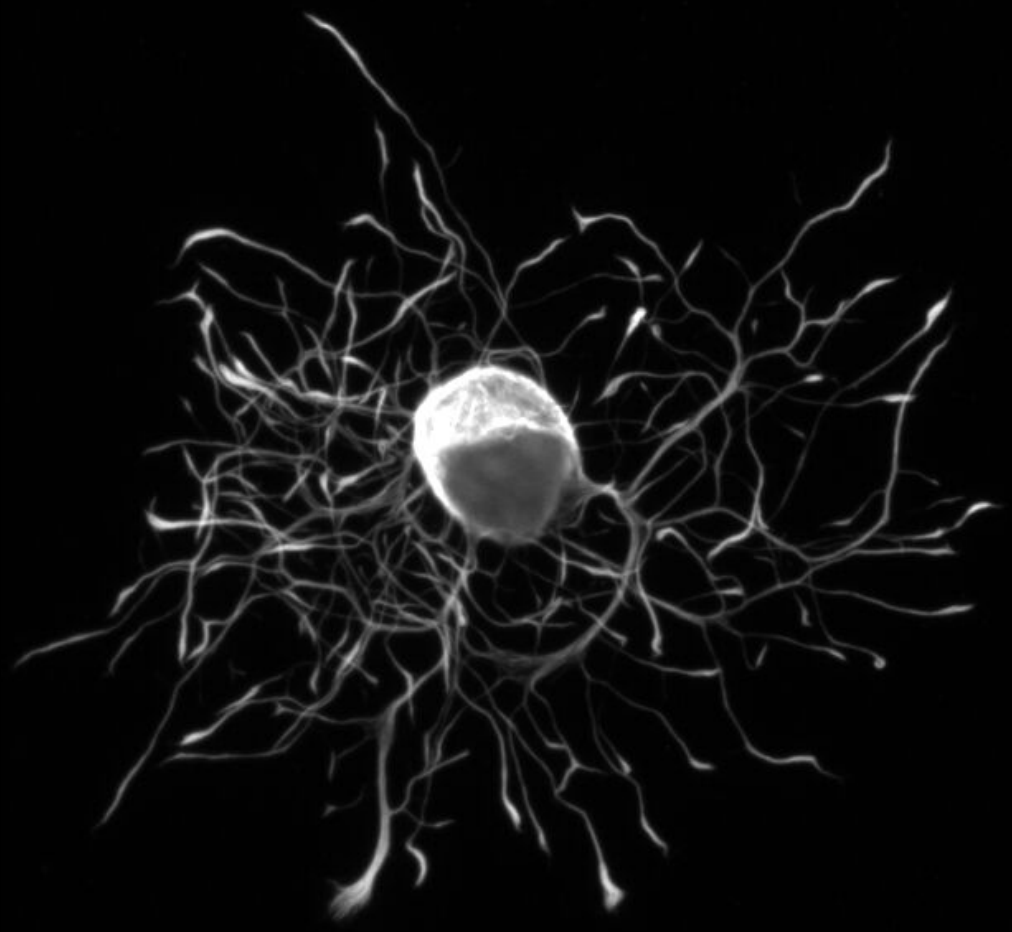
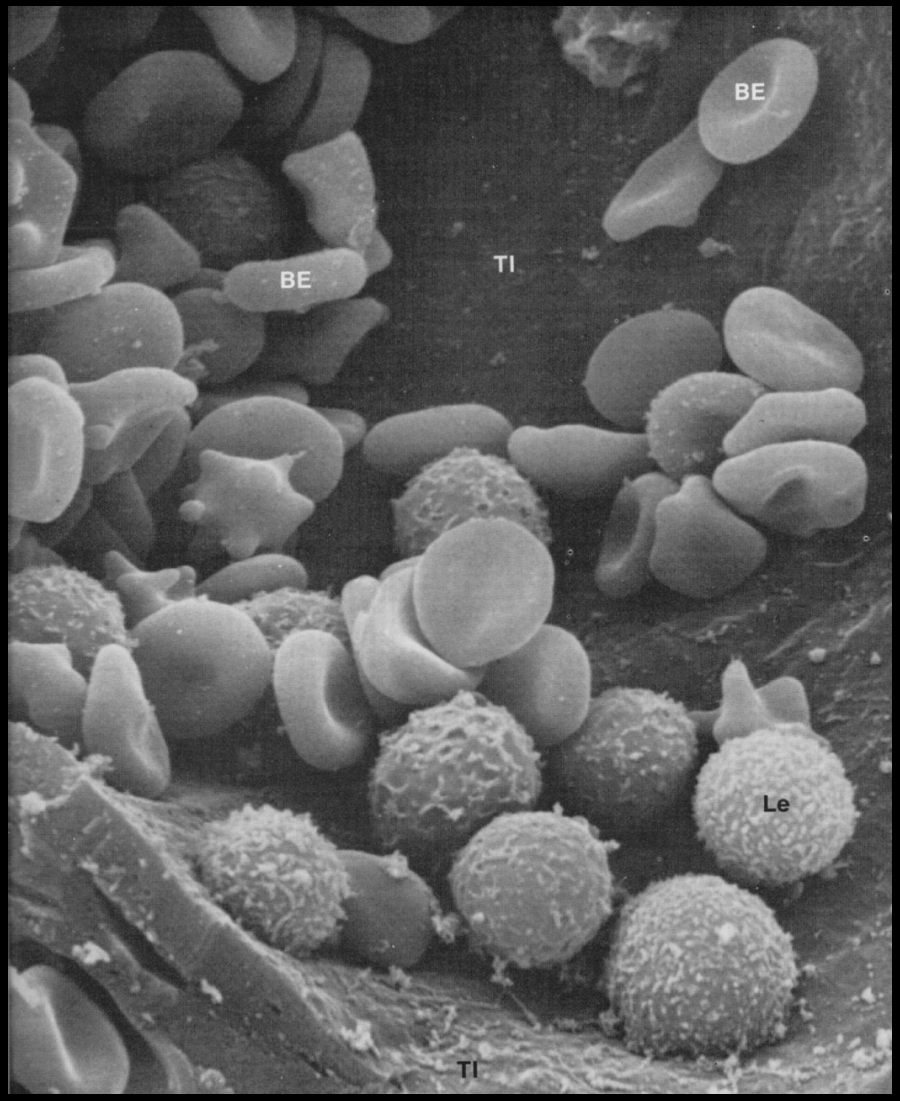
Cell Structure and Function



