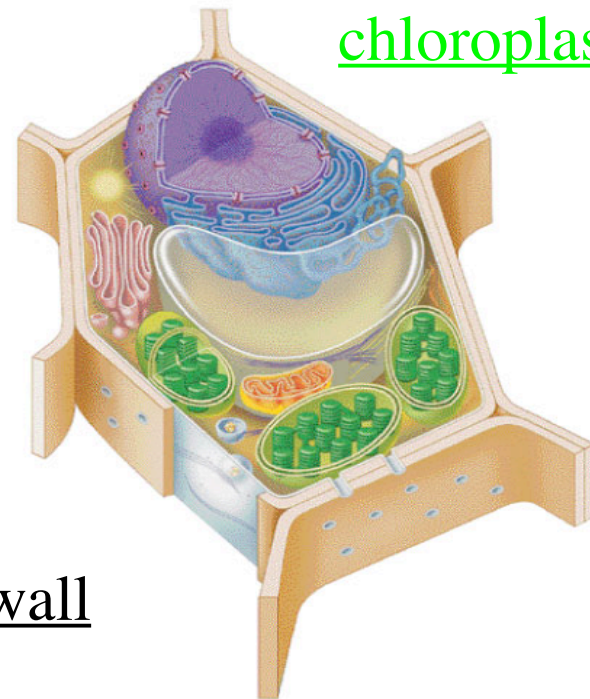
- Compartmentalizes the functions of a cell
- Maintains organelle's unique environment

- Most organelles are found in both plant and animal cells

# Plant v. Animal Cells



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chloroplasts

Cell wall

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# Eukaryotic Cells



## Major Cellular Components

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

# Eukaryotic Cells



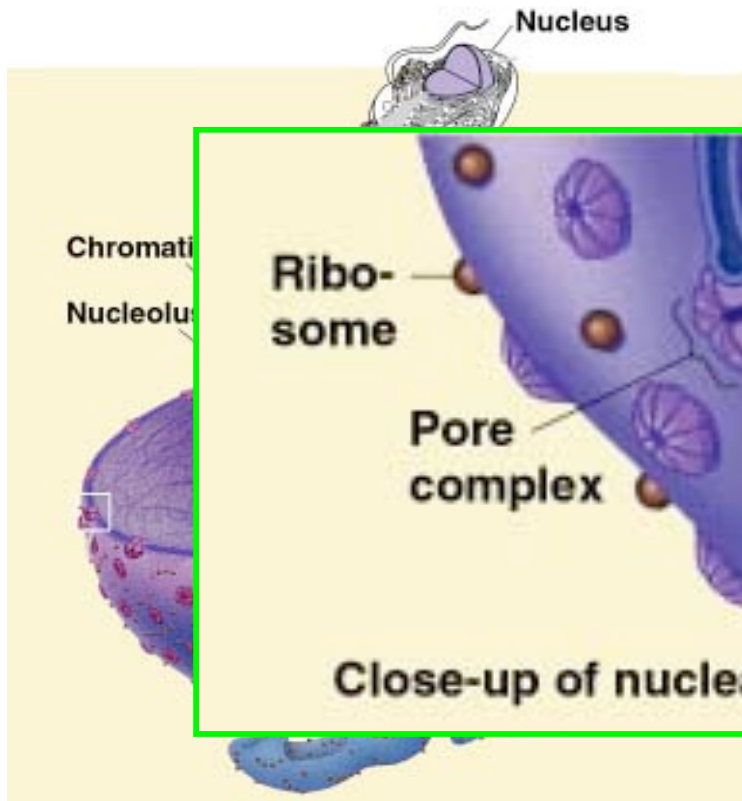
## Genetic control of the cell

- **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



**Nuclear envelope** encloses the nucleus

Double membrane separates

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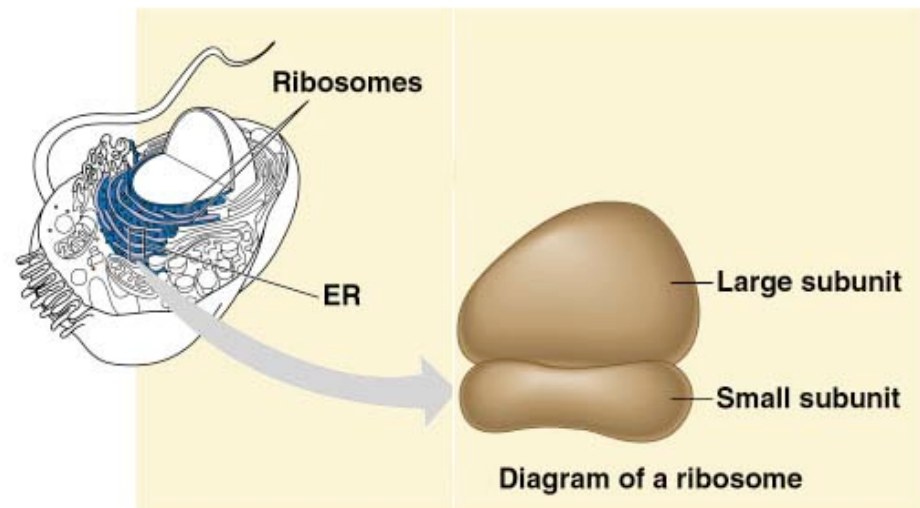
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## **Nucleolus**

