INSIDE A CELL

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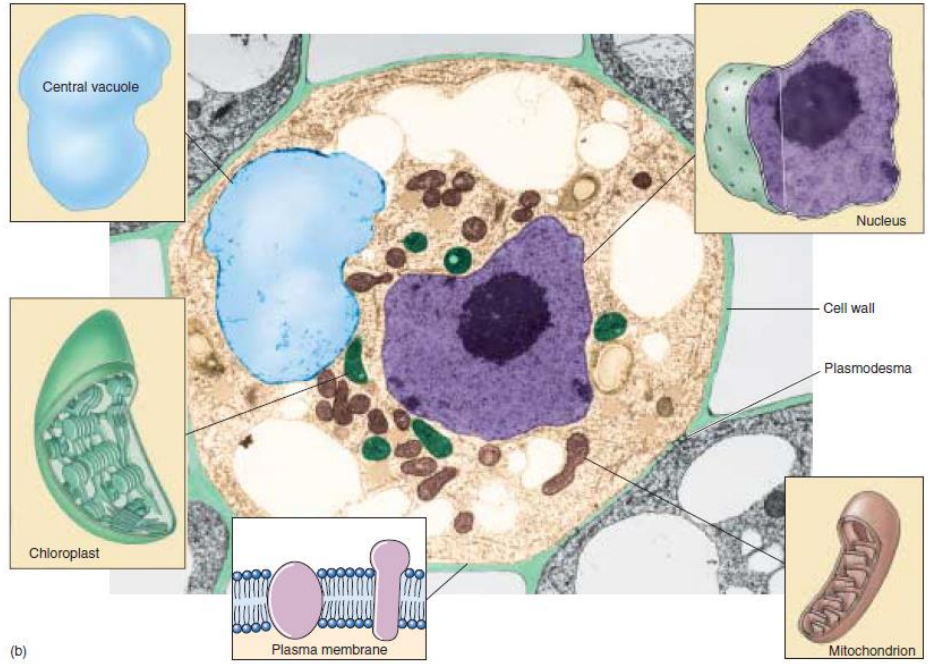
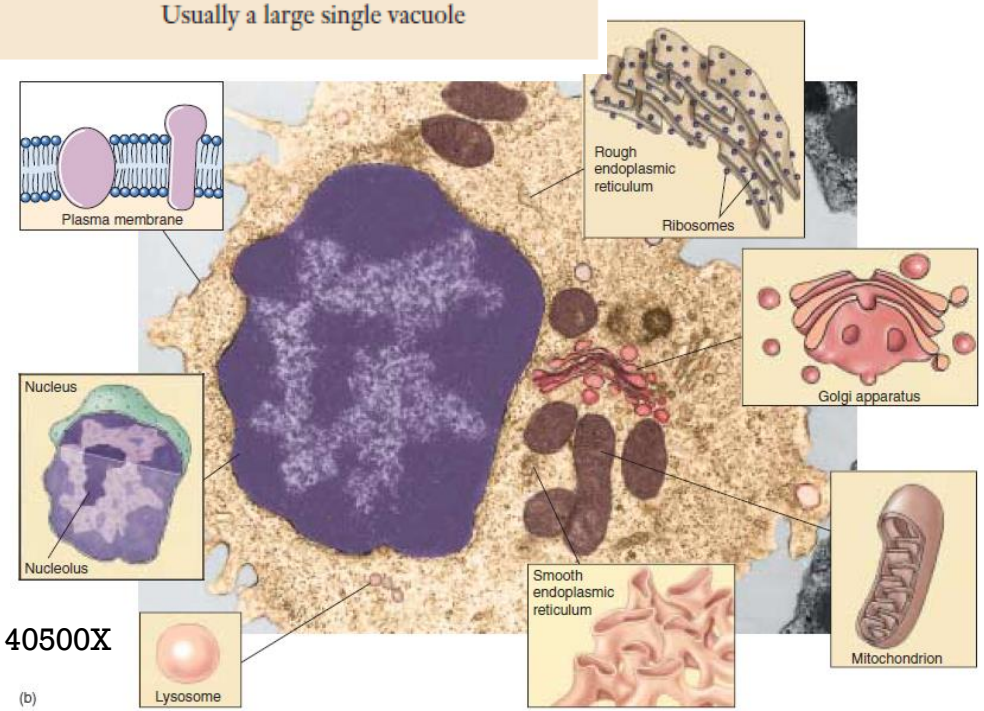
Table 5.2 A Comparison of Bacterial, Animal, and Plant Cells

	Bacterium	Animal	Plant
EXTERIOR STRUCTURES			
Cell wall	Present (protein-polysaccharide)	Absent	Present (cellulose)
Cell membrane	Present	Present	Present
Flagella	May be present (single strand)	May be present	Absent except in sperm of a few species
INTERIOR STRUCTURES			
ER	Absent	Usually present	Usually present
Ribosomes	Present	Present	Present
Microtubules	Absent	Present	Present
Centrioles	Absent	Present	Absent
Golgi apparatus	Absent	Present	Present
Nucleus	Absent	Present	Present
Mitochondria	Absent	Present	Present
Chloroplasts	Absent	Absent	Present
Chromosomes	A single circle of DNA	Multiple; DNA-protein complex	Multiple; DNA-protein complex
Lysosomes	Absent	Usually present	Present
Vacuoles	Absent	Absent or small	Usually a large single vacuole



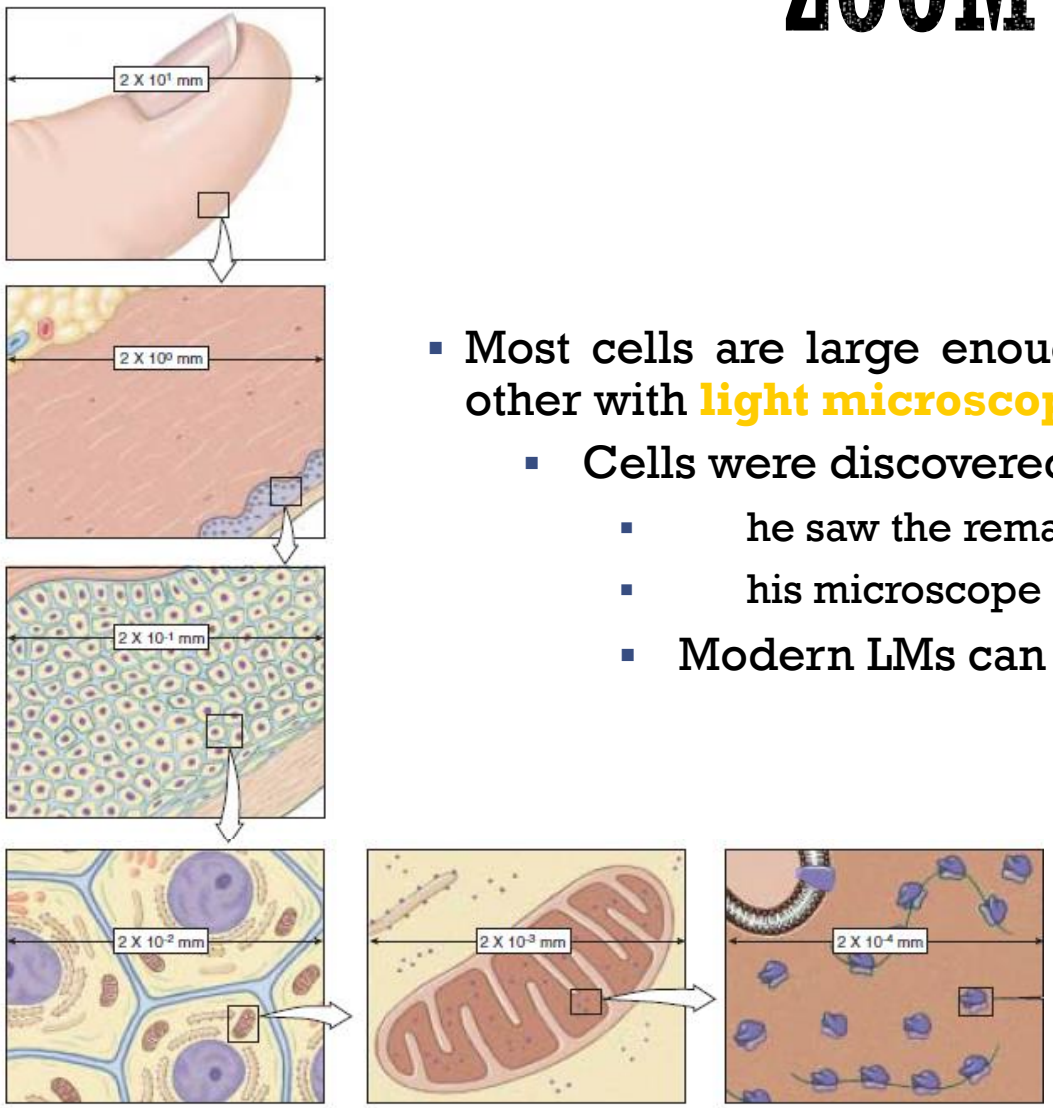
Plant Cell Magnification: 14000X



Animal Cell Magnification: 40500X
(White Blood Cells)

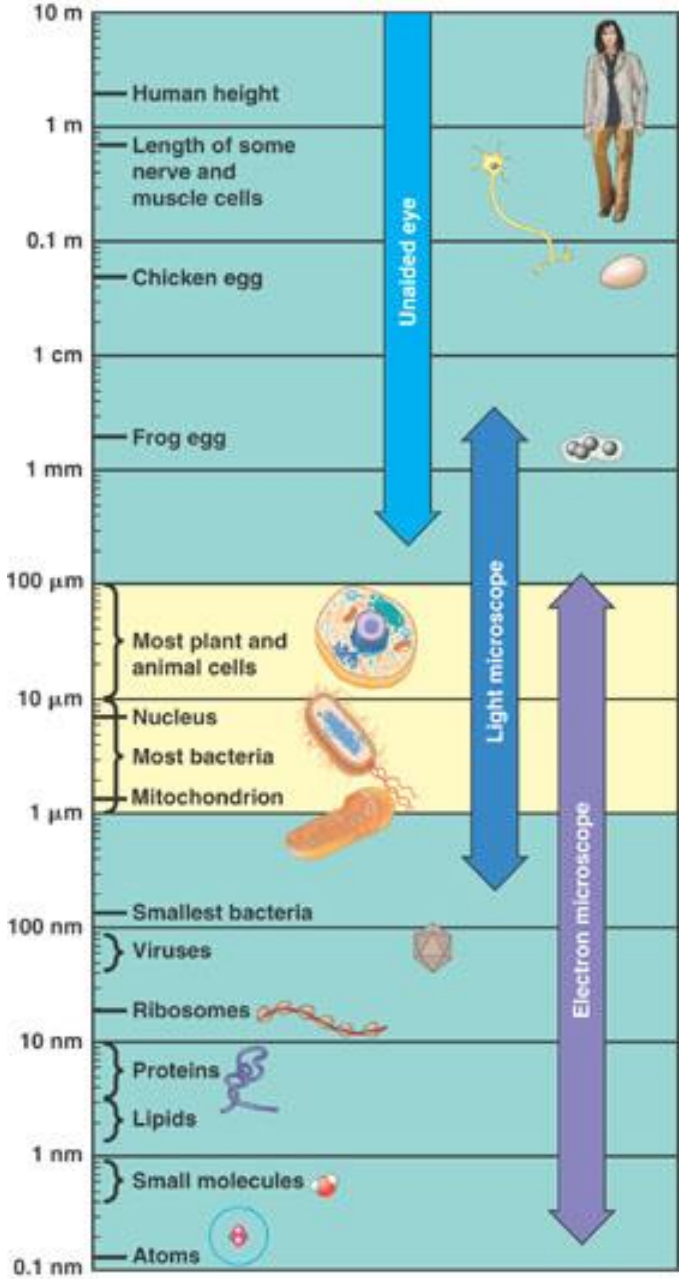
Plant vs Animal Cells

ZOOM IN



- Most cells are large enough to be resolved from each other with **light microscopes** (**LM**)
  - Cells were discovered by Robert Hooke in 1665
    - he saw the remains of cell walls in cork with a LM
    - his microscope had about 30x magnification
  - Modern LMs can reach up to 1000x

SCALE



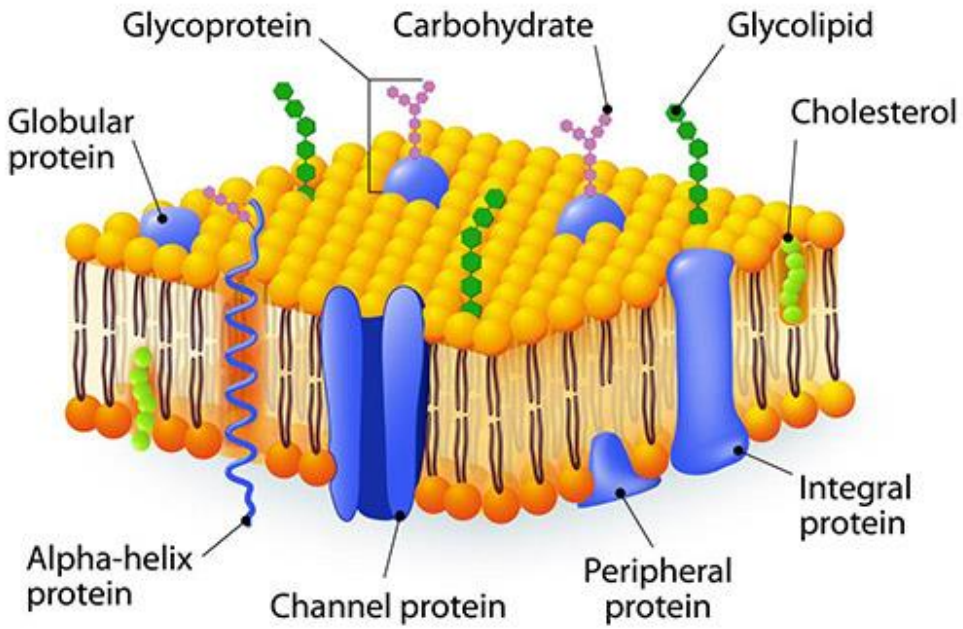
Measurements
1 centimeter (cm) = 10^{-2} meter (m) = 0.4 inch
1 millimeter (mm) = 10^{-3} m
1 micrometer (µm) = 10^{-3} mm = 10^{-6} m
1 nanometer (nm) = 10^{-3} µm = 10^{-9} m

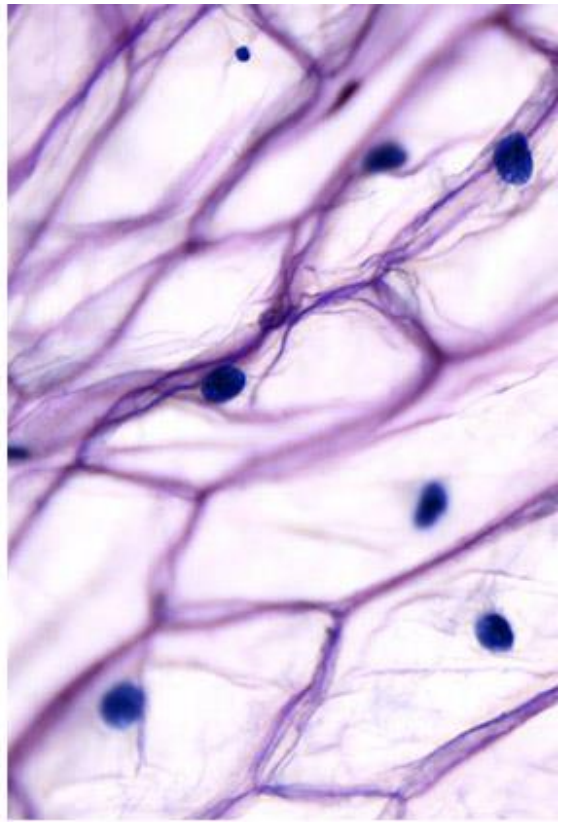
- How do proteins get outside of a cell?
- How do proteins get into a cell membrane?
- How does a cell digest its food?
- How does a cell commit suicide?
- Why would a cell commit suicide?