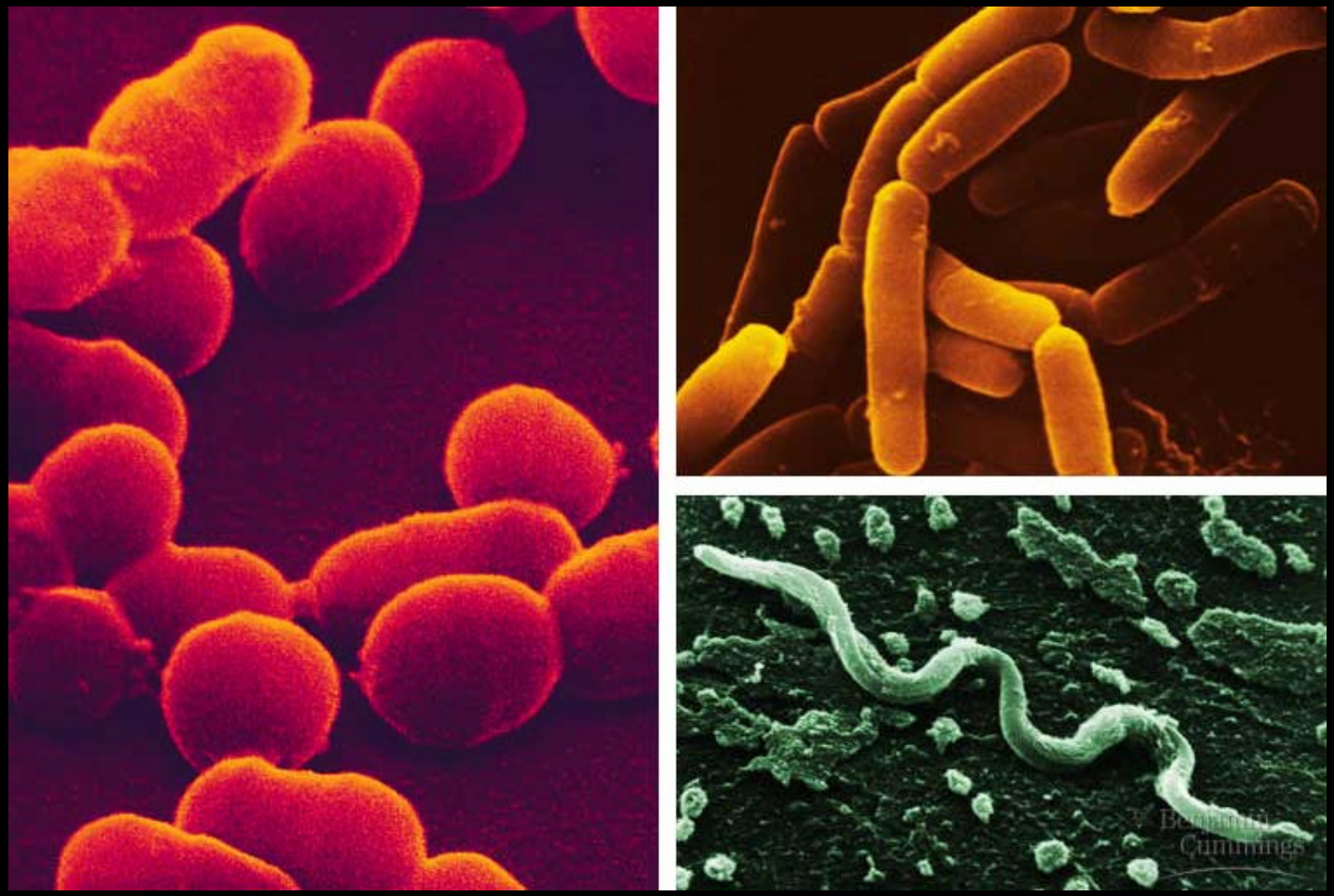
Eukaryotic Cell: Neuron

Cell Structure and Function



Eukaryotic Cells: Blood Cells

Cell Structure and Function

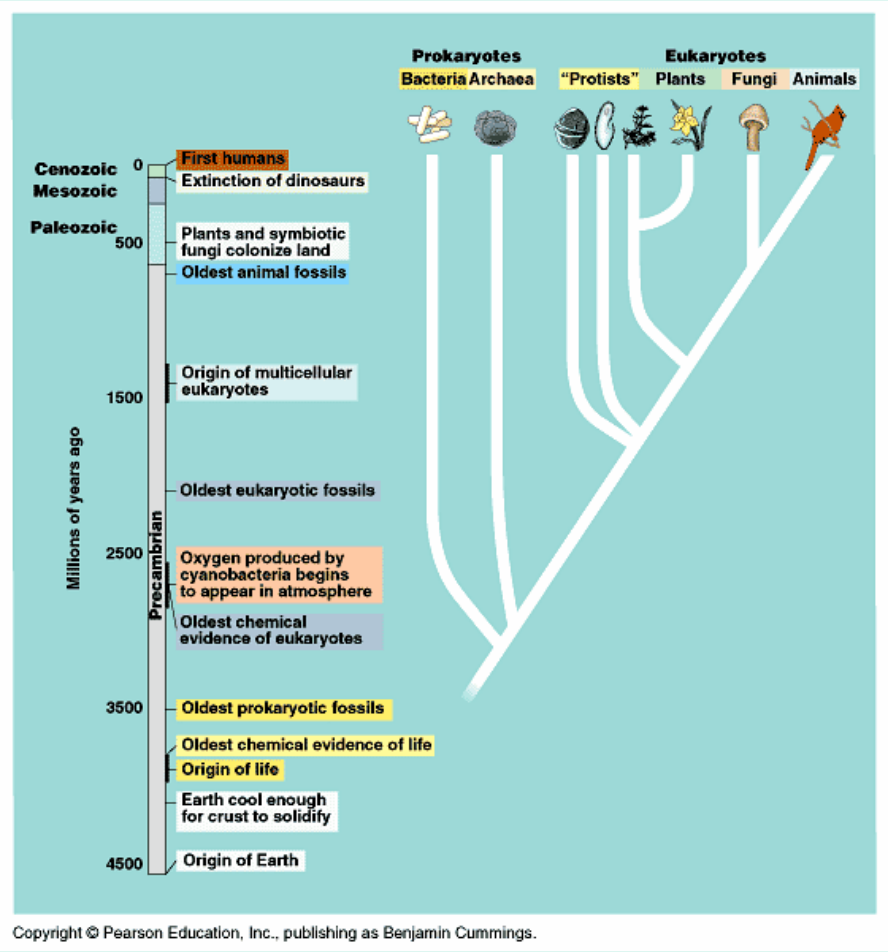


Prokaryotic Cells: Bacteria

Cell Structure and Function

- All living organisms are made of cells. A cell is a small, membrane enclosed structure filled with an aqueous solution where organelles and other *subcellular* structures are found.
- Cells are of different size and shape
- The cell's size and shape can be related to its specific function.

From Prokaryotes to Eukaryotes