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

# Ribosomes

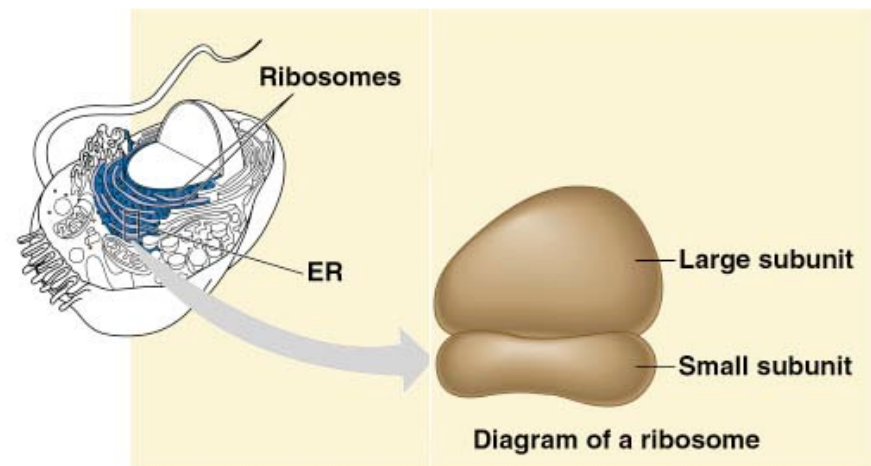
- Sites of protein synthesis
- Composed of 2 subunits
- Size
  - Prokaryotes (70S)
  - Eukaryotes (80s)
    - Except ribosomes of mitochondria and chloroplasts (70S)



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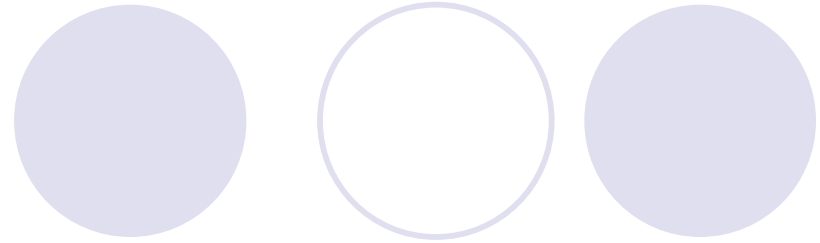
# Ribosomes

- 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

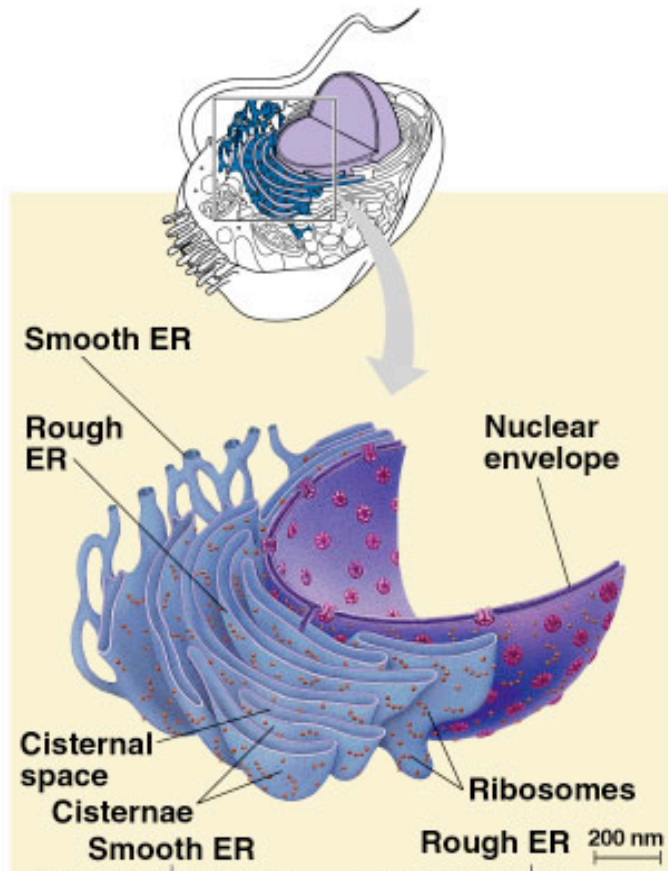
- Responsible for the manufacture and distribution of cellular products
- This system includes the:
  - Endoplasmic reticulum (ER)
  - Golgi apparatus
  - Lysosomes
  - Vacuoles