PLASMA MEMBRANE

FUNCTIONS OF PLASMA MEMBRANE

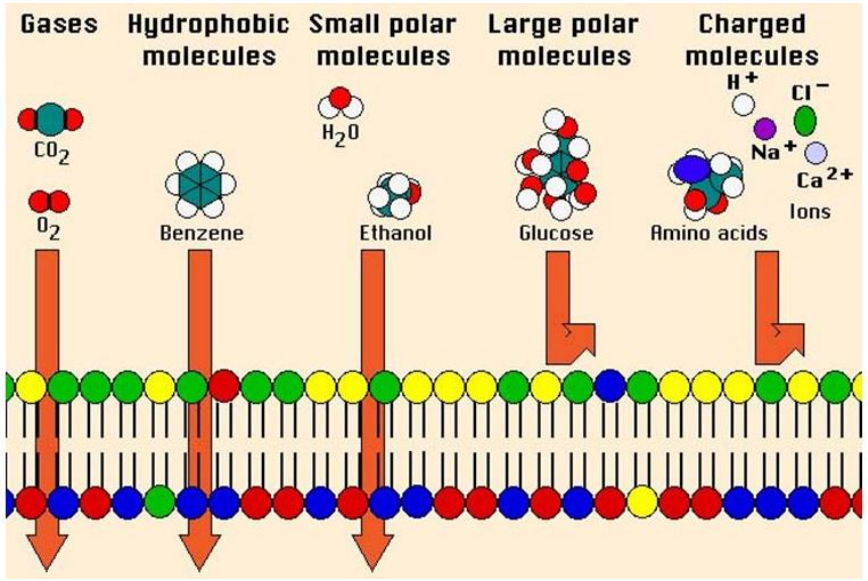
- **Protective**:- Forms outermost boundary of the cells.
- **Digestive**:-Takes in food and excretes waste products.
- **Selective Permeability**:-Helps in transport across the membrane.
- Contains cell **surface receptors** (e.g: Glycoprotein receptors present on RBCs).
- **Cell Adhesion Molecules** (Cadherins) present on the plasma membrane of certain cells plays an important role in the process of inflammation.
- **Junctions:** Helps in formation of various types of junction (Adherens & Anchoring) along with the help of cytoskeleton elements.

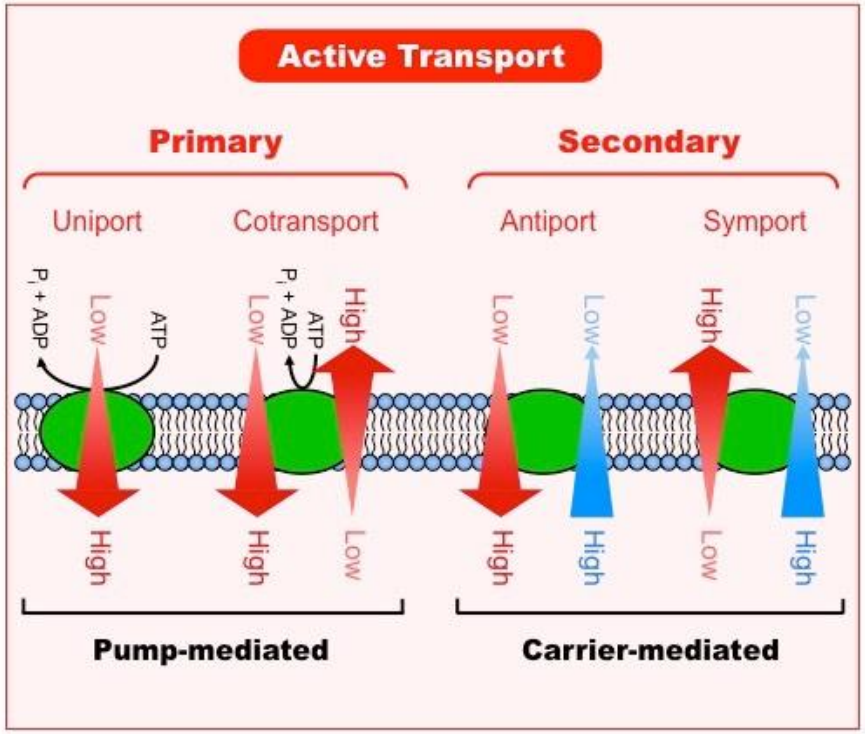


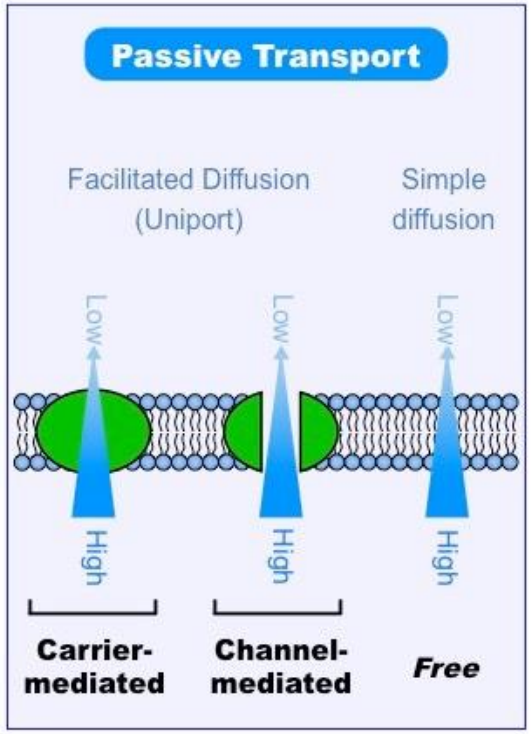


Video Link

PLASMA MEMBRANE

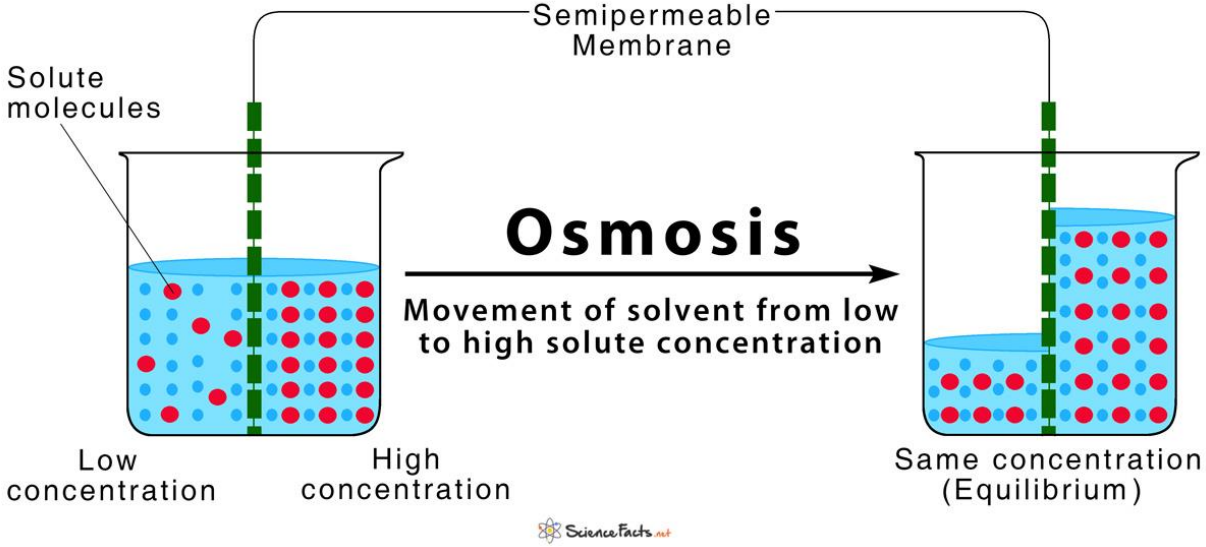


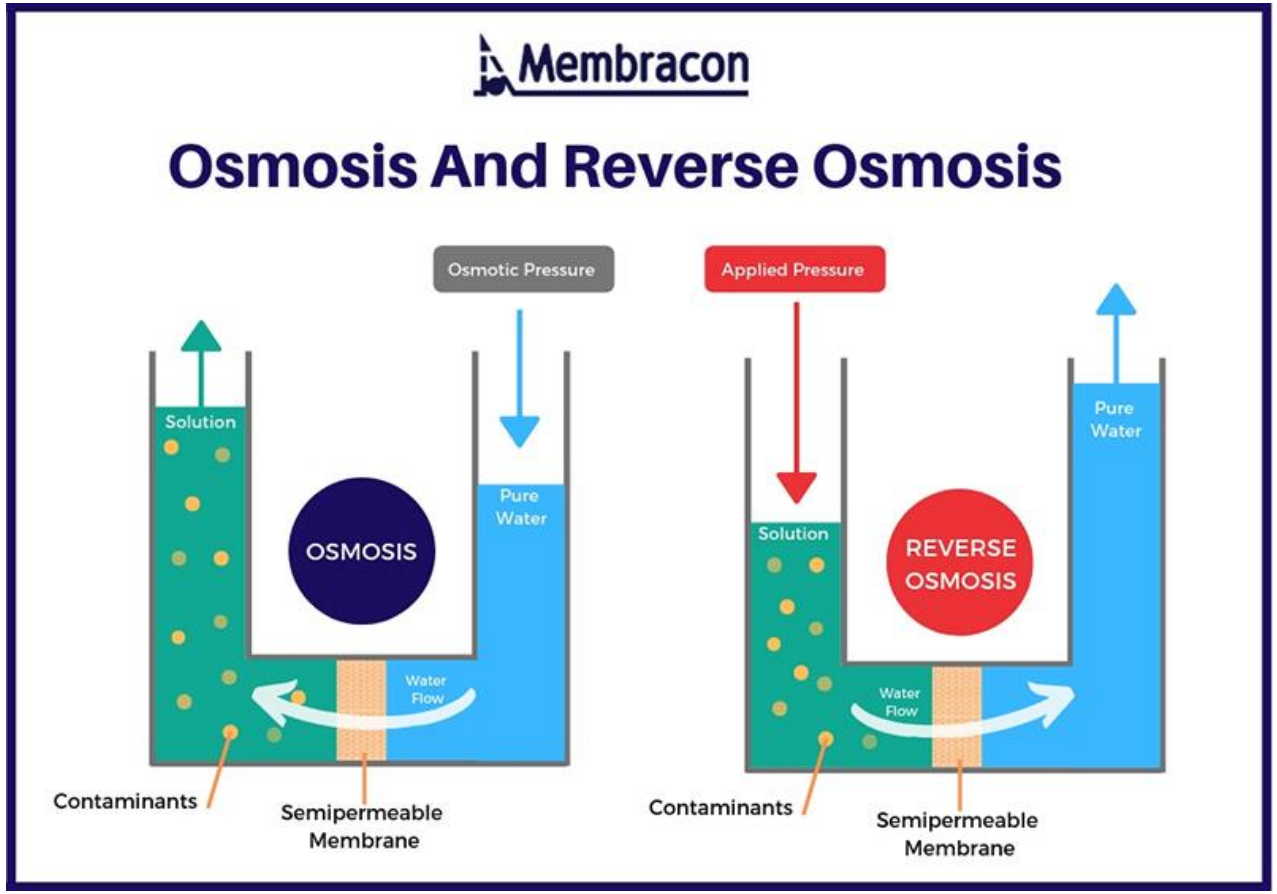




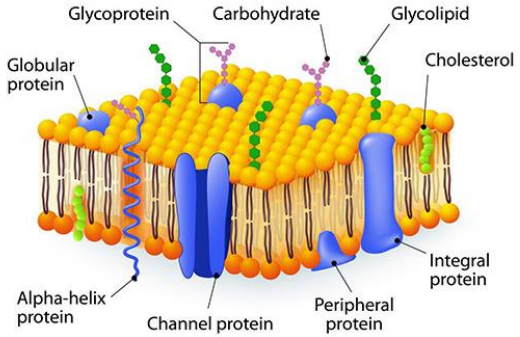
[Video Link]