From Prokaryotes to Eukaryotes

- It is thought that all organisms living now on Earth are derived from a single cell born 3,500 millions of years (my) ago.
- This primordial cell was defined by an outer membrane ? one of the crucial events leading to the establishment of life on Earth
- Simple organic molecules are likely to have been produced in the conditions that existed on the Earth in its infant state (approximately during its first billion years)

Unicellular vs. Multicellular Organisms

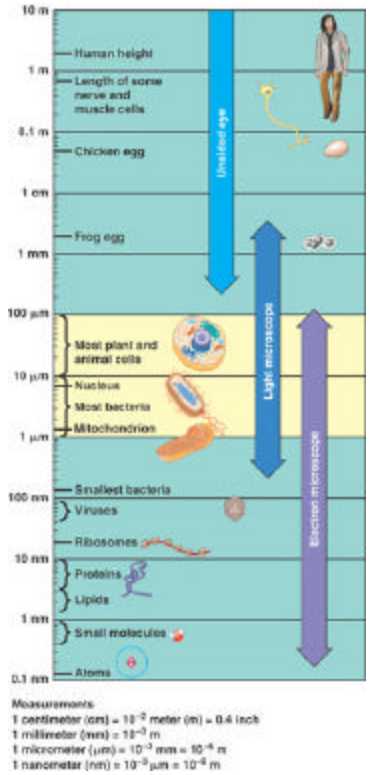
- Why unicellular?