# 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

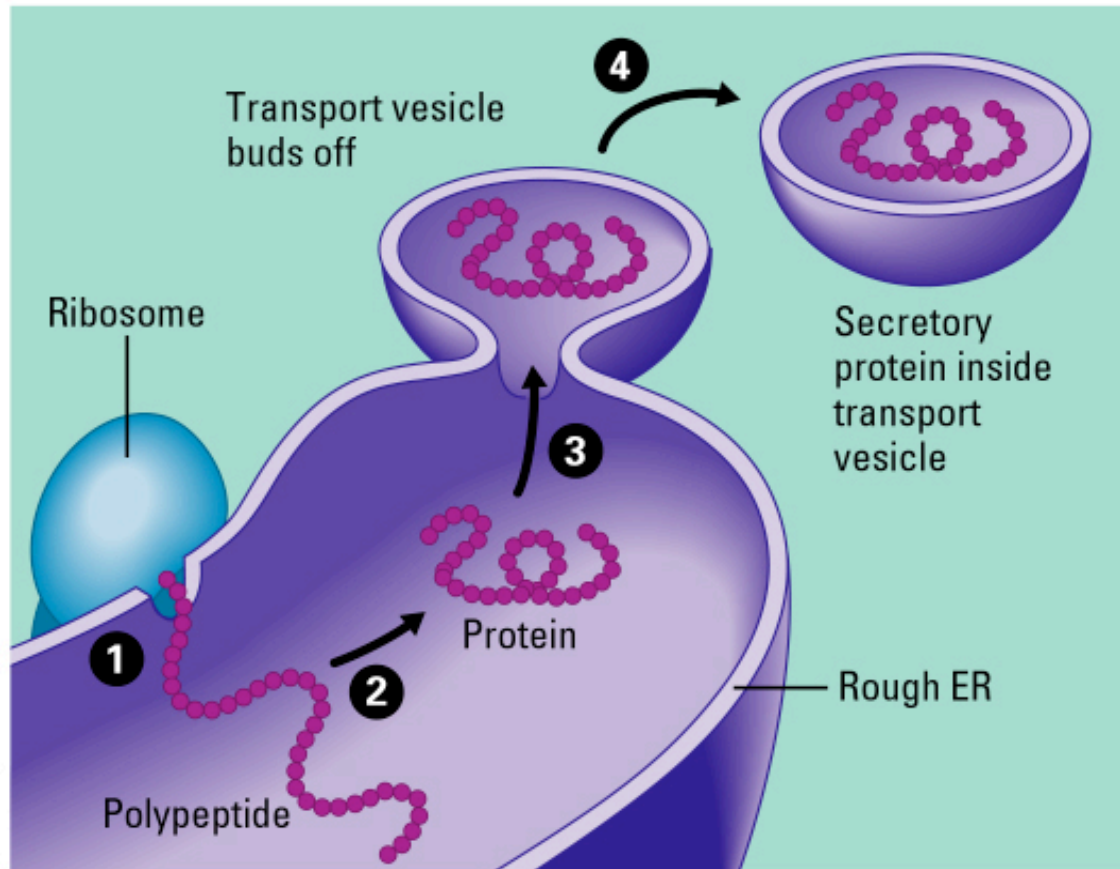
# Rough ER



- 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

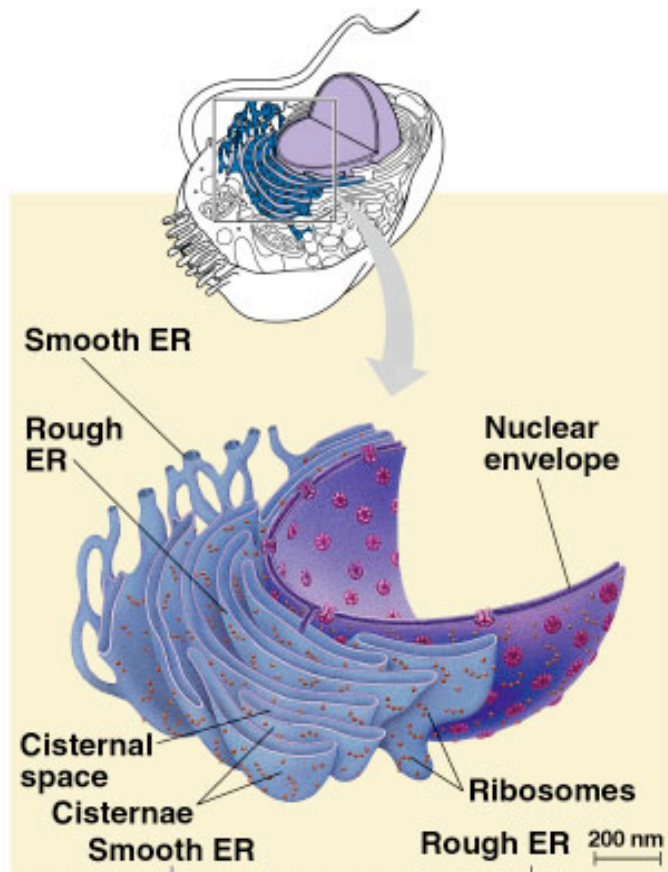


# Transport vesicles



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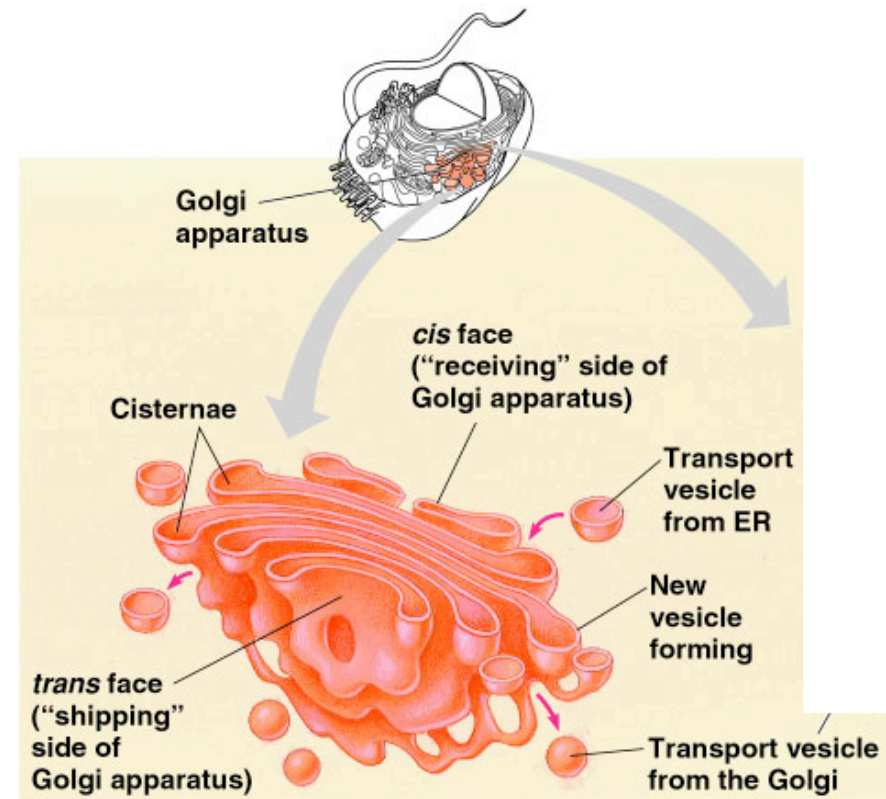
# Smooth ER