OSMOSIS VS REVERSE OSMOSIS





BLOOD GROUPS



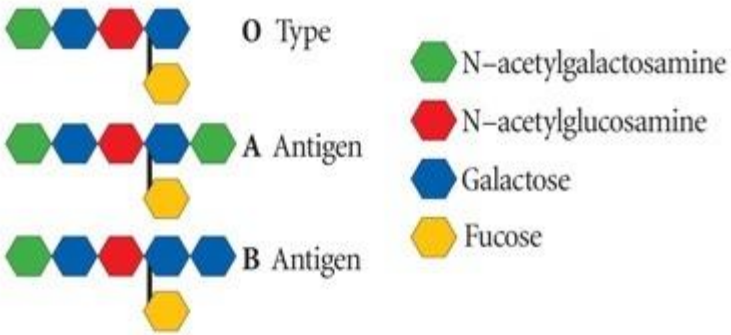
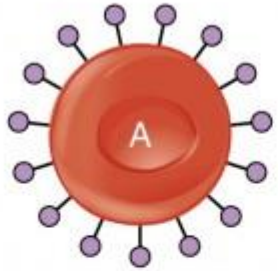
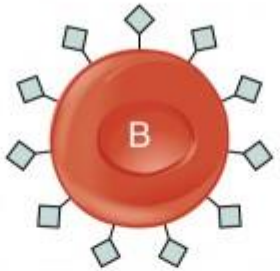
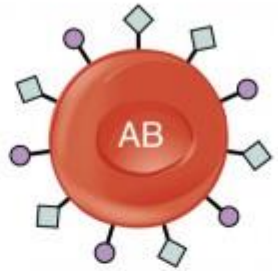
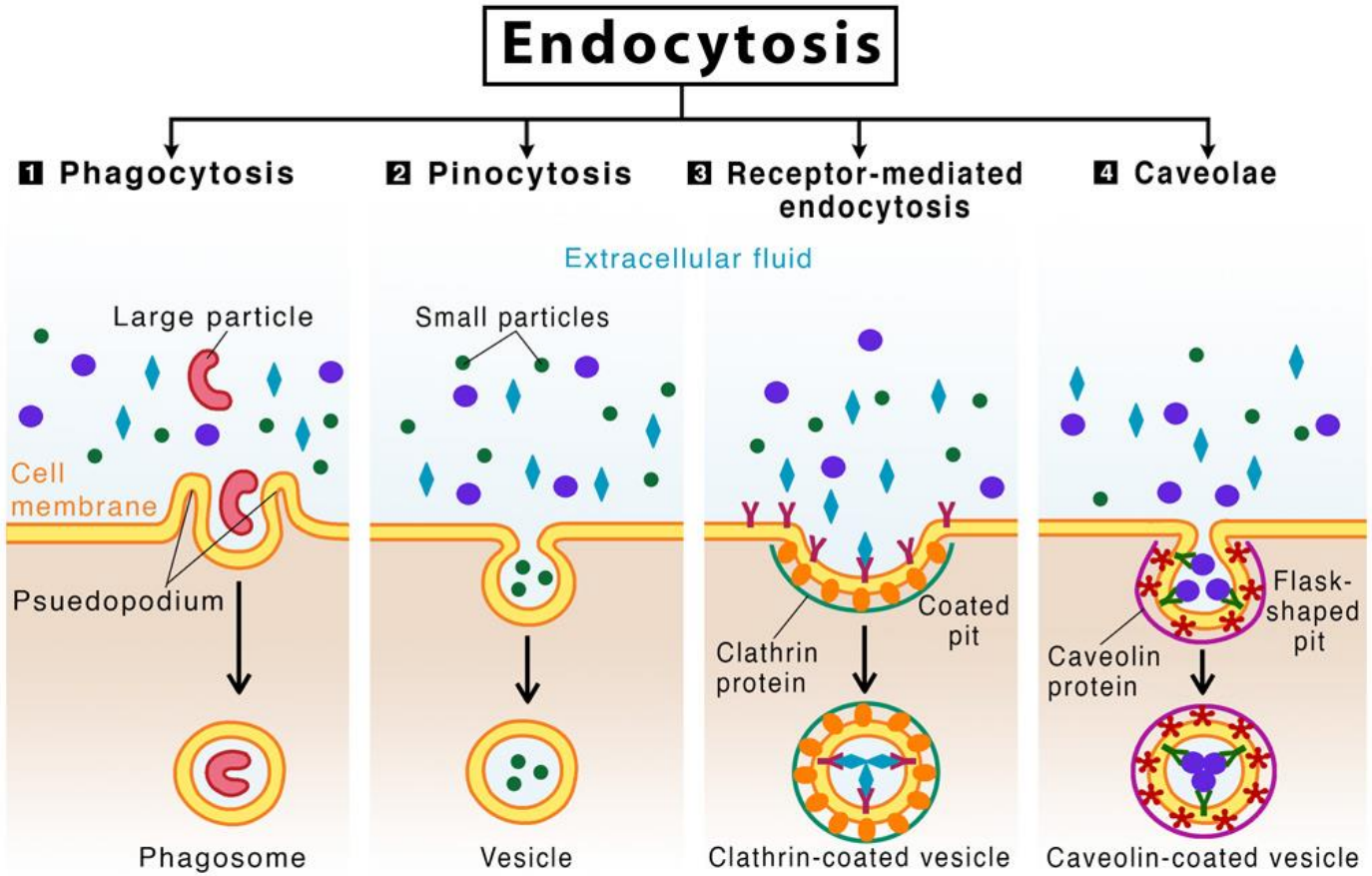
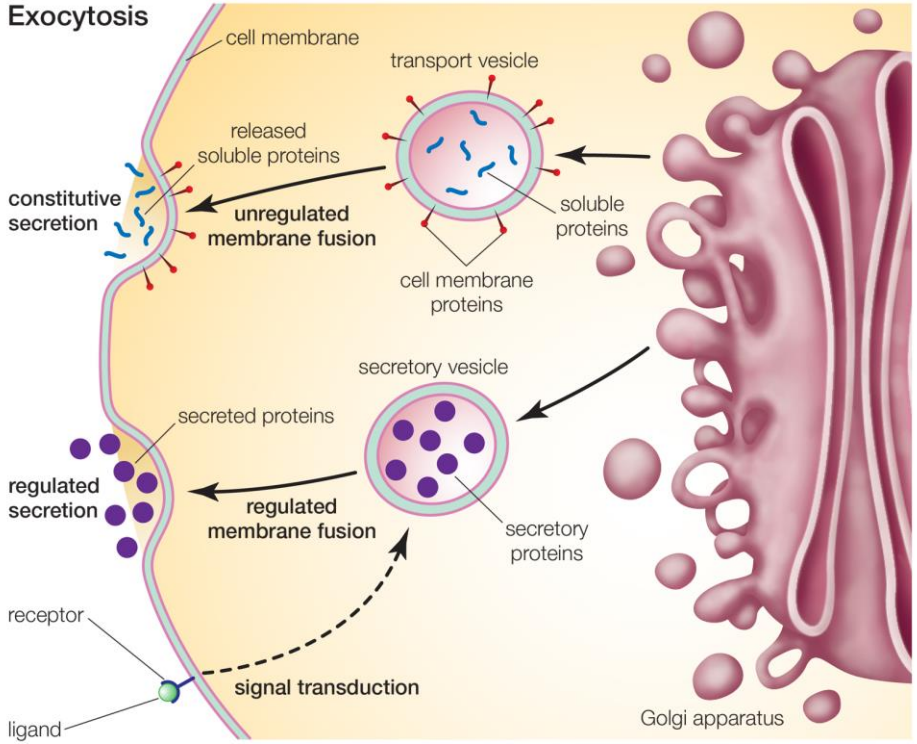


Figure 1. ABO antigen specificity. The ABO antigens differ by just one sugar at the antigen terminus. Only the carbohydrate portion of the antigen is illustrated.

	Blood Type			
	A	B	AB	O
Red Blood Cell Type				
Antibodies in Plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in Red blood Cell	 A antigen	 B antigen	 A and B antigens	None
Blood Types Compatible in an Emergency	A, O	B, O	A, B, AB, O (AB^+ is the universal recipient)	O (O is the universal donor)

PLASMA MEMBRANE-TRANSPORT

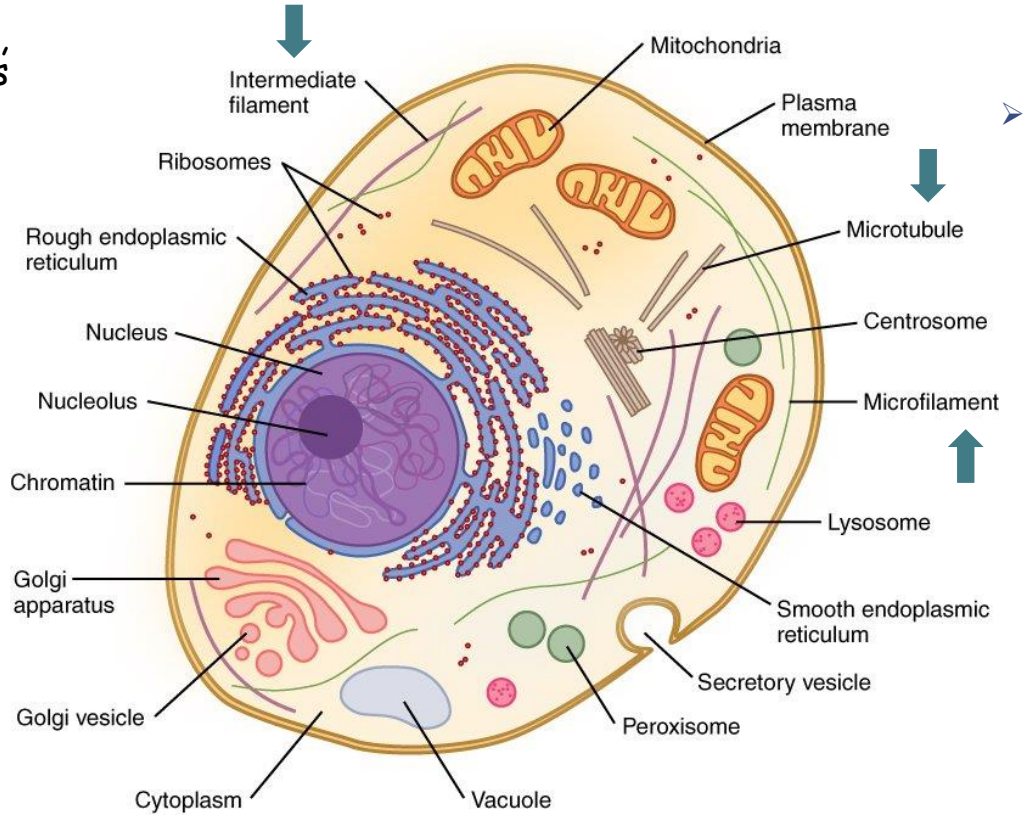




>1μm >250nm ~120nm ~80nm

CYTOPLASM

- Water-like substance fills the space between the plasma membrane and the nuclear membrane
- Consists of **cytosol** and **cellular organelles** except for the cell nucleus.
- **Cytosol** is made up of water, salts, organic molecules and many enzymes that catalyze reactions.



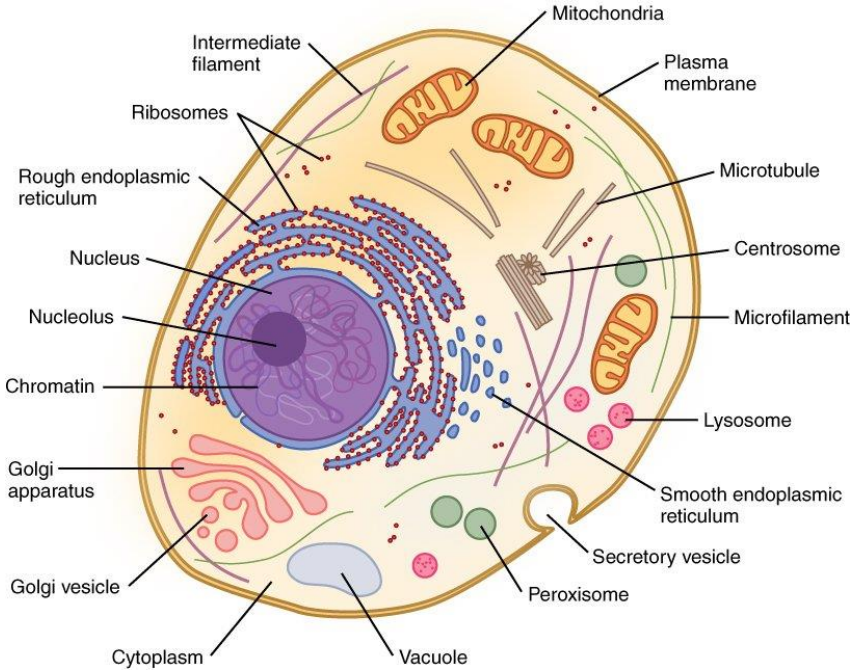
CYTOSKELETON

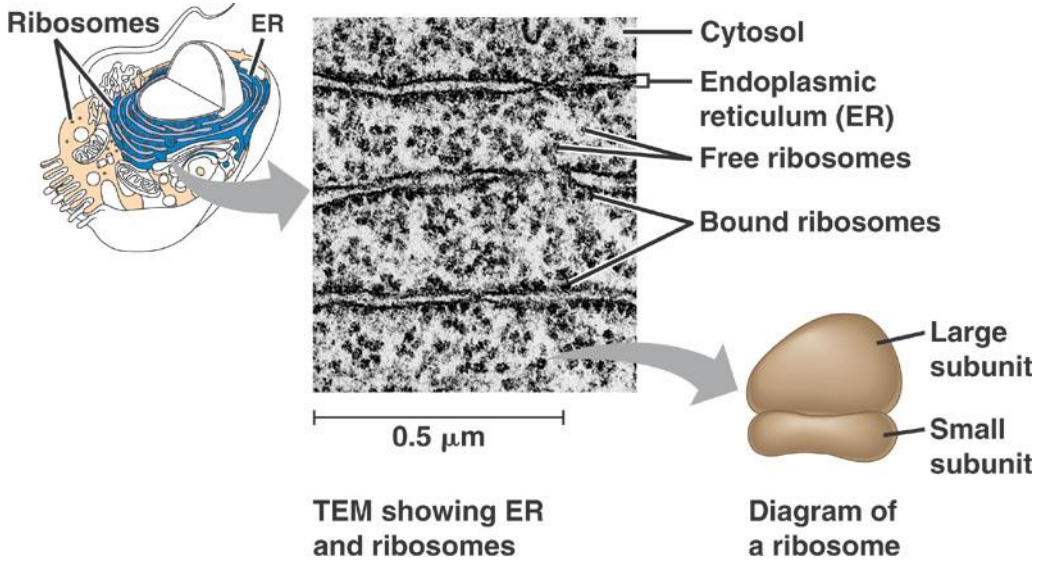
- Maintains cell shape.
- Protects the cell.
- Plays important roles in intra-cellular transport (the movement of vesicles and organelles).
- Plays important role in cell division.

RIBOSOME- PROTEIN FACTORIES

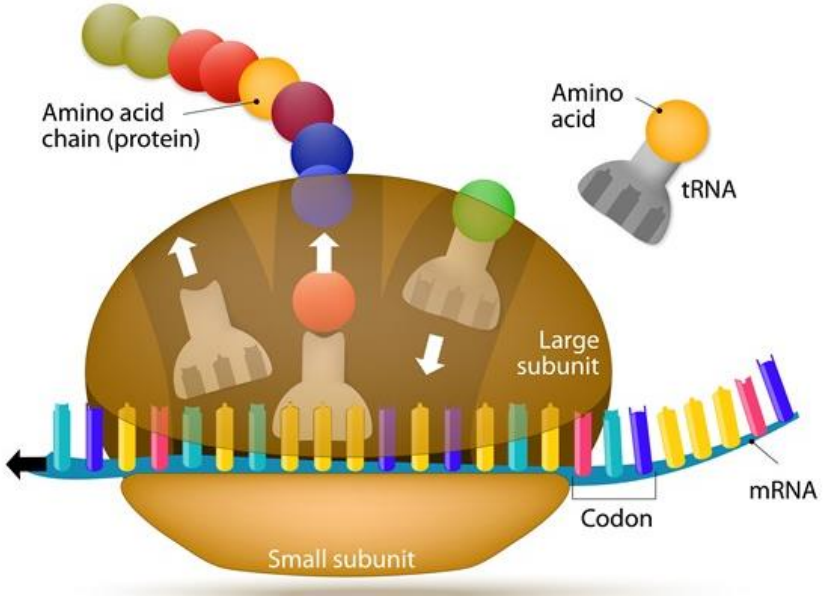
Granular bodies which are made up of ribonucleoprotein (RNA+Protein)

- two main subunits- large and small
- perform the enzymatic activity for forming peptide bonds, and serve as the sites of translation of genetic information (mRNA) into protein
- some are free in the cytoplasm while others are associated with the endoplasmic reticulum (ER)