Unicellular - Amoeba proteus

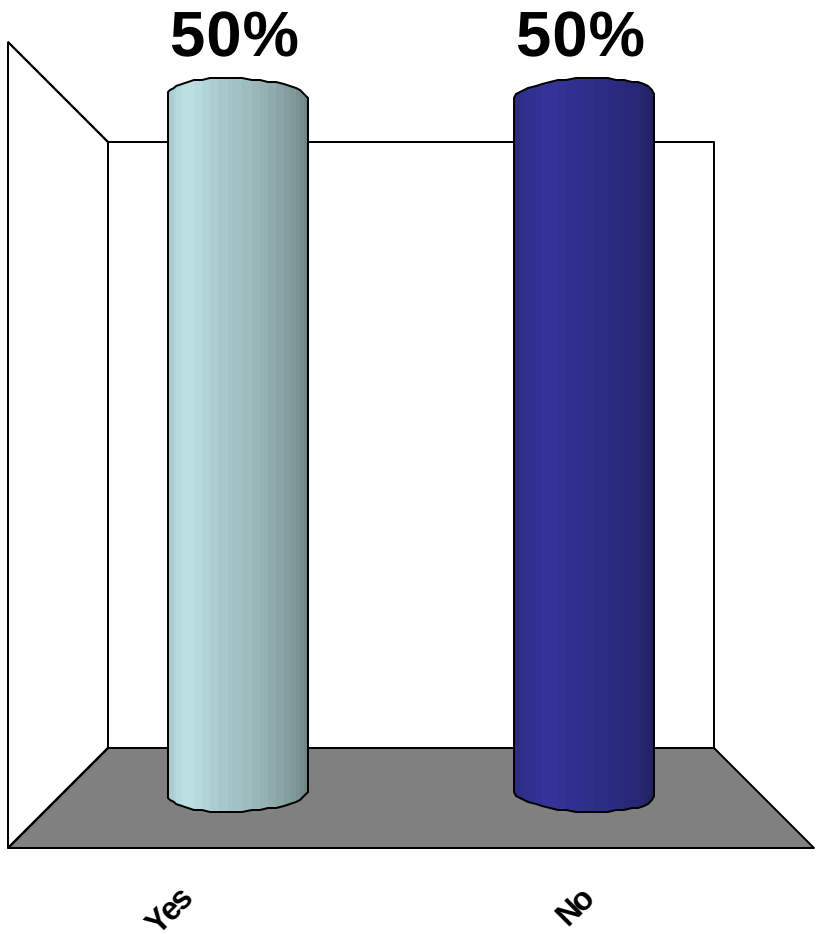
- Why multicellular?

Multicellular

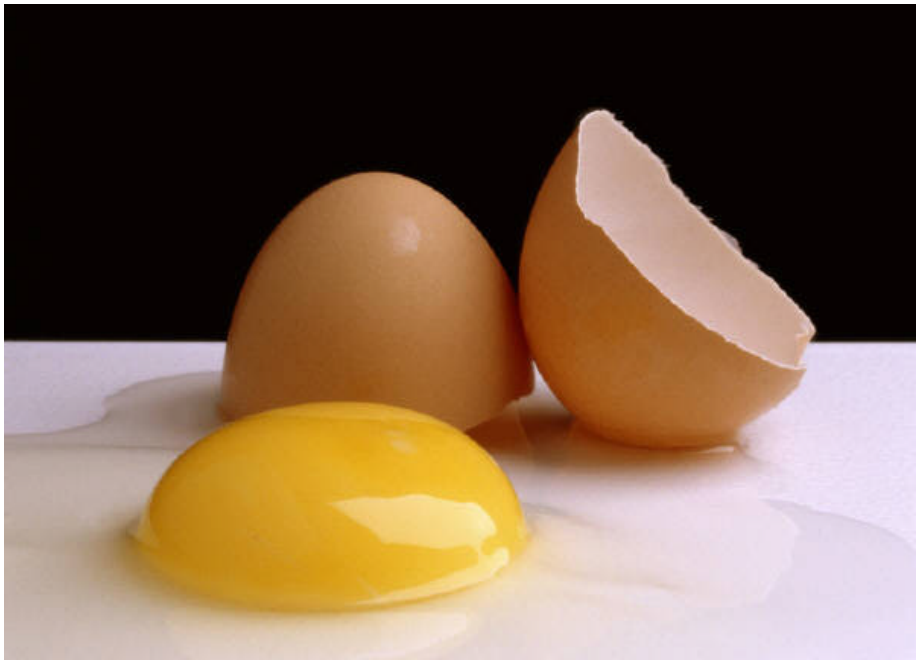
Can we see cells?