- 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

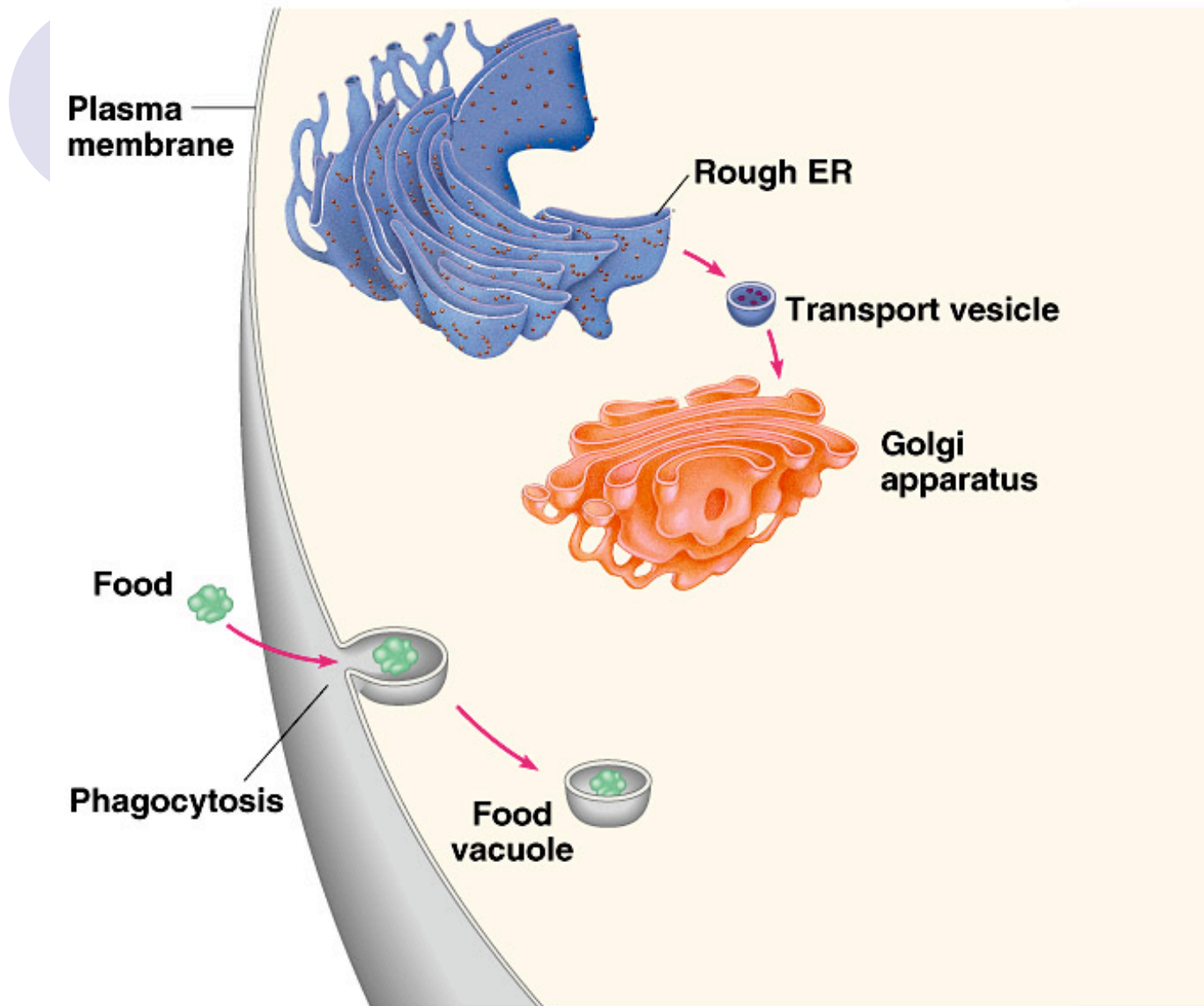


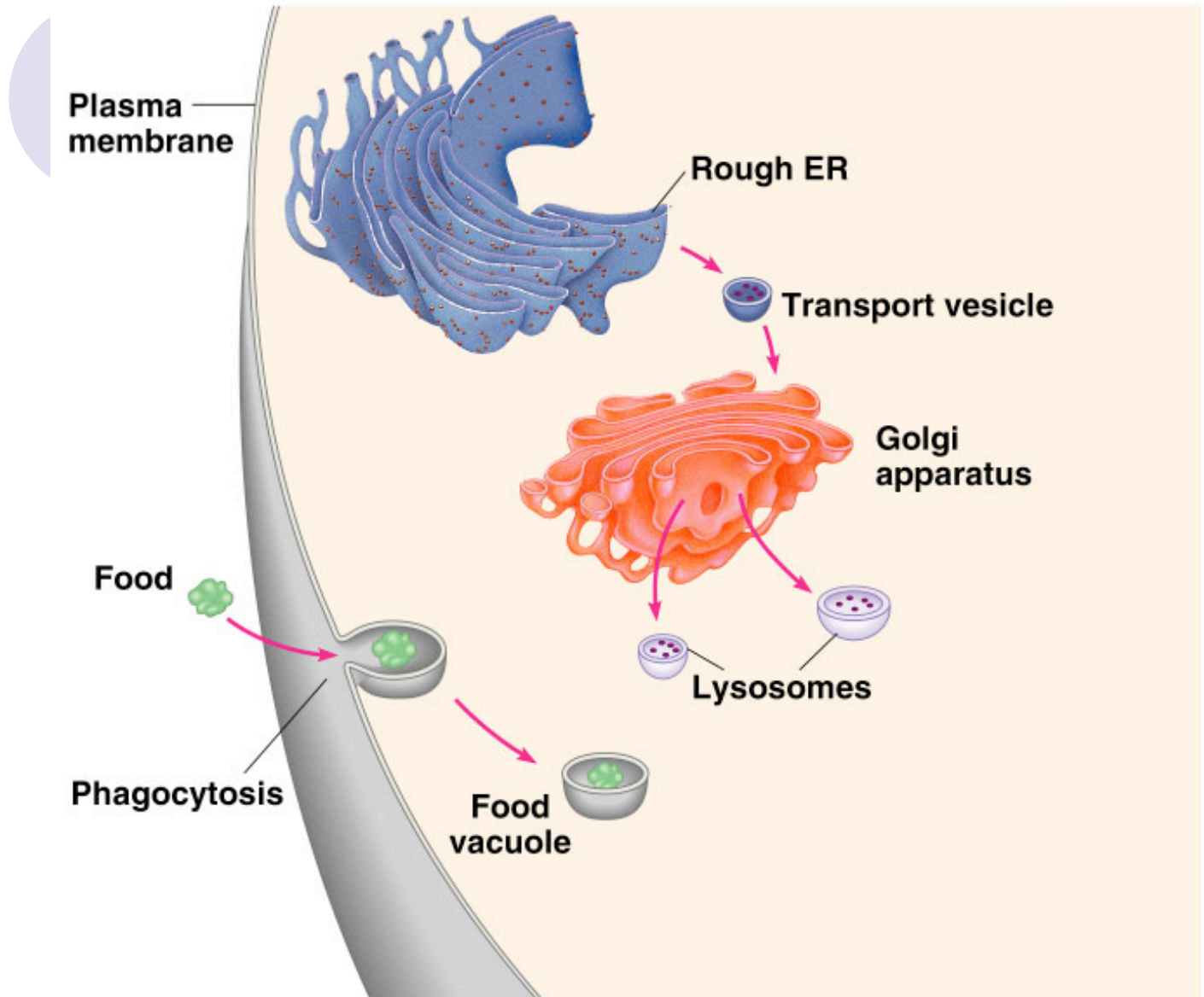