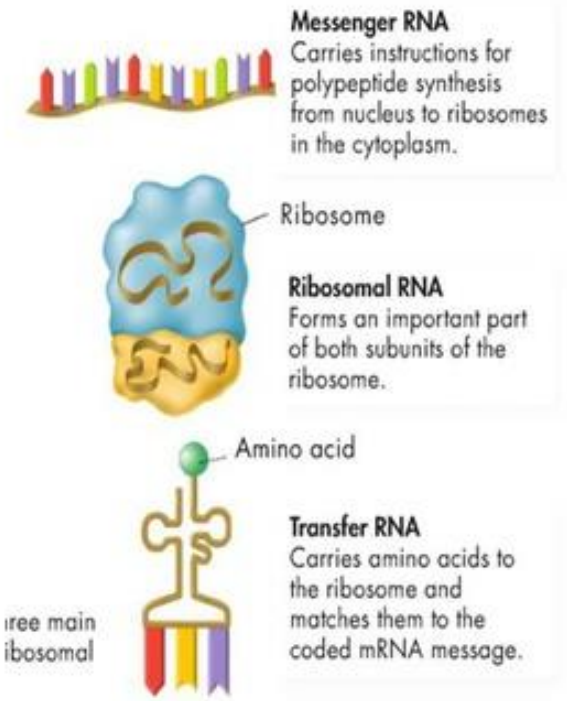


RIBOSOME-ZOOM IN

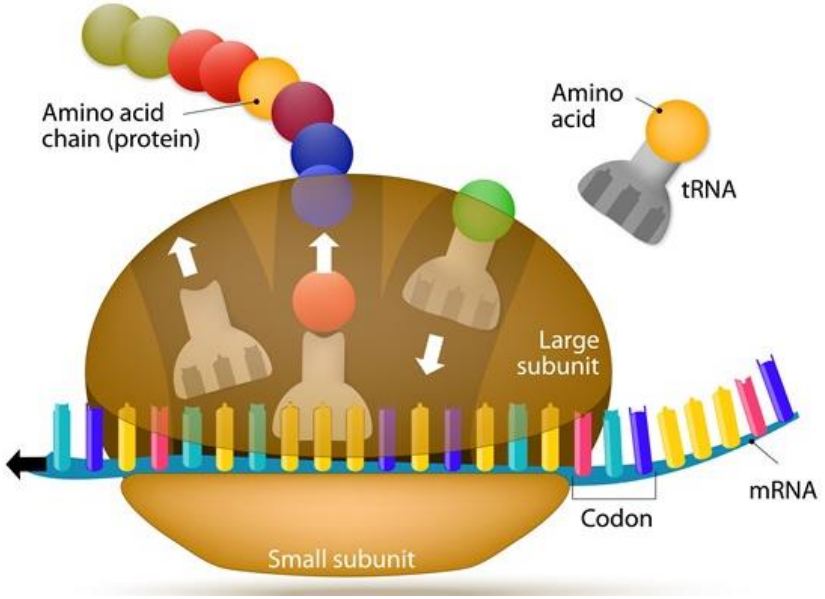


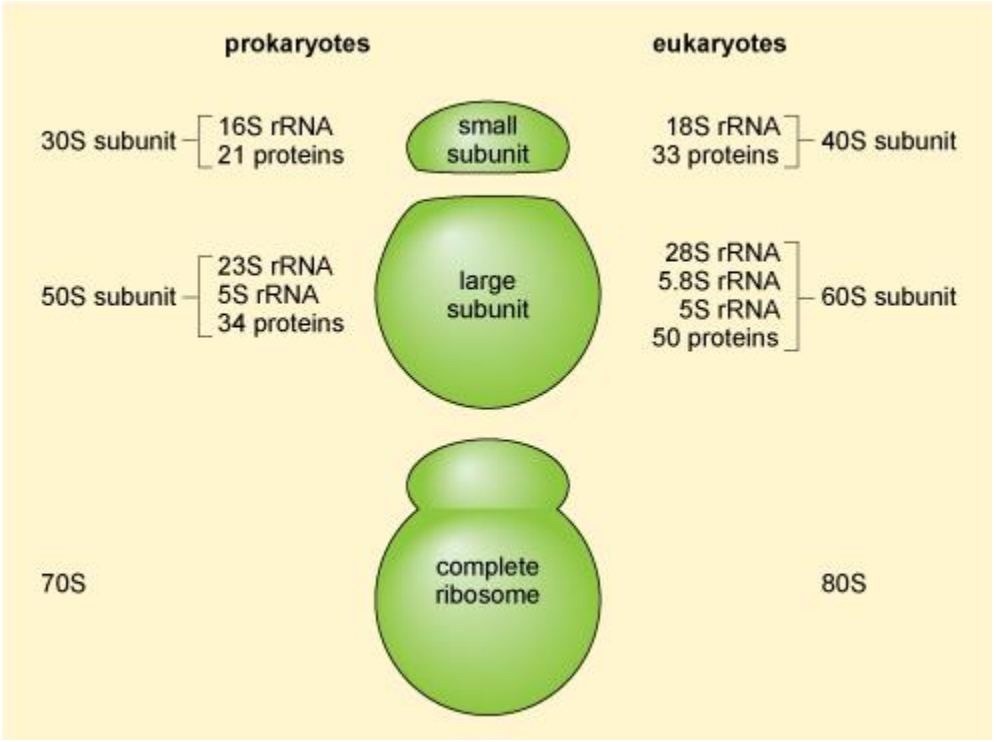
RNA Functions

- Three different types of RNA:
  - mRNA (messenger) used as template to make proteins
  - rRNA (ribosomal) makes up ribosomes
  - tRNA (transfer) matches amino acids to mRNA to help make proteins

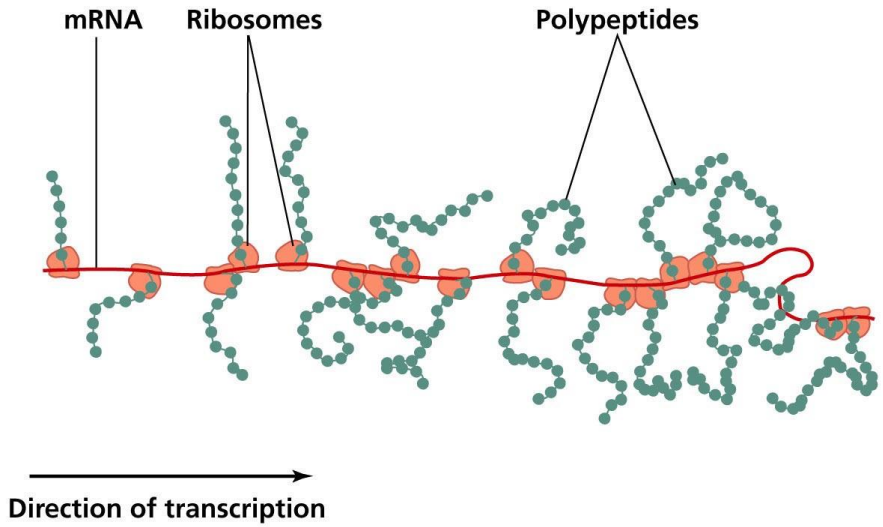


RIBOSOME-ZOOM IN





POLYRIBOSOME IN ACTION

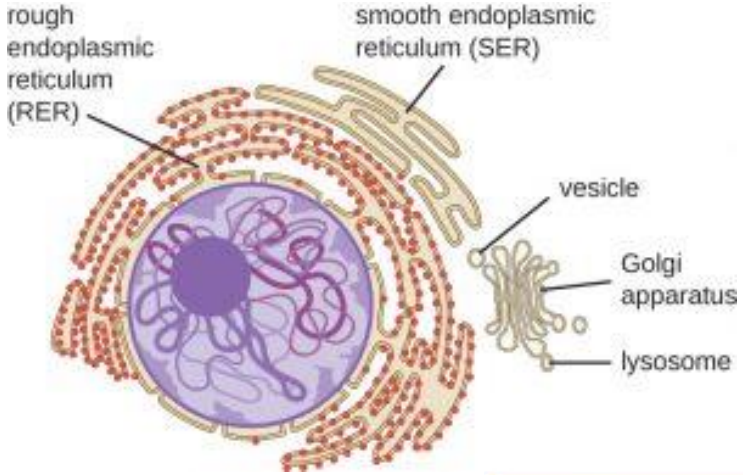


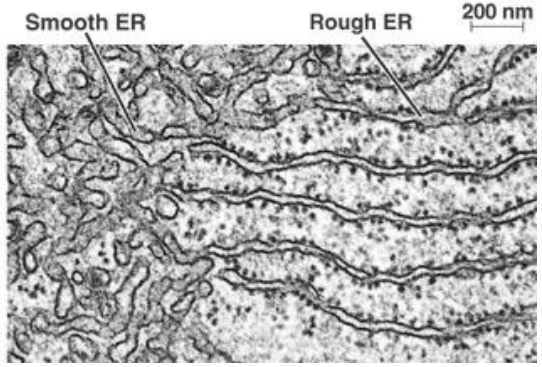
Link

Single mRNA can lead to formation of multiple proteins as per requirement

ENDOPLASMIC RETICULUM (ER)

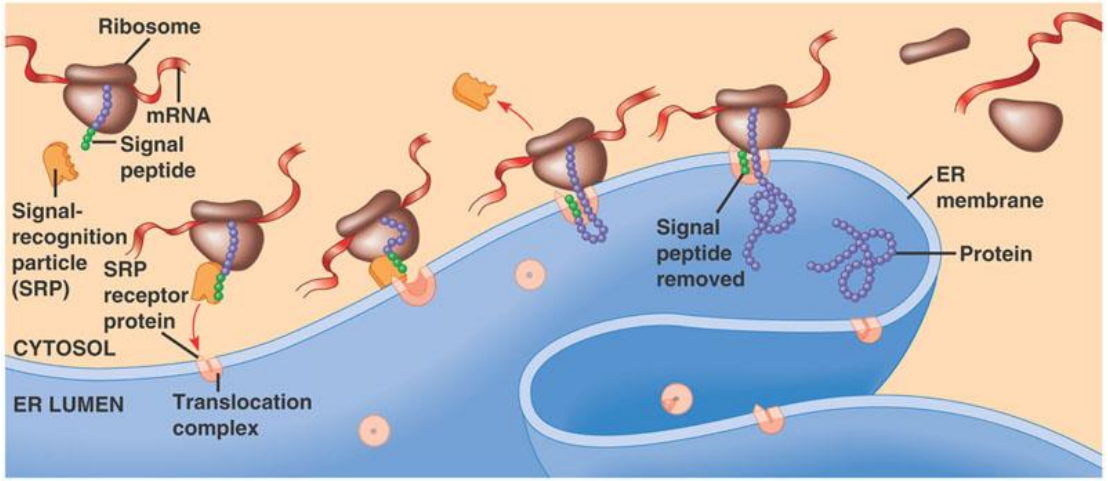
- Make and package proteins and lipids
- Much like an assembly line
- Found in eukaryotic organisms
- Forms an interconnected network of flattened, membrane-endosed sacs or tubes known as cisternae.
- Largest organelle in eukaryotic cell.
- It provides separate chemical environment which allows for correct protein folding.
- Two types
  - Rough Endoplasmic Reticulum
  - Smooth Endoplasmic Reticulum





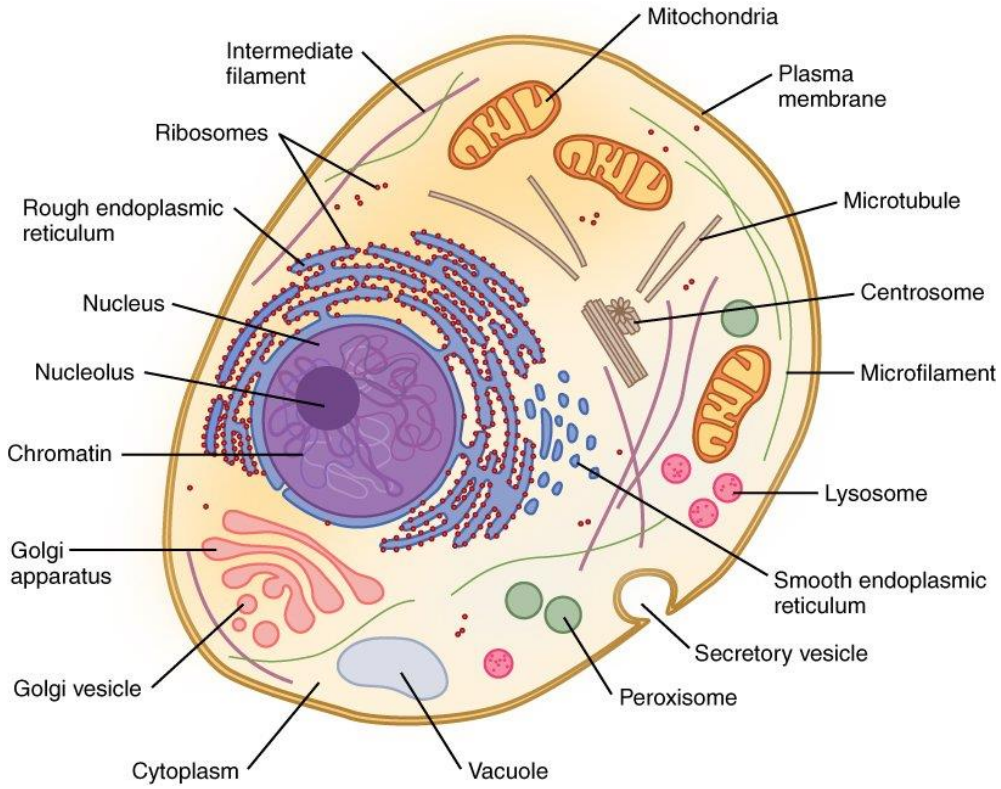
Smooth ER – primary site of lipid synthesis, many detoxification reactions in liver cells

Rough ER – ribosomes that attach & insert proteins into the ER lumen as they are synthesized



ENDOPLASMIC RETICULUM (ER)

- Endoplasmic reticulum (**ER**) – membrane network that winds through the cytoplasm
  - winding nature of the ER provides a lot of surface area
  - many important cell reactions or sorting functions require ER membrane surface
  - **ER lumen** – internal aqueous compartment

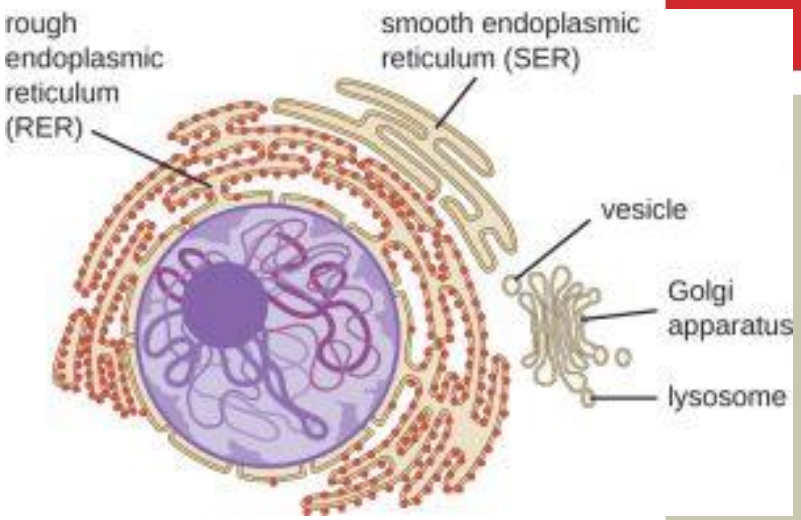


- Proteins processed:

Soluble- ER Lumen

Membrane bound- ER membrane

SMOOTH VS ROUGH ER

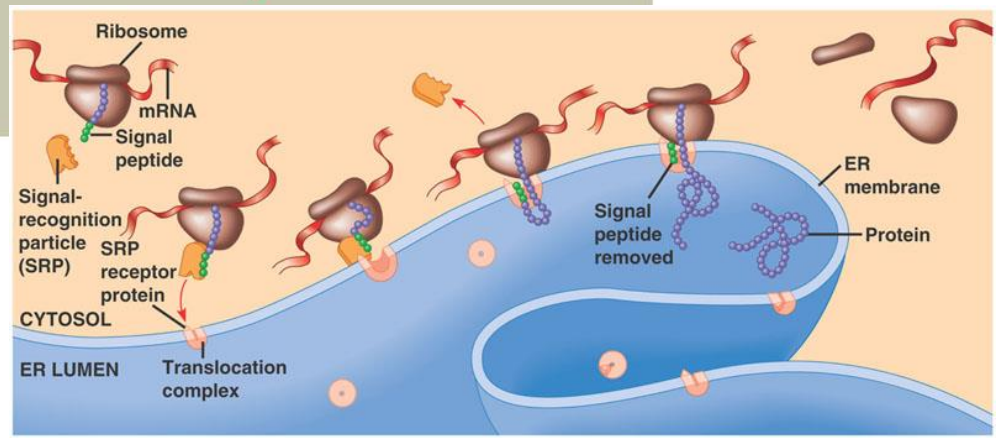


Smooth ER

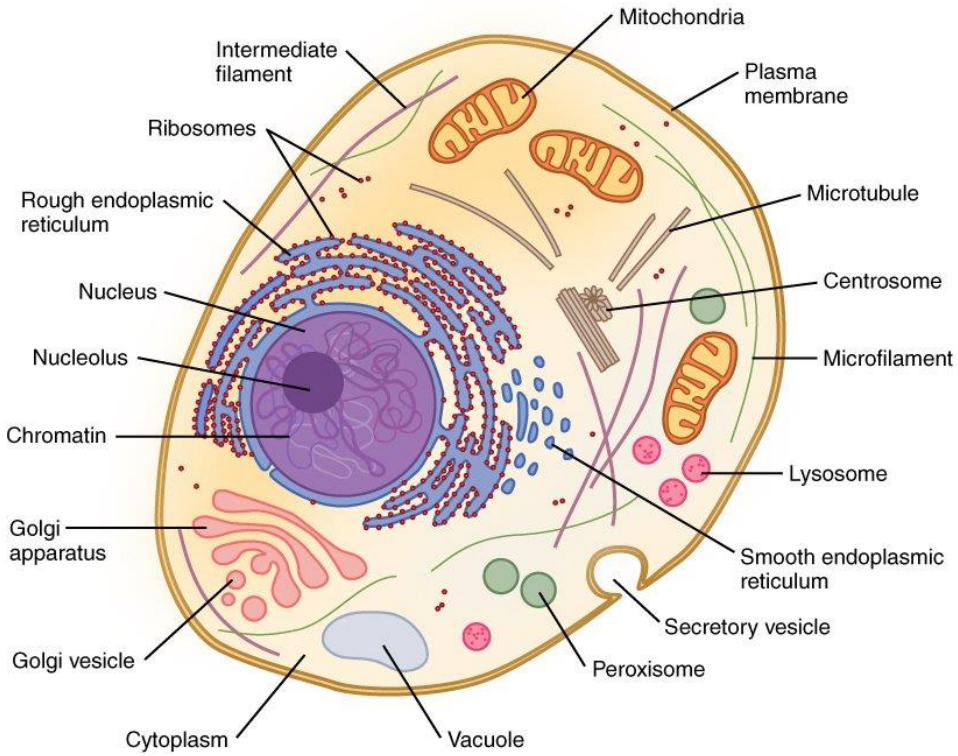
- Synthesizes lipids
- Metabolizes carbohydrates
- Detoxifies drugs and poisons
- Stores calcium ions