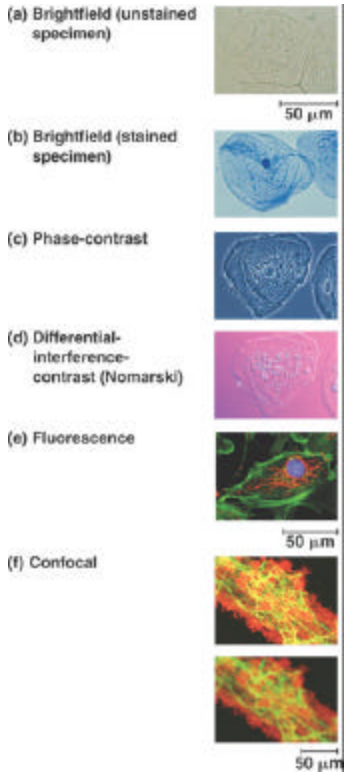


1. Yes
2. No



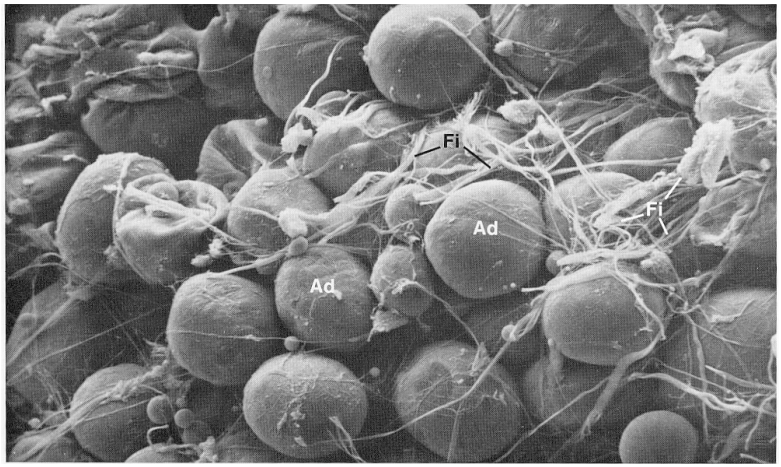
Can We See Cells?





Structural Features of Cells: Outside Covers

- All cells have a *plasma or cell membrane*, which contains the cell
- Plant cells and most bacteria have an outermost additional layer, the *plant cell wall* and the *bacterial cell wall* respectively



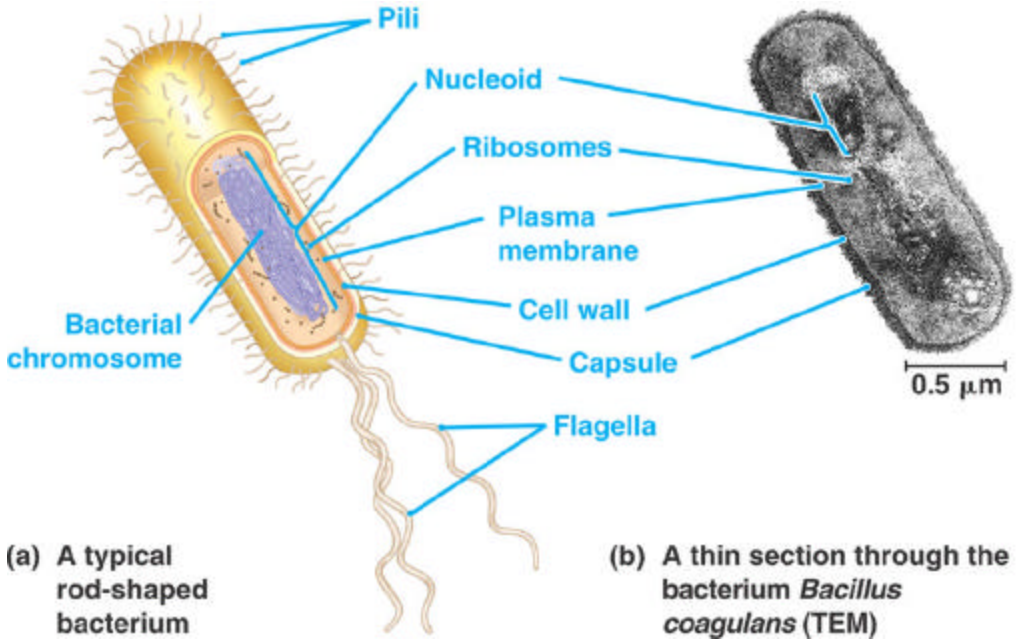
Adipose Cells (Ad)

Plant Cell Wall

Outside Covers: The Plant Cell Wall

- The plant cell wall is the outermost layer of plant cells
- It provides extra protection to the plant and cohesiveness among neighbor plant cells. Why do plants need these extra features?
- Cell walls of adjacent plant cells are in close communication through *plasmodesmata*