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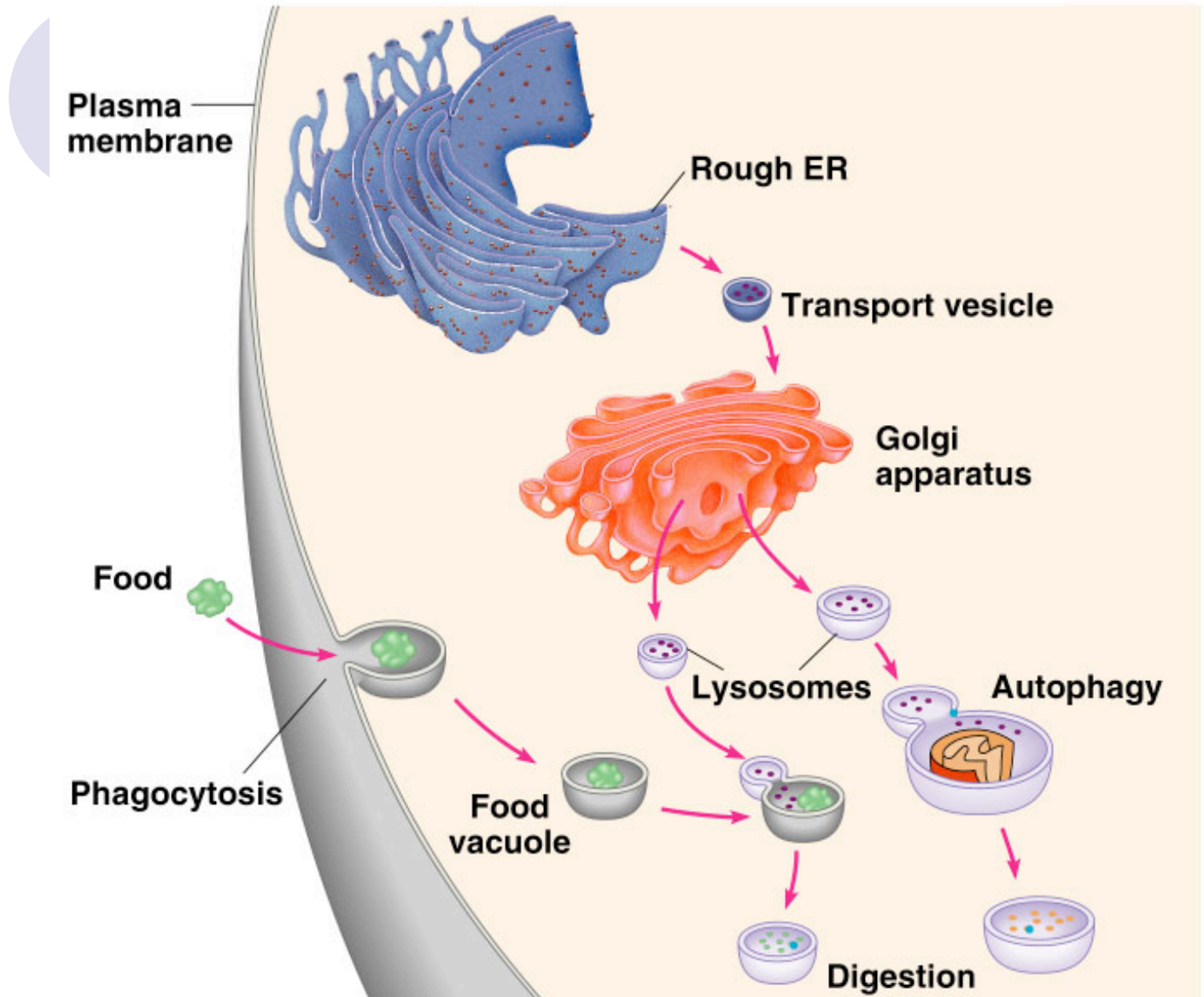
# Lysosomes