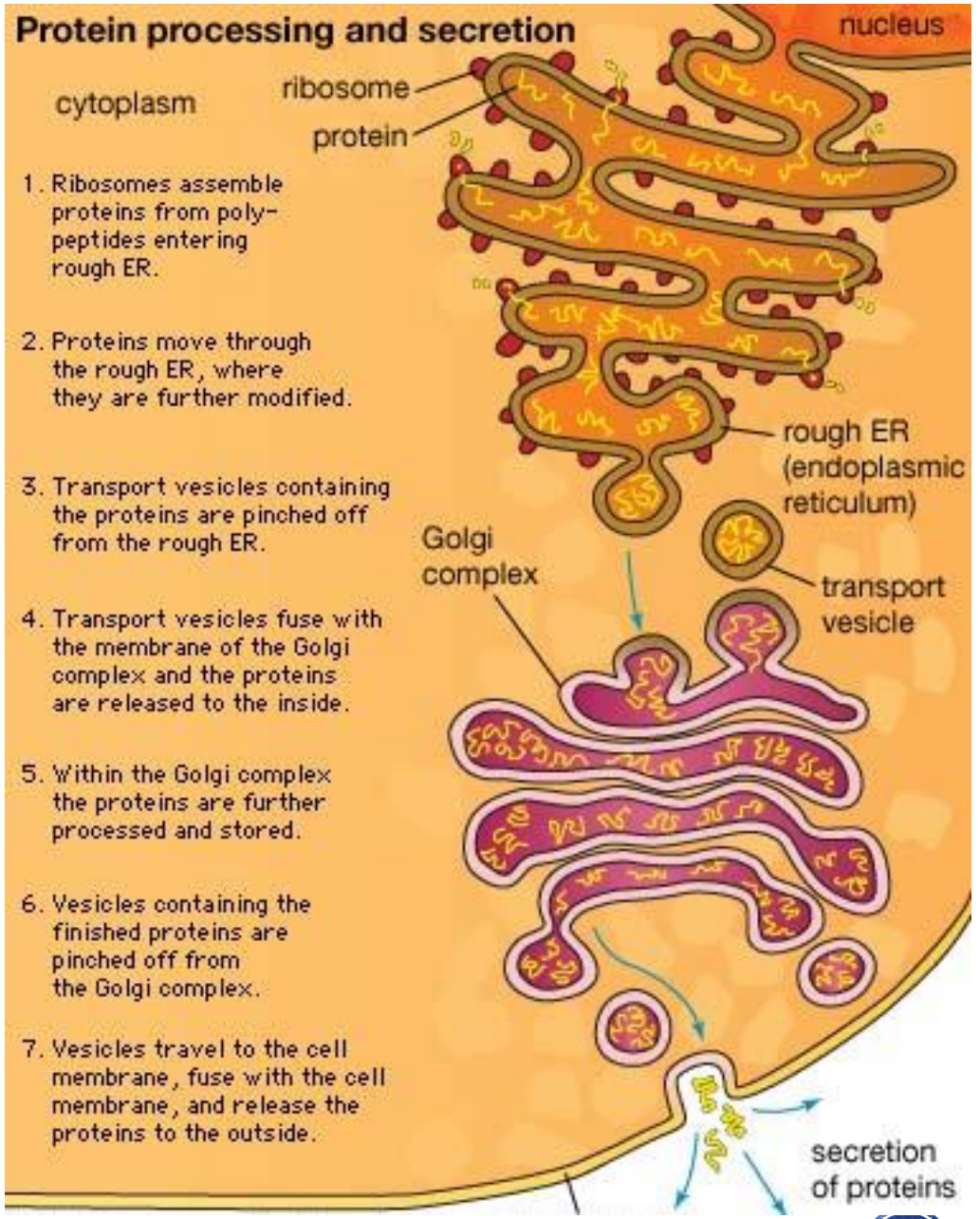
Rough ER

- Has bound ribosomes, which secrete **glycoproteins**
- Distributes **transport vesicles**
- Is a membrane factory for the cell



ROUGH ER TO GOLGI BODIES

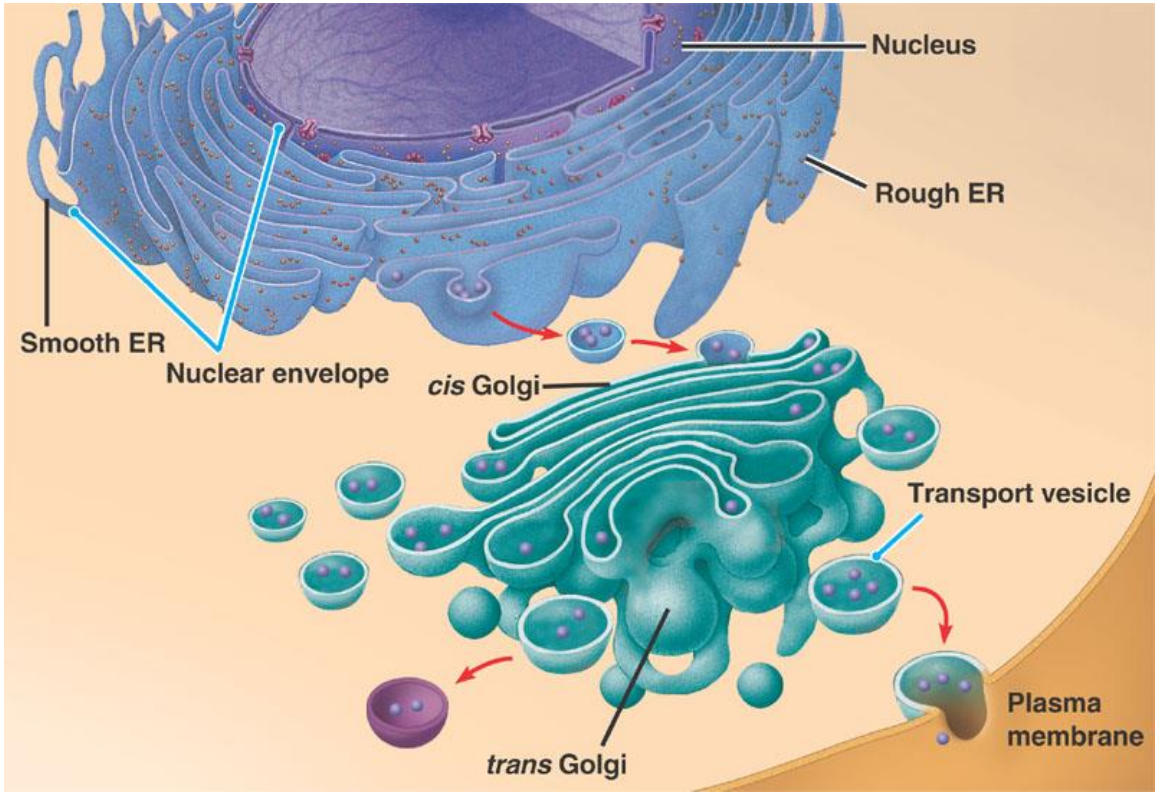




[Video Link]

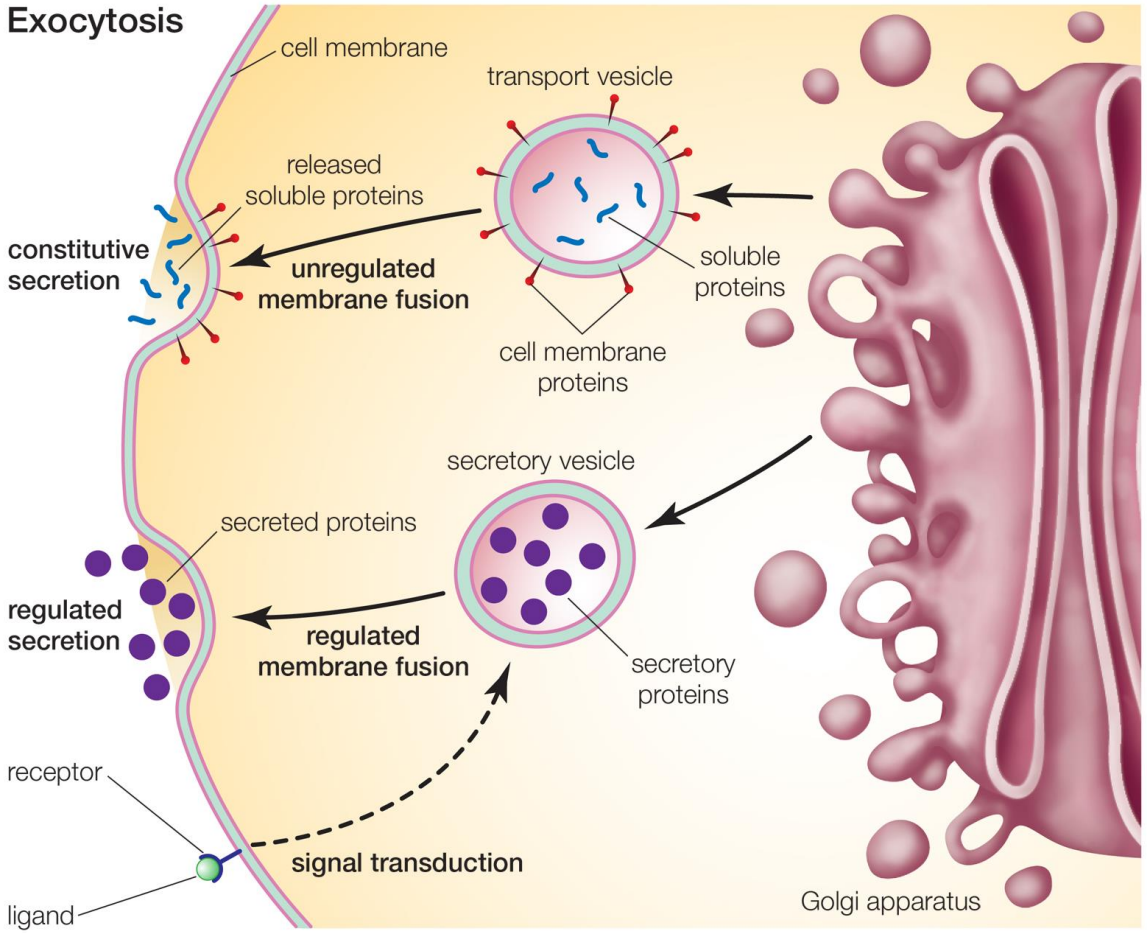
GOLGI BODIES-POST OFFICE

- Glycosylation of proteins and lipids
- Processing, sorting and transport of membrane molecules
- Carbohydrate and lipid metabolism
- Synthesis of complex polysaccharides for cell wall
- Produce mucus
- Packages products into vesicles for transport



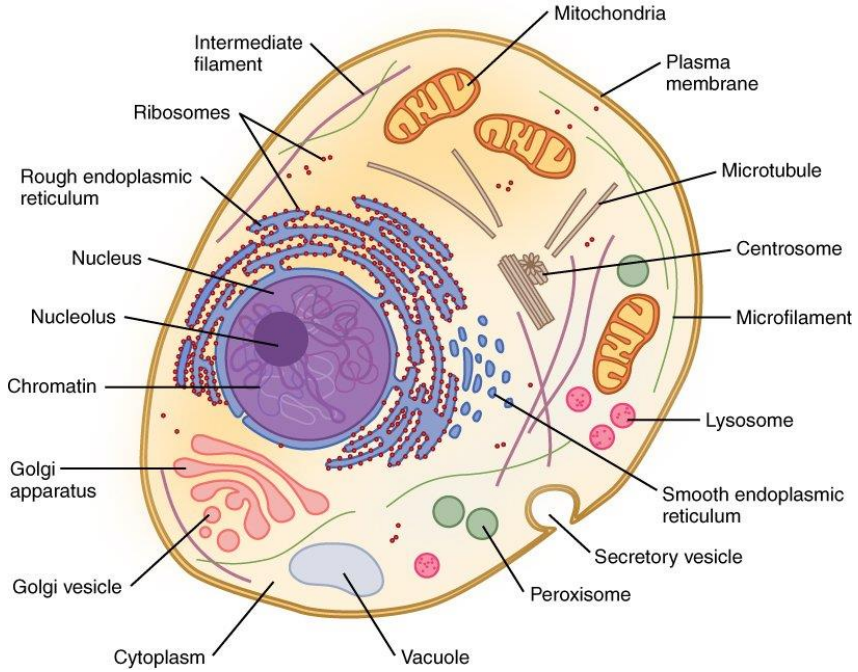
RER → ER-Golgi vesicles → Golgi Cisternae Network → Secretory Vesicles → Cell Exterior