Structural Features of Cells: Inner Structures of Prokaryotic Cells



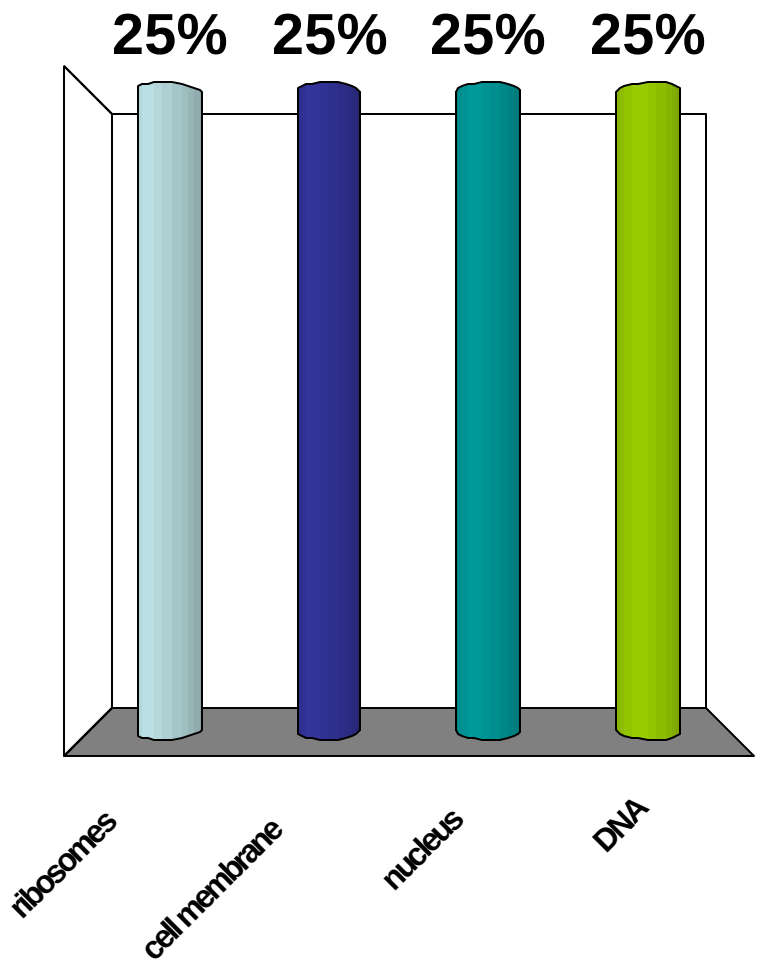
No nucleus or membrane-enclosed organelles in prokaryotic cells. Ribosomes present.

Structural Features of Cells: Inner Structures of Prokaryotic Cells

Electron Micrograph of Bacteria (Cross and Longitudinal Sections)

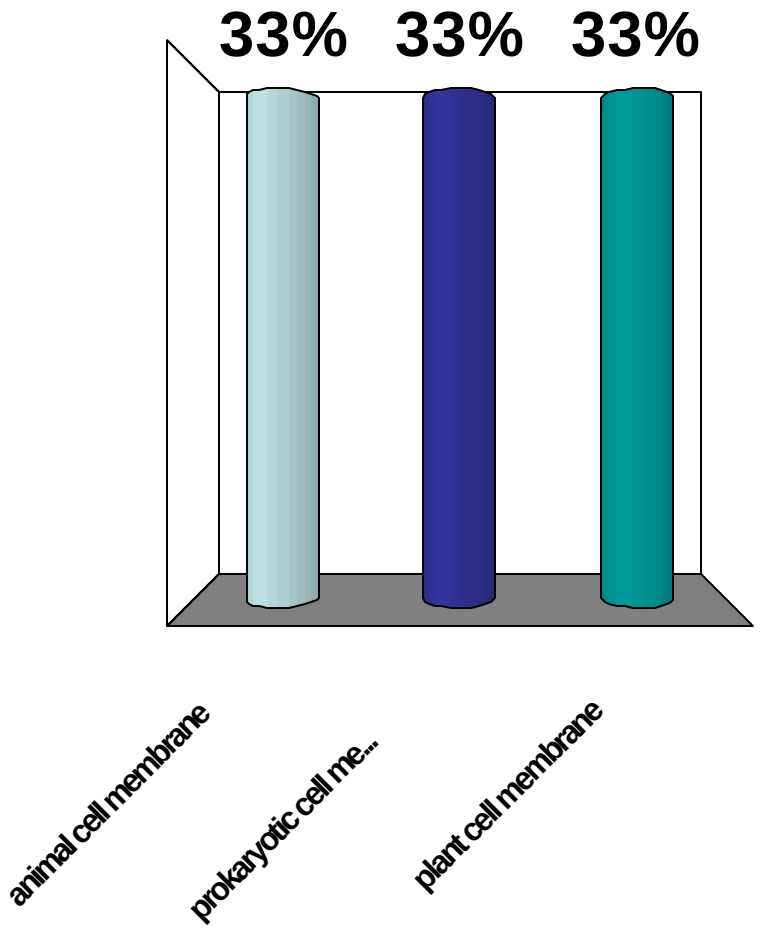
Which one of these would not be found in a prokaryotic cell?