- 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

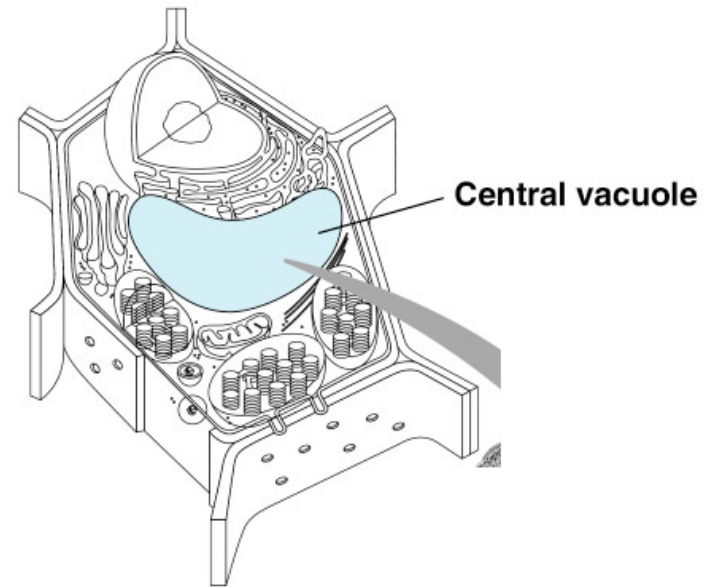






# Vacuoles

- 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

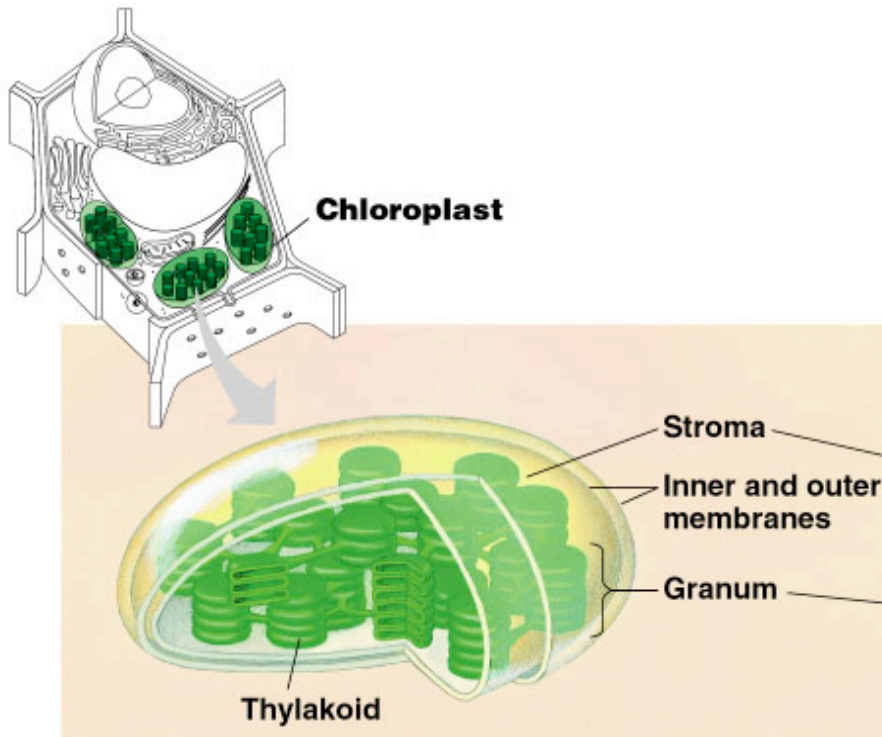
## Endomembrane System

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

## Energy-converting Organelles

- Chloroplasts
- Mitochondria

# Chloroplasts



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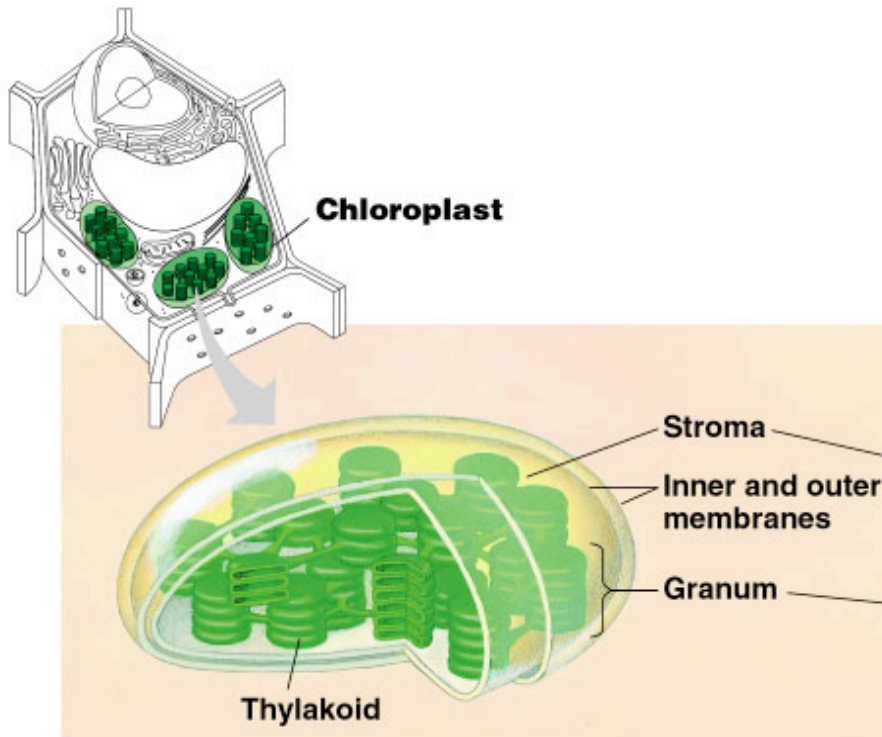
- Organelles of plants and some protists that perform photosynthesis
- Process of converting:

**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

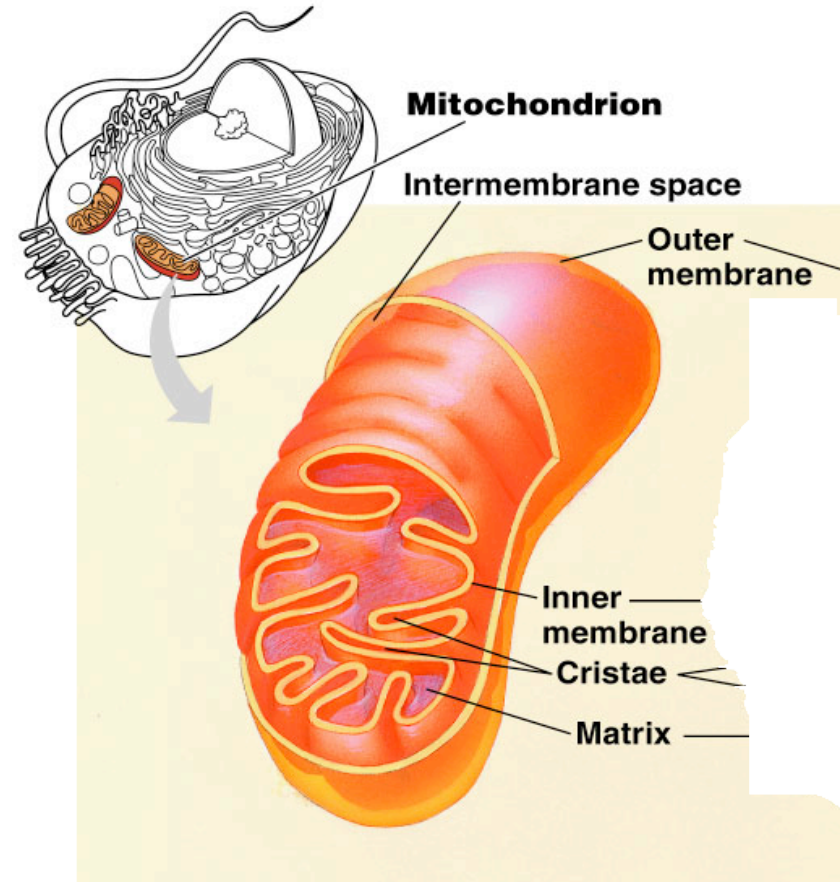
# Mitochondria

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

Energy from sugar



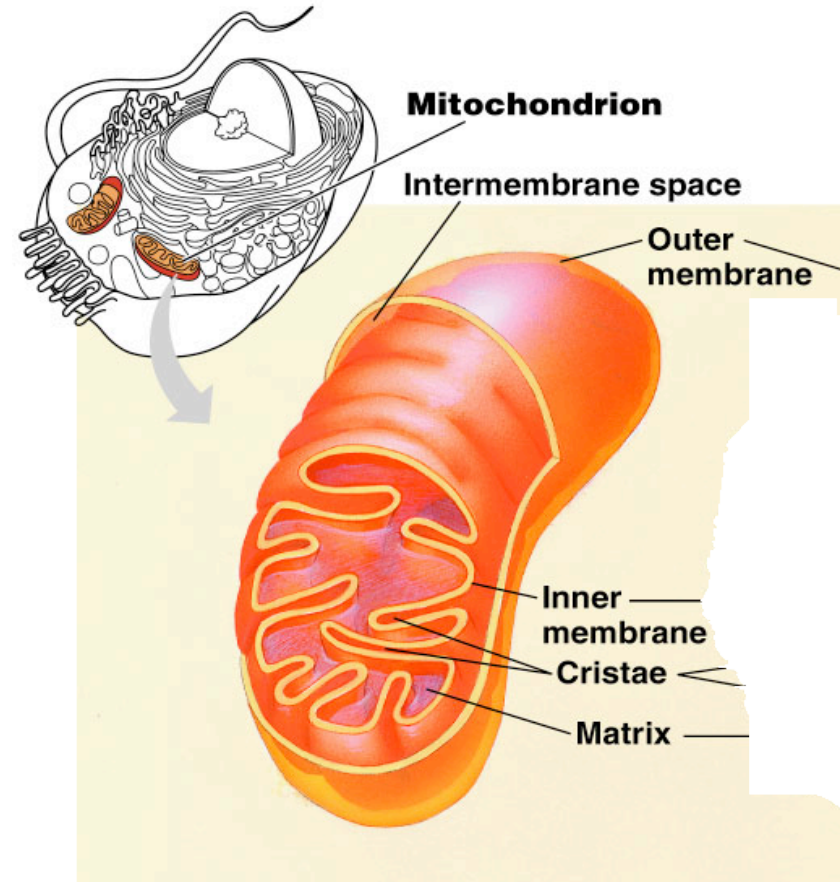
Converted to ATP



# Mitochondria

## Structure

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

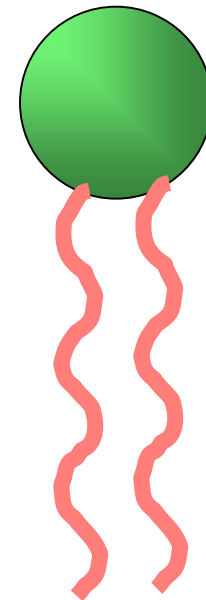


# Membrane Structure

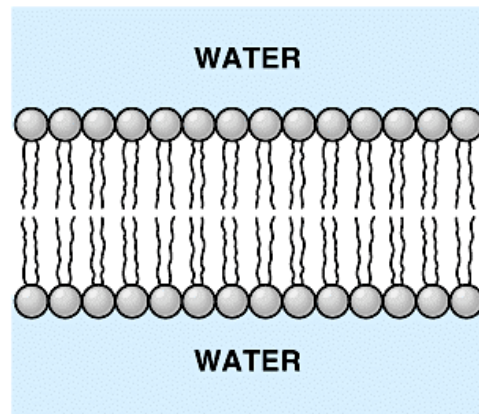
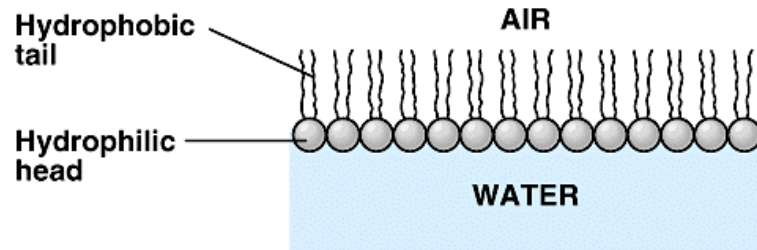
- Composed of mostly proteins and lipids (but carbohydrates are also important)