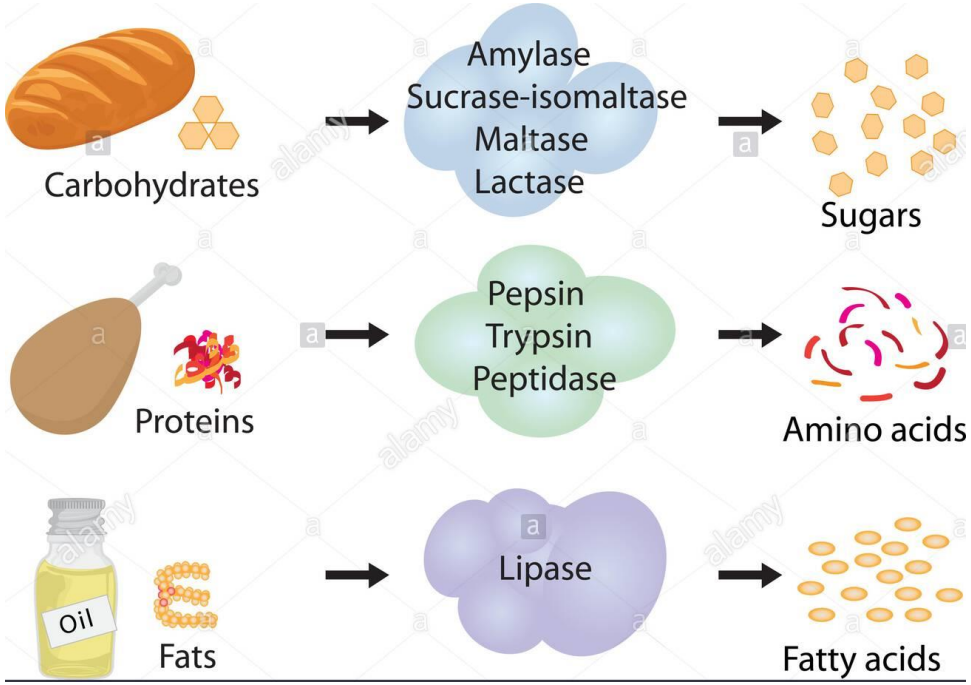
GOLGI BODIES-POST OFFICE/ EXOCYTOSIS



LYSOSOME- DIGESTIVE SYSTEM

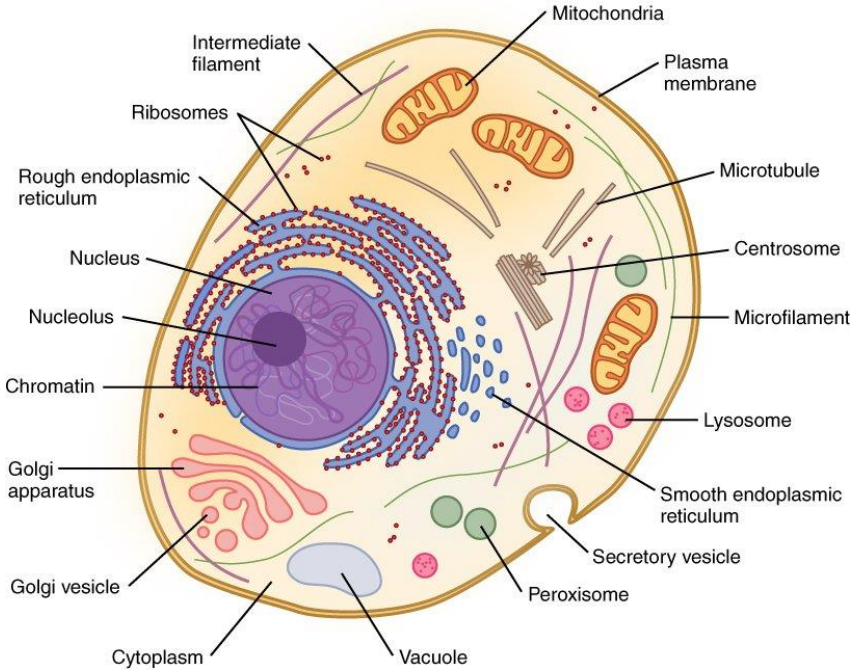
- Vary in size and shape
- Acidic pH (5) maintained by H+ ATPase pumps
- Hydrolytic enzymes- protease, nuclease, glycosidase, lipase
- Microbial killing via phagocytosis of immune cells
- Heterophagy and autophagy (self-eating)

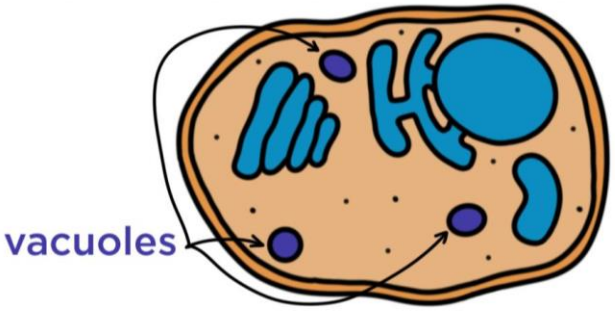
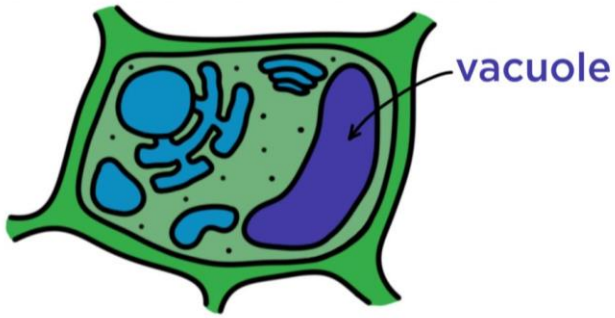




VACUOLES

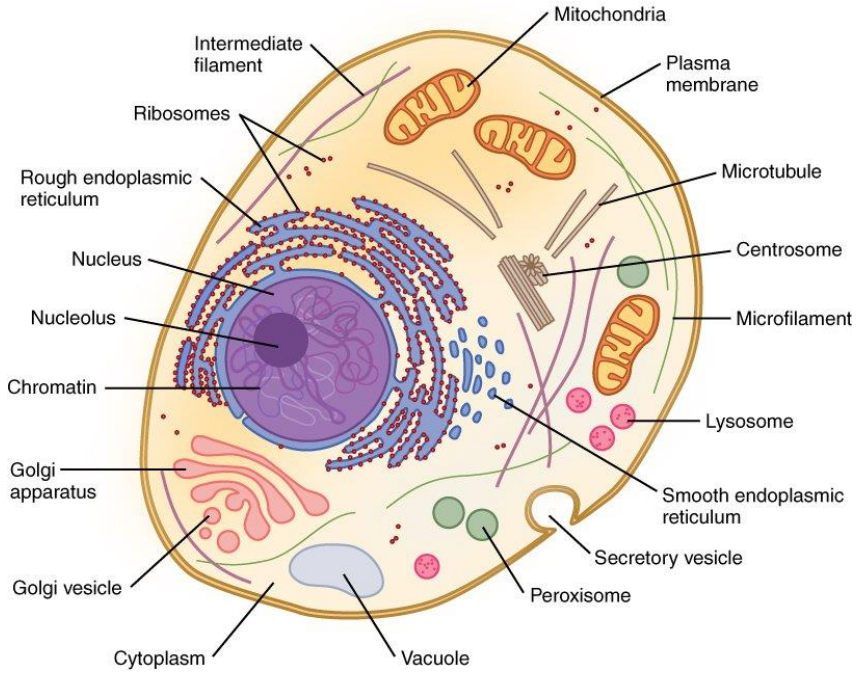
- Plant and fungal cells
- Membrane called tonoplast
- Filled with water, ions, acids, sugars, enzymes
- Amoeba and paramecium have contractile vacuole

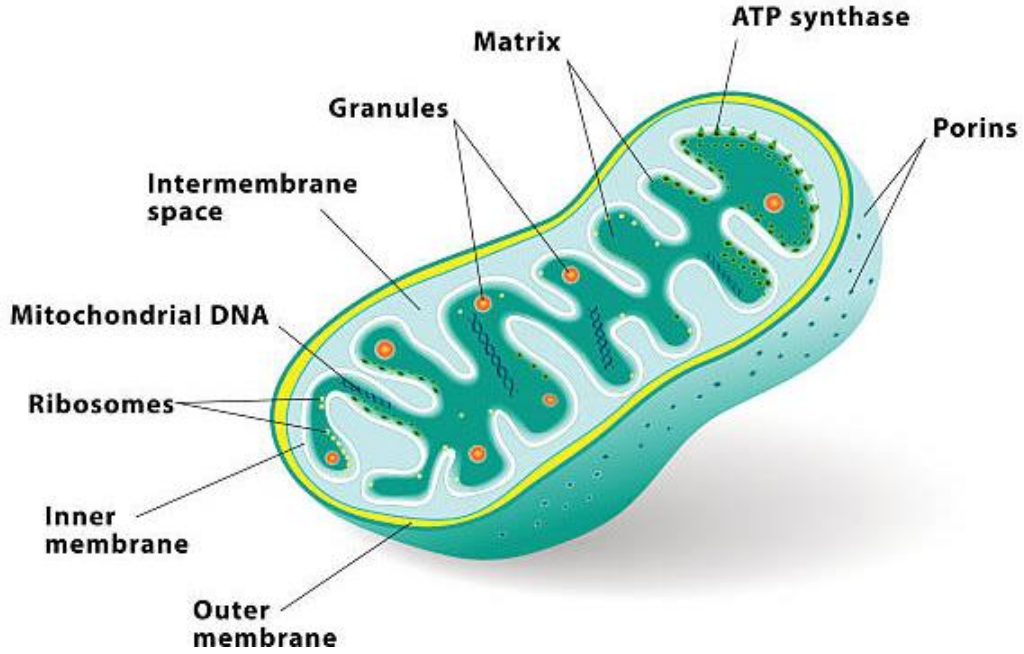


ANIMAL CELL	PLANT CELL
	
· several small vacuoles · used for storage · can contain nutrients, water, or waste	· one large vacuole · used to store water and push against the cell wall · keeps the plant rigid

MITOCHONDRIA

- Powerhouse of cells
- Produce celluar energy in the form of ATP through aerobic respiration
- Double membrane
- Humans have 16.6 kilobase sized DNA in mitochondria (mtDNA)
- Maternal Inheritence
- Divide on their own





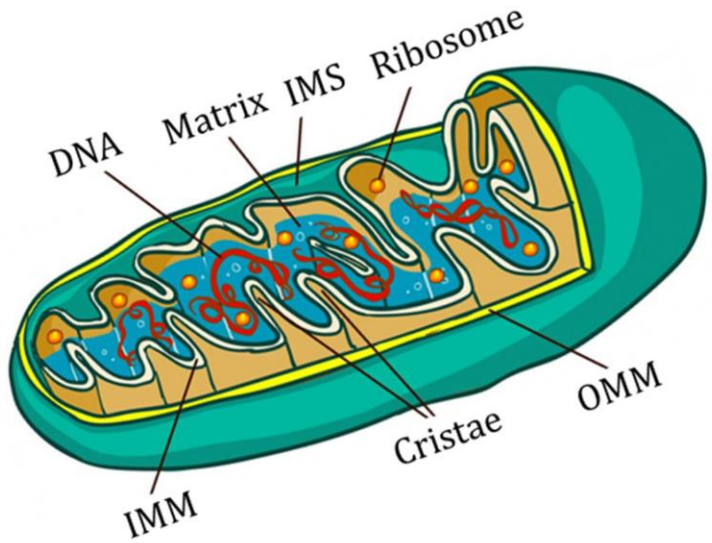
MITOCHONDRIA

Skeletal Muscle & Movement Disorders

Neurologic Disorders & Autism

Metabolic Disorders & Diabetes

Renal Diseases



Mitochondrial Diseases

Dystrophies

Cancer

Aging

Cardiac Diseases

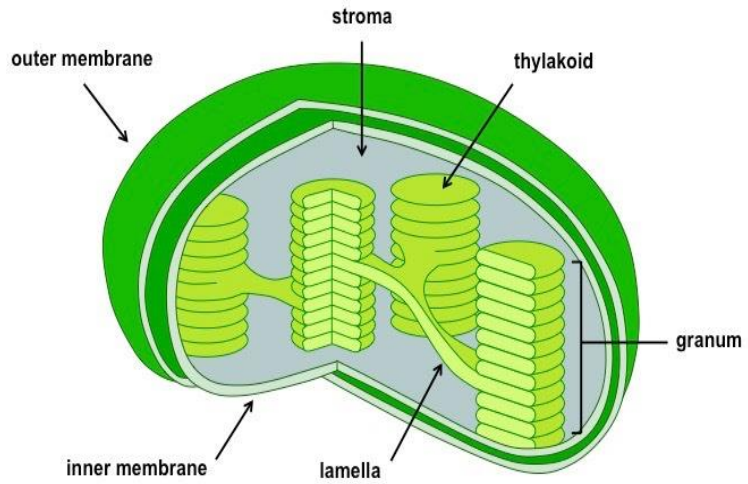
Vascular Diseases & Atherosclerosis

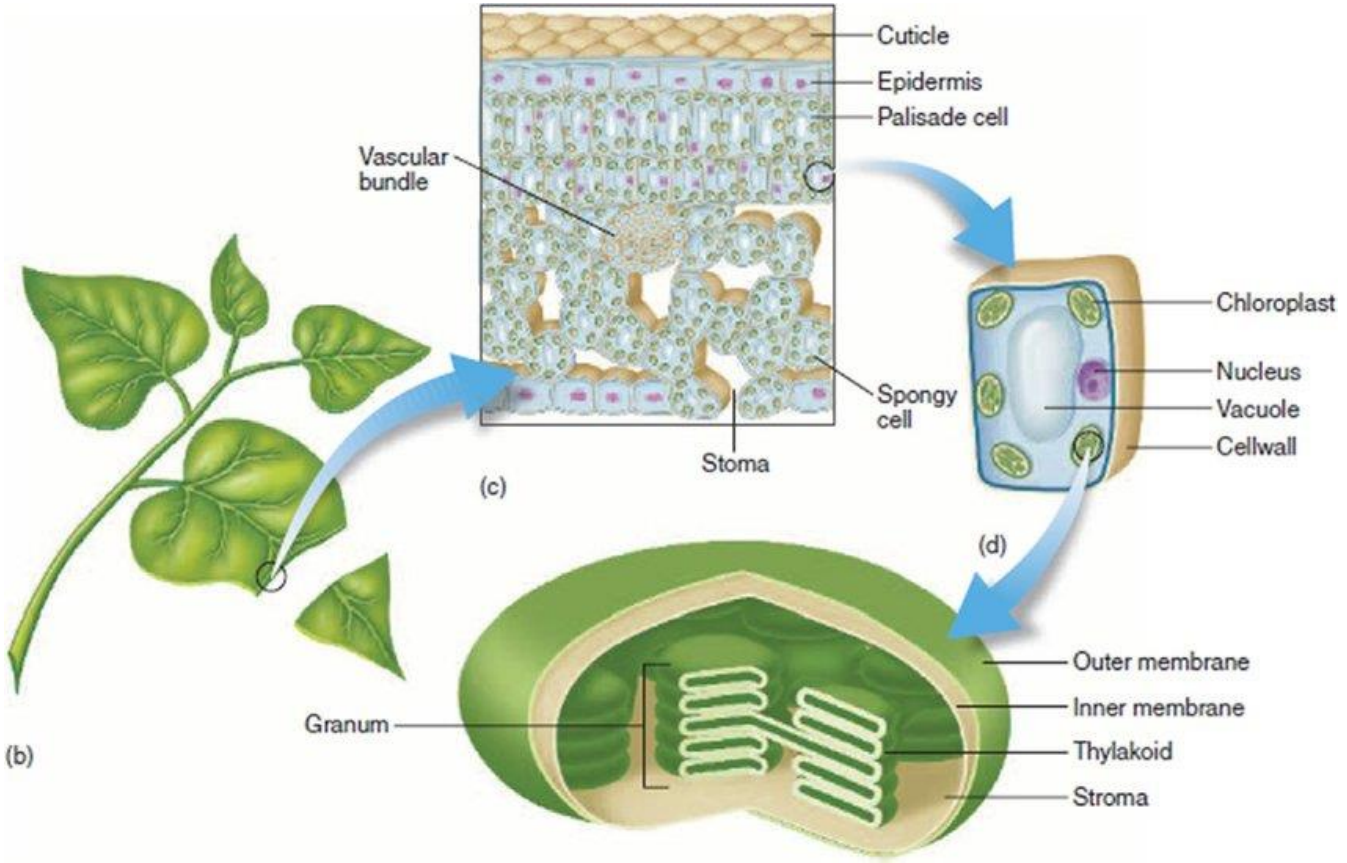
Neurodegenerative Diseases

Pulmonary & Respiratory Disorders

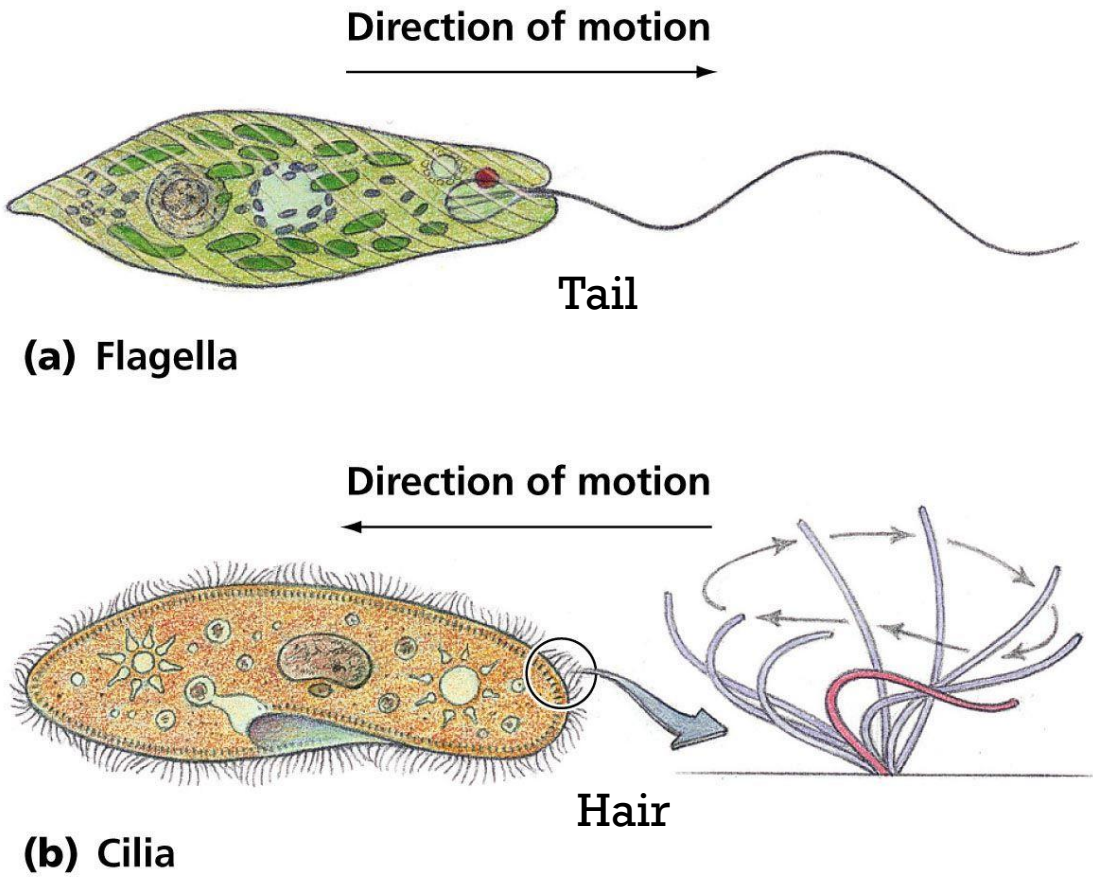
CHLOROPLAST

- Double membrane bound organelle called plastids
- Differentiate as leucoplast, chromoplast, chloroplast
- Flattened sacs called granum, stacked together called thylakoids
- Comprised mainly of lipids
- Self-replicating organelles

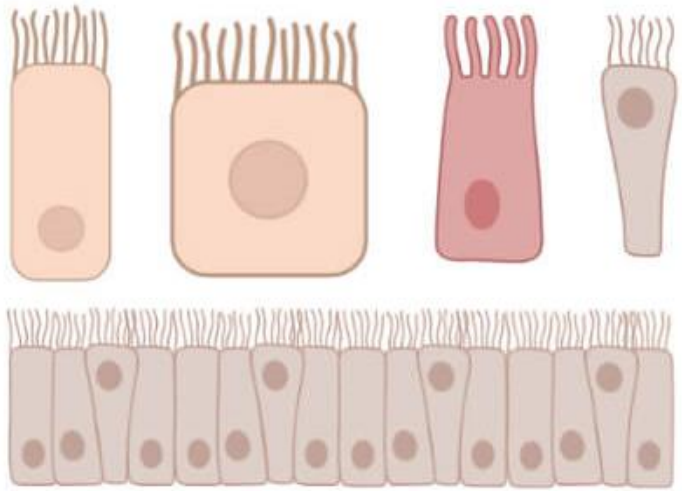




MOVEMENT APPENDAGES

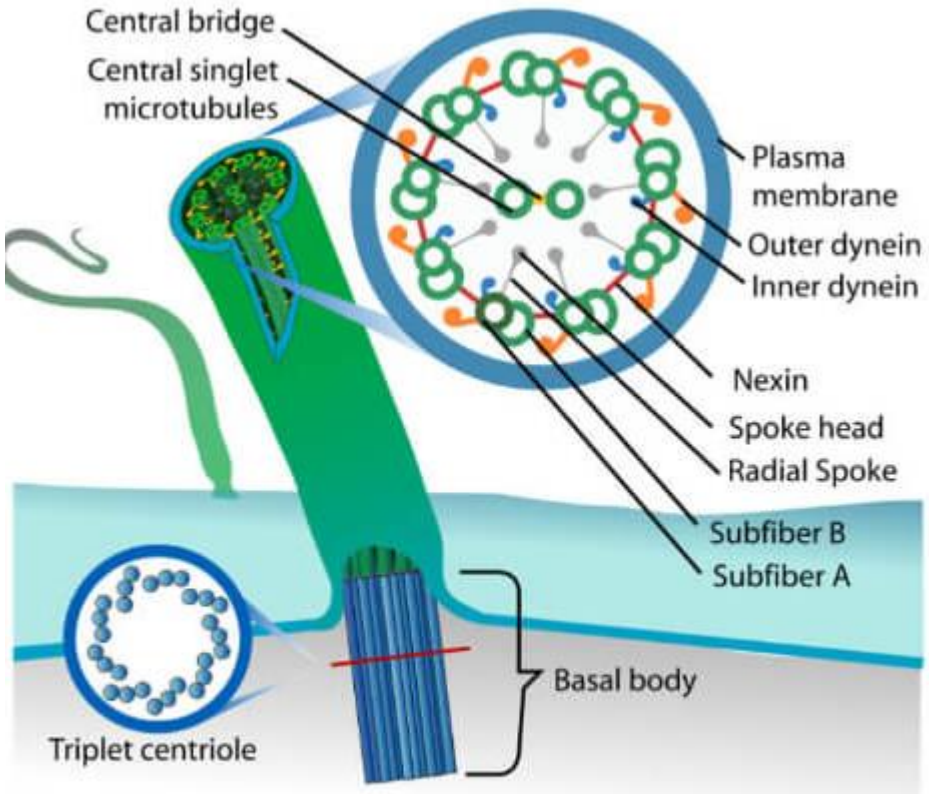


Protists

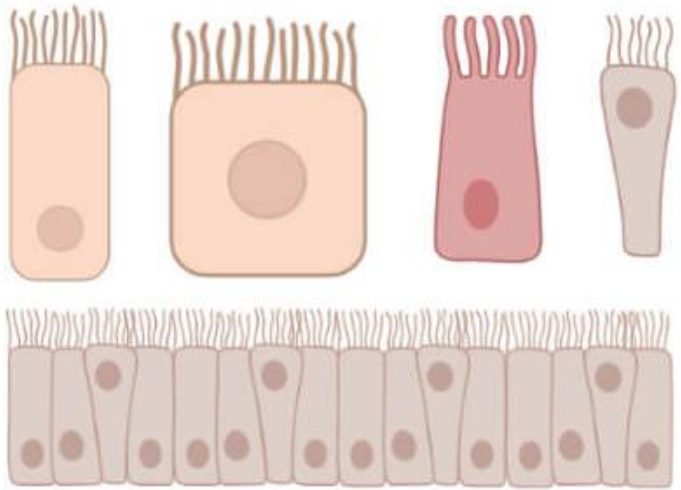


Gut cells

CILIA



Structure of Eukaryotic Cilium

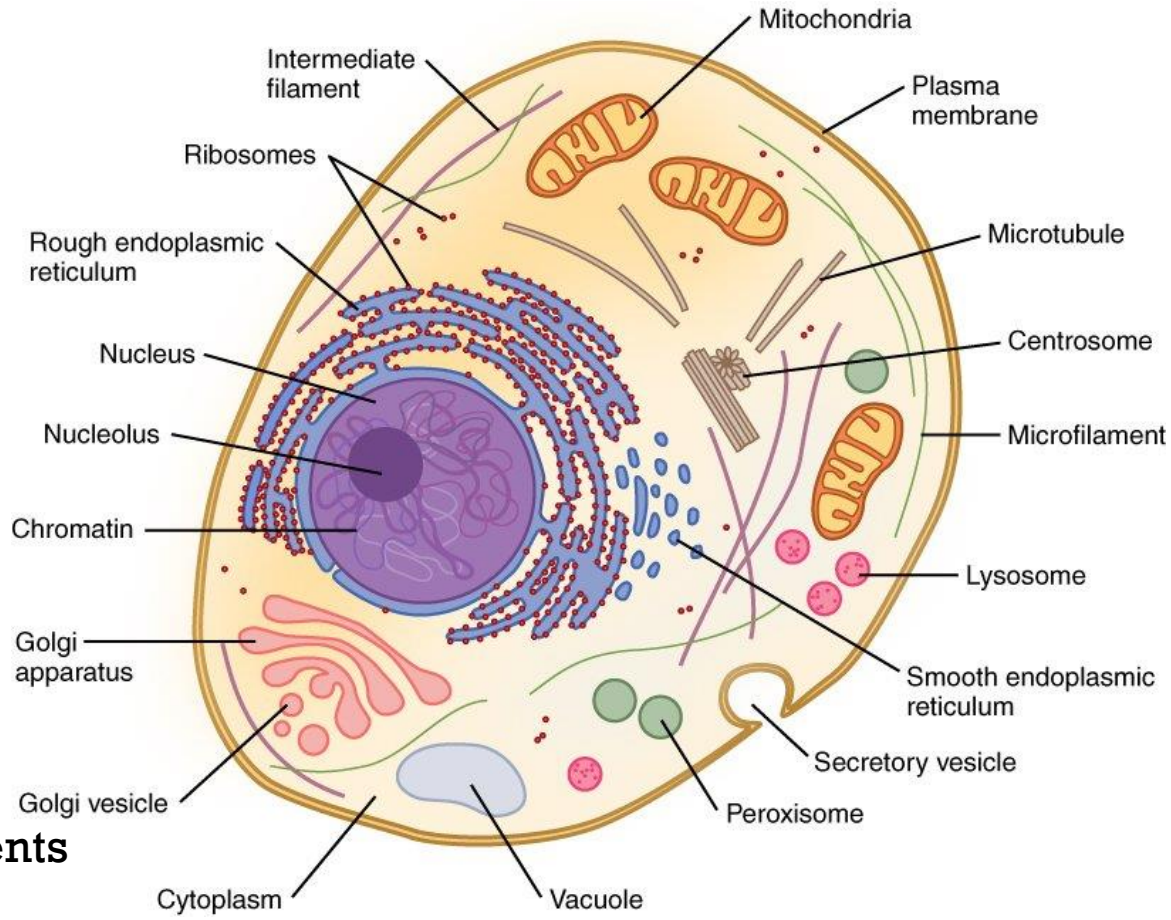


- Occur throughout the cell
- Beat in coordination
- Found in lining of body tubes
- Nasal passage clean by preventing dust accumulation and secretion of mucus
- Locomotion, feeding, circulation

Animation Link

NUCLEUS

1. Nuclear Envelope
2. Matrix
3. Nucleolus
4. Chromatin



Nuclear Matrix

- Structural framework for organizing chromatin
- High-salt buffers, nucleases & non-ionic detergents

Video Link

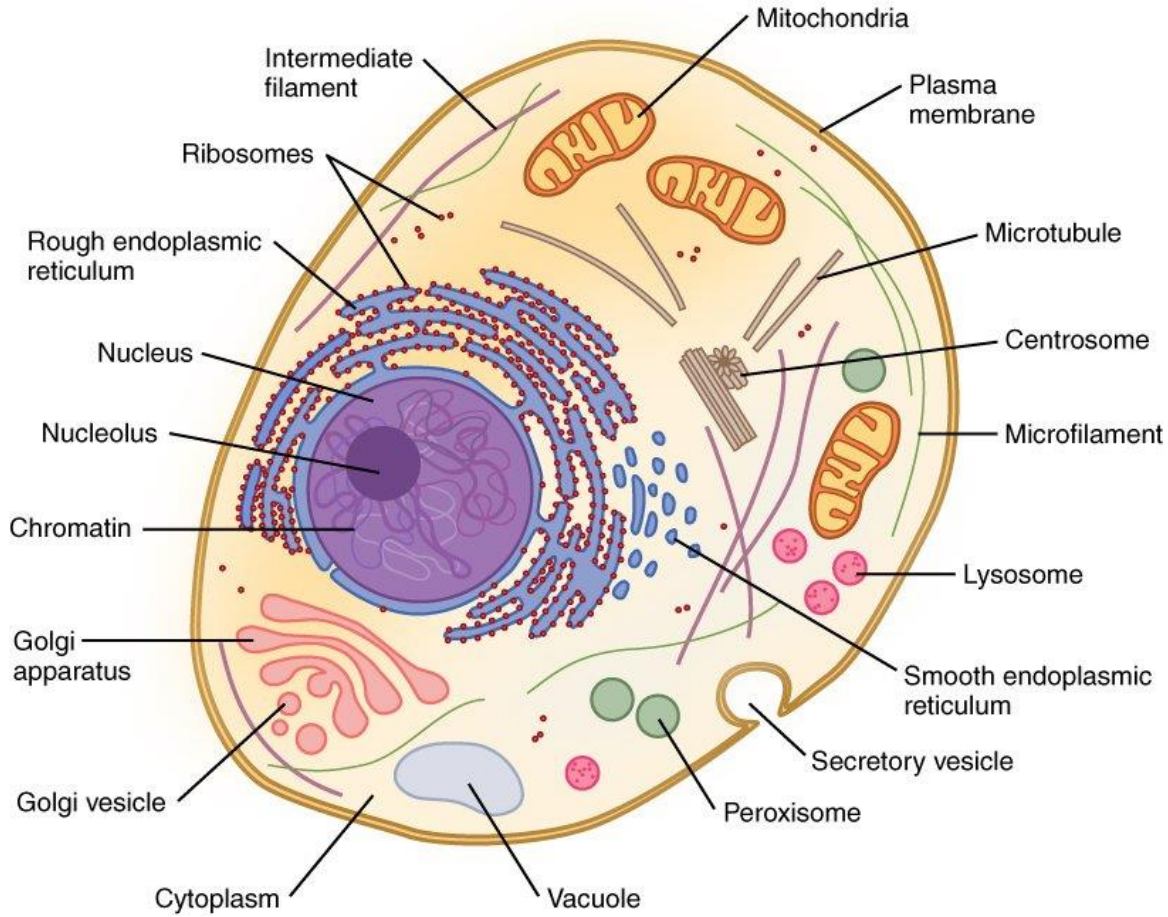
NUCLEAR ENVELOPE & NUCLEUS

Nuclear Envelop

- Contains pores- nuclear pore complex
- Transportation between cytoplasm & nucleus

Nucleolus

- Non-membrane bound dynamic body
- Disappears during late prophase
- Site of transcription of ribosomal RNA
- Assembly of ribosome



CHROMATIN

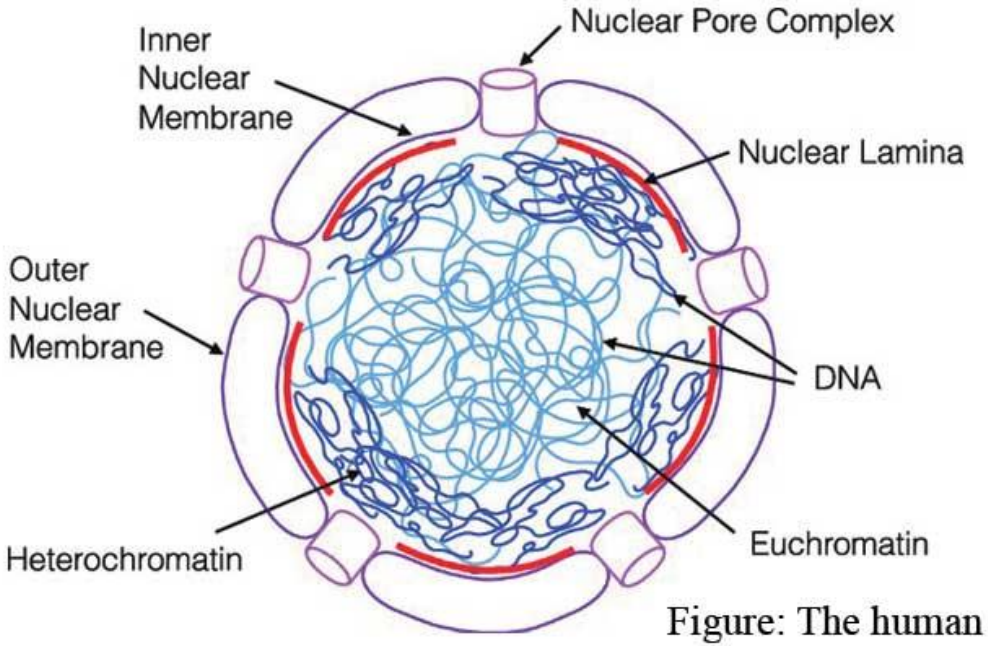
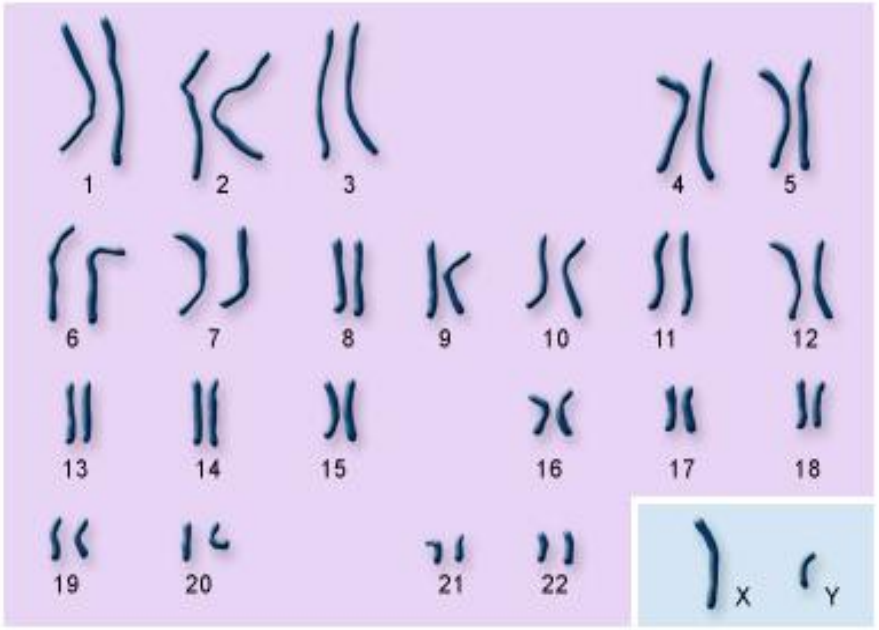
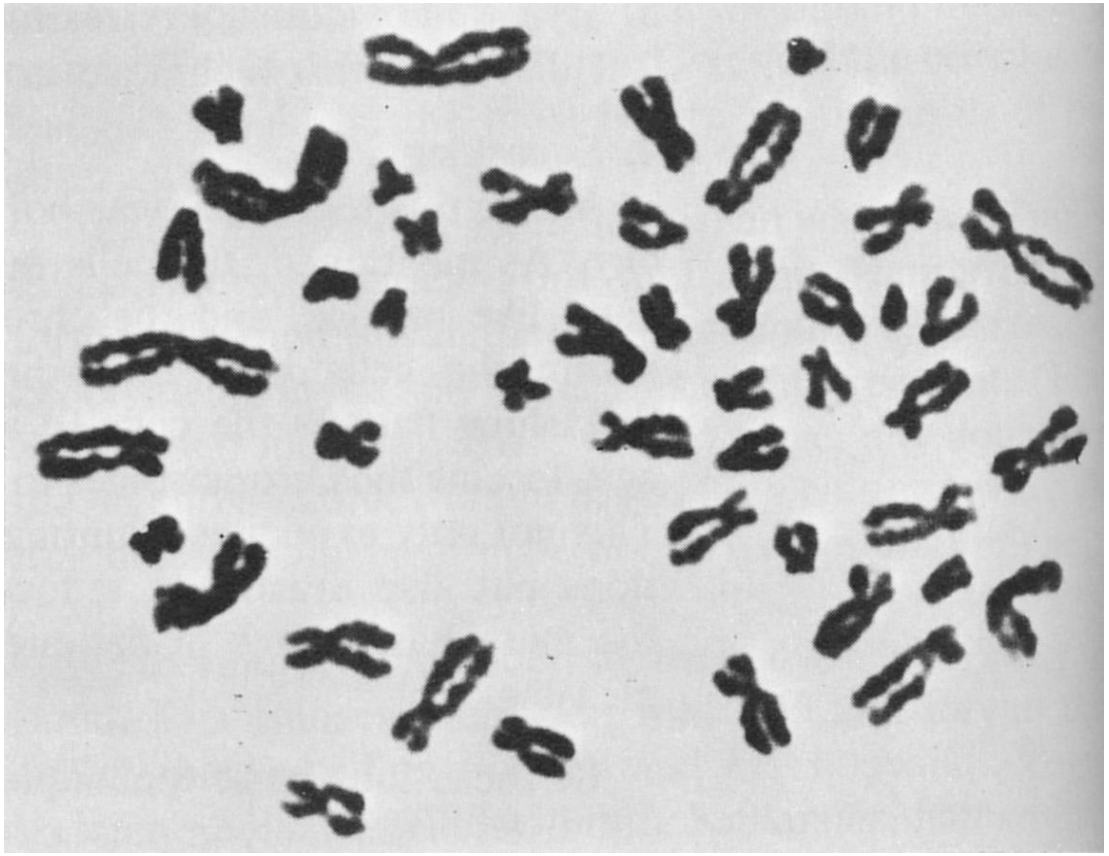


Figure: The human cell nucleus.

- Organized structure of DNA and protein that is found in the nucleus
- In G0 stage, one chromatin contains a single dsDNA in coiled and condensed form
- Chromosomes are more condensed than chromatin
- Regions- Euchromatin and Heterochromatin
- Euchromatin- Region active in transcription
- Heterochromatin- transcriptionally silent and stains darker

HUMAN CHROMOSOMES





Karyotyping

NUCLEUS

Centromere-
- Constricted region of linear chromosome
- Site of attachment of sister chromatids

Telomeres
- Caps the ends of chromosomes
- Rich in G

Origin of replication

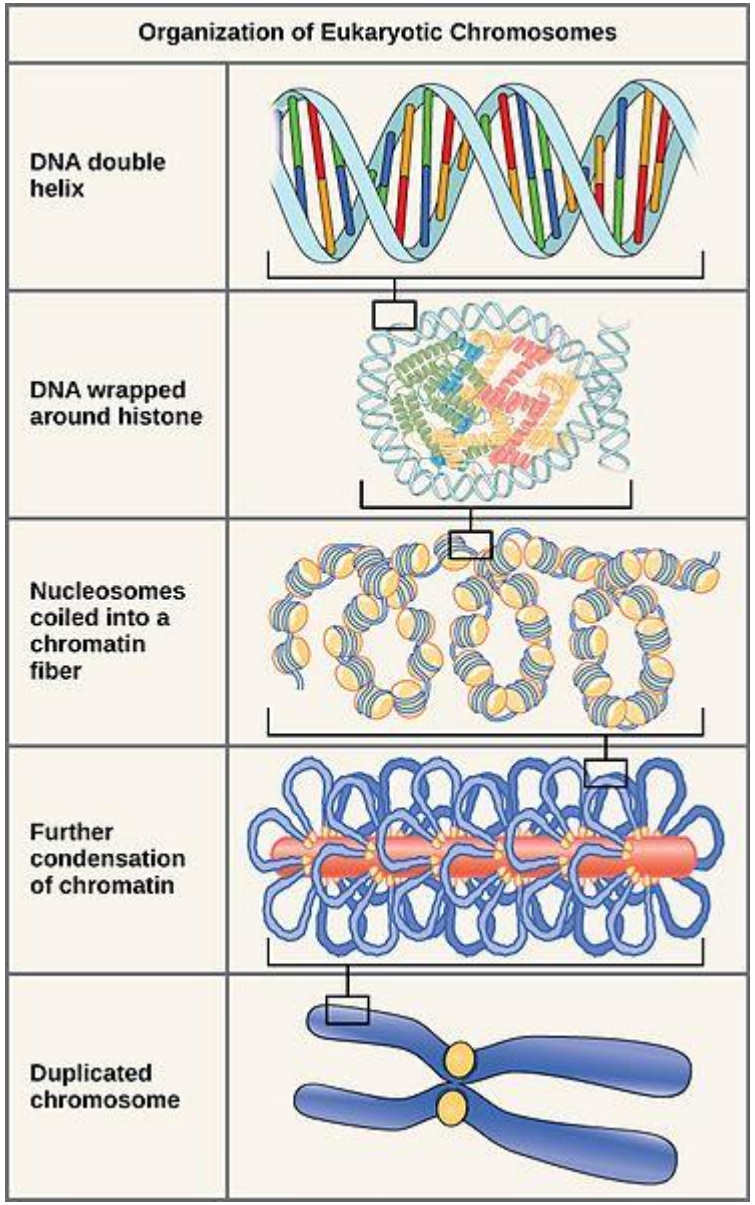
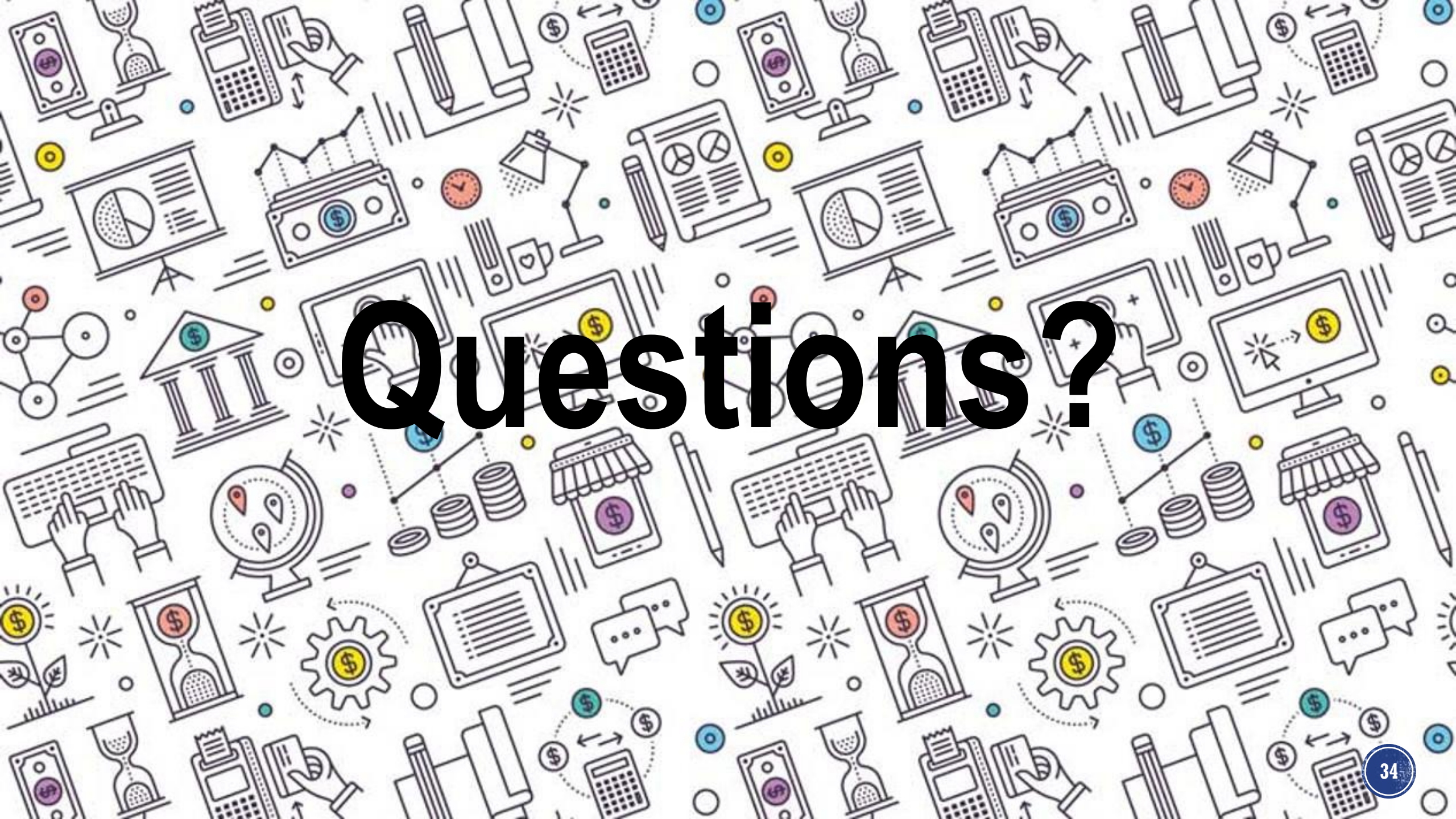


Table 5.1 Eukaryotic Cell Structures and Their Functions

Structure	Description	Function
Cell wall	Outer layer of cellulose or chitin; or absent	Protection; support
Cytoskeleton	Network of protein filaments	Structural support; cell movement
Flagella (cilia)	Cellular extensions with 9 + 2 arrangement of pairs of microtubules	Motility or moving fluids over surfaces
Plasma membrane	Lipid bilayer with embedded proteins	Regulates what passes into and out of cell; cell-to-cell recognition
Endoplasmic reticulum	Network of internal membranes	Forms compartments and vesicles; participates in protein and lipid synthesis
Nucleus	Structure (usually spherical) surrounded by double membrane that contains chromosomes	Control center of cell; directs protein synthesis and cell reproduction
Golgi apparatus	Stacks of flattened vesicles	Packages proteins for export from cell; forms secretory vesicles
Lysosomes	Vesicles derived from Golgi apparatus that contain hydrolytic digestive enzymes	Digest worn-out organelles and cell debris; play role in cell death
Microbodies	Vesicles formed from incorporation of lipids and proteins containing oxidative and other enzymes	Isolate particular chemical activities from rest of cell
Mitochondria	Bacteria-like elements with double membrane	"Power plants" of the cell; sites of oxidative metabolism
Chloroplasts	Bacteria-like elements with membranes containing chlorophyll, a photosynthetic pigment	Sites of photosynthesis
Chromosomes	Long threads of DNA that form a complex with protein	Contain hereditary information
Nucleolus	Site of genes for rRNA synthesis	Assembles ribosomes
Ribosomes	Small, complex assemblies of protein and RNA, often bound to endoplasmic reticulum	Sites of protein synthesis

Inside Cell


Questions?

ANNEXURE

Blood Type	Antigens Present	Antibodies in Serum
AB+	*ABH, Rh D*	*None*
AB-	ABH	Rh D
A+	*AH, Rh D*	*B*
A-	AH	B, Rh D
B+	*BH, Rh D*	*A*
B-	BH	A, Rh D
O+	*H, Rh D*	*AB*
O-	H	AB, Rh D
Bombay	*None*	*ABH, Rh D*

BOMBAY BLOOD GROUP OR HH BLOOD GROUP