1. ribosomes
2. cell membrane
3. nucleus
4. DNA

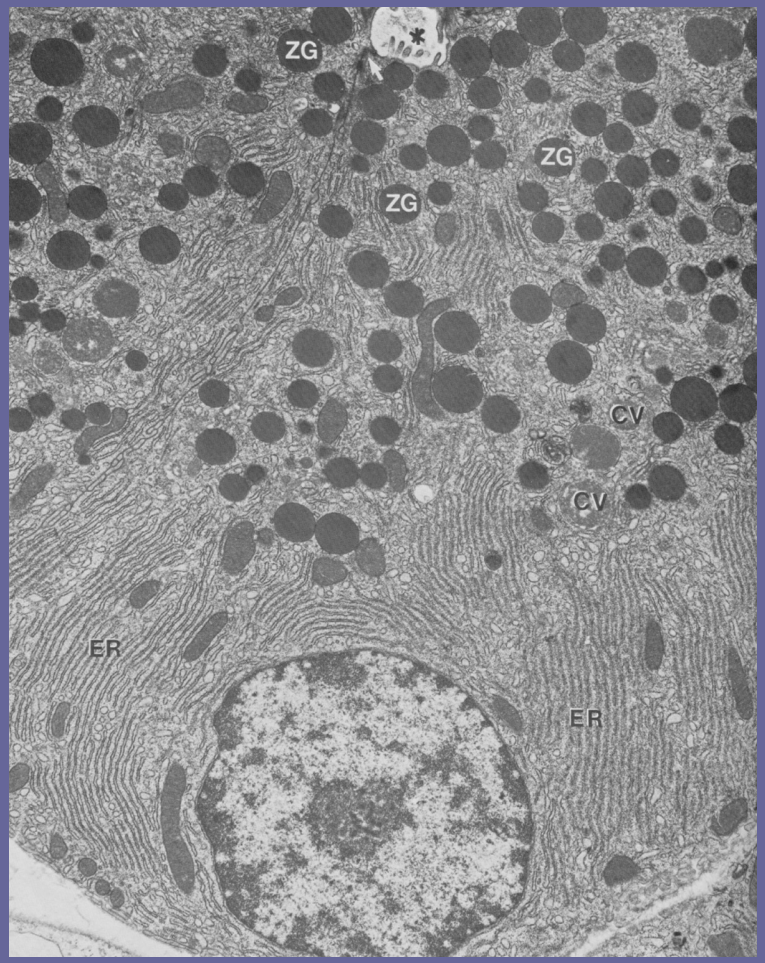


cellulose: plasmodesmata :protection and cohesiveness: outermost cell cover

1. animal cell membrane
2. prokaryotic cell membrane
3. plant cell membrane



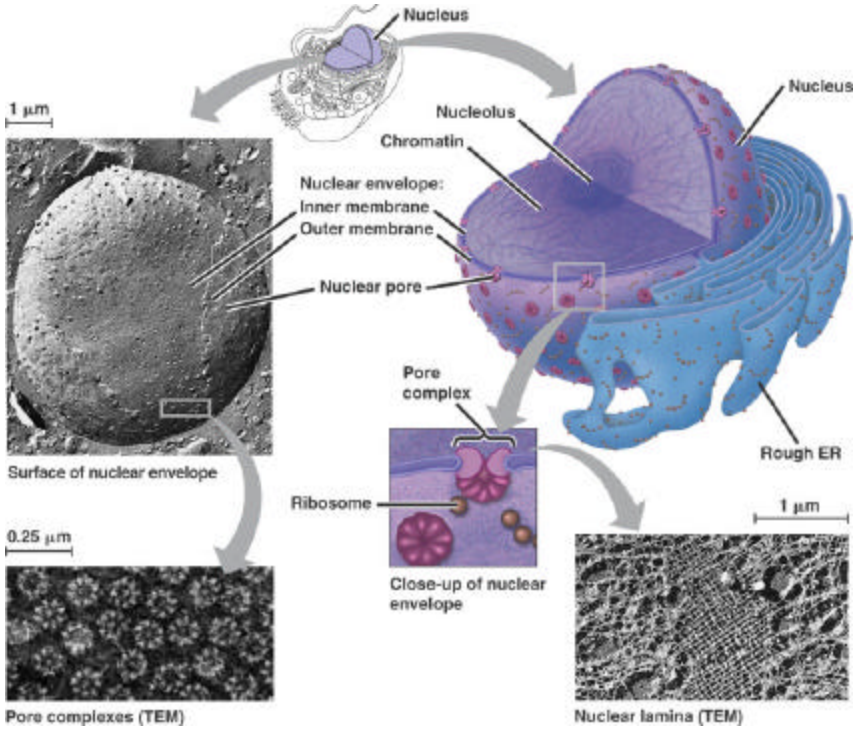
Structural Features of Cells: Inner Structures of Eukaryotic Cells



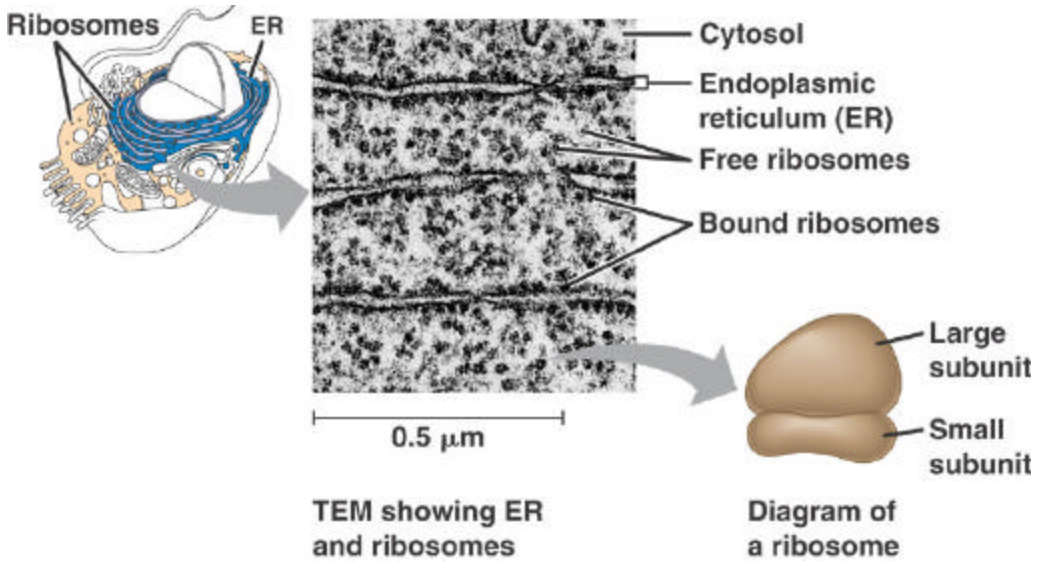
Pancreatic Cell: In Eukaryotic Cells, Nucleus, Cytoplasm, and Membrane- bounded Organelles Are Present

Inner Structures of Eukaryotic Cells: The Nucleus

- The nucleus of eukaryotic cells is contained by the *nuclear envelope*, which is made of two membranes (inner and outer) decorated with *pore complexes*
- Inside the nucleus, chromatin (DNA + DNA associated proteins) and a *nucleolus* are present
- The *nuclear lamina* (made of *intermediate filaments*) covers the inner nuclear membrane, helping in the maintenance of nuclear shape
- The nucleus hosts the genetic material (DNA and RNA)

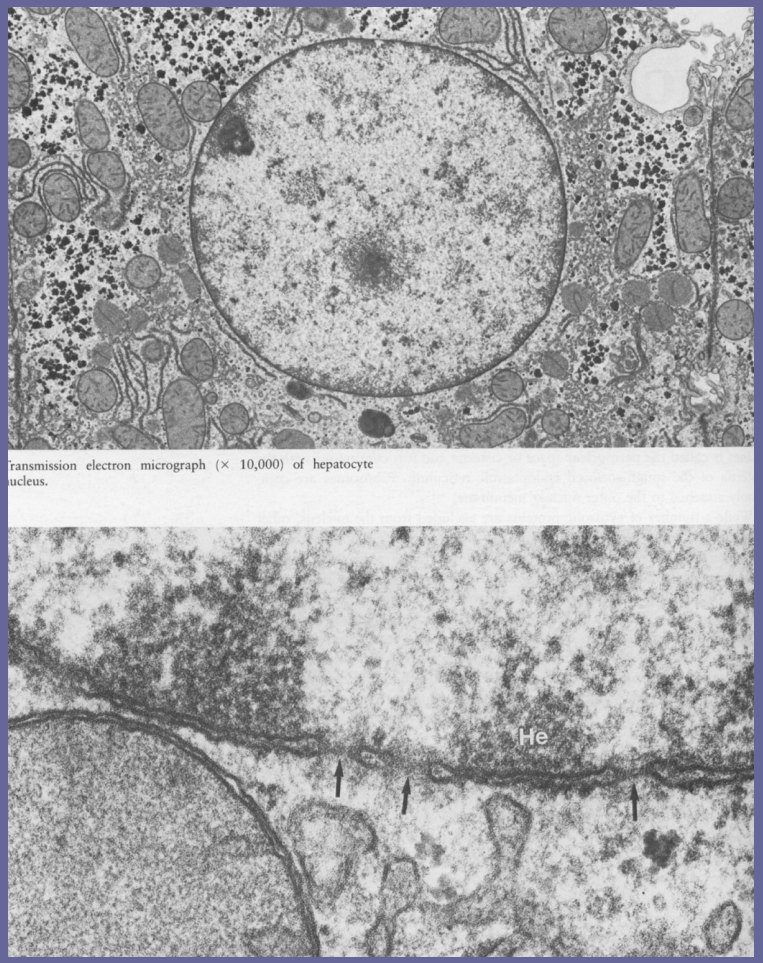


Inner Structures of Eukaryotic Cells: The Nucleus