- Most abundant lipids in most membranes are **phospholipids**

- Amphipathic structure

- **Phosphate group**
  - Hydrophilic (likes water) because it has an electrical charge
- **Two fatty acids**
  - Hydrophobic (fears water) - no charge



# Membrane Structure



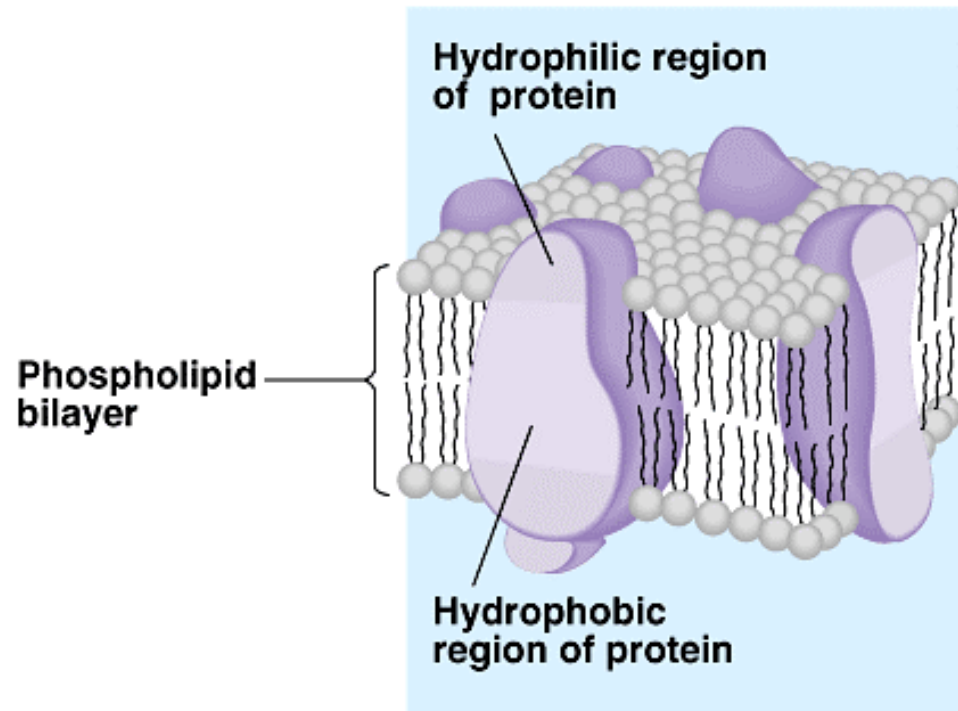
Cell membranes are phospholipid bilayers

- Stable boundary between 2 aqueous compartments
- Hydrophobic tails are sheltered from the water
  - Hydrophilic heads exposed

# Membrane Structure

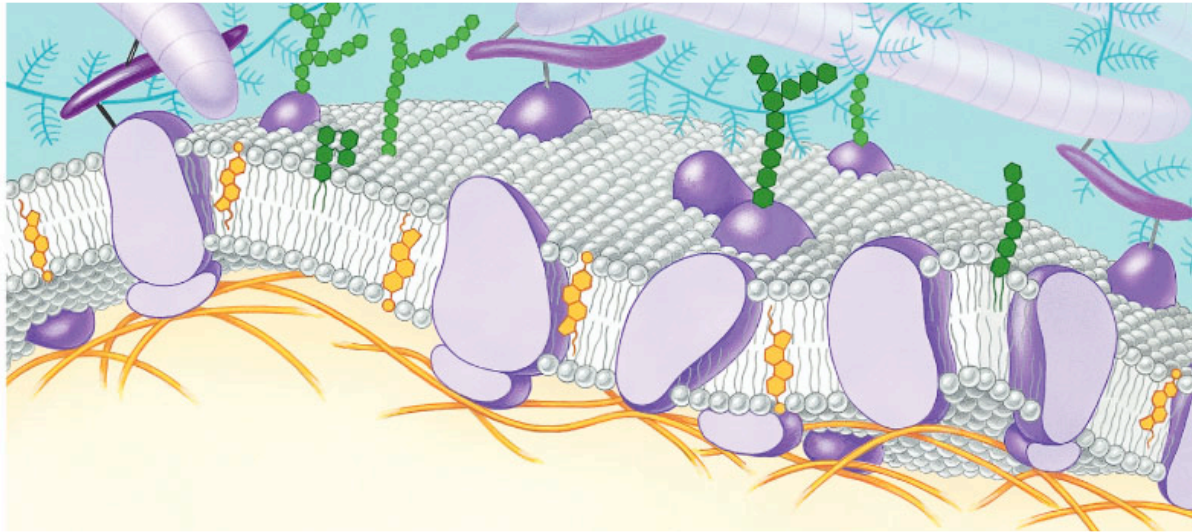
## Membrane proteins

- 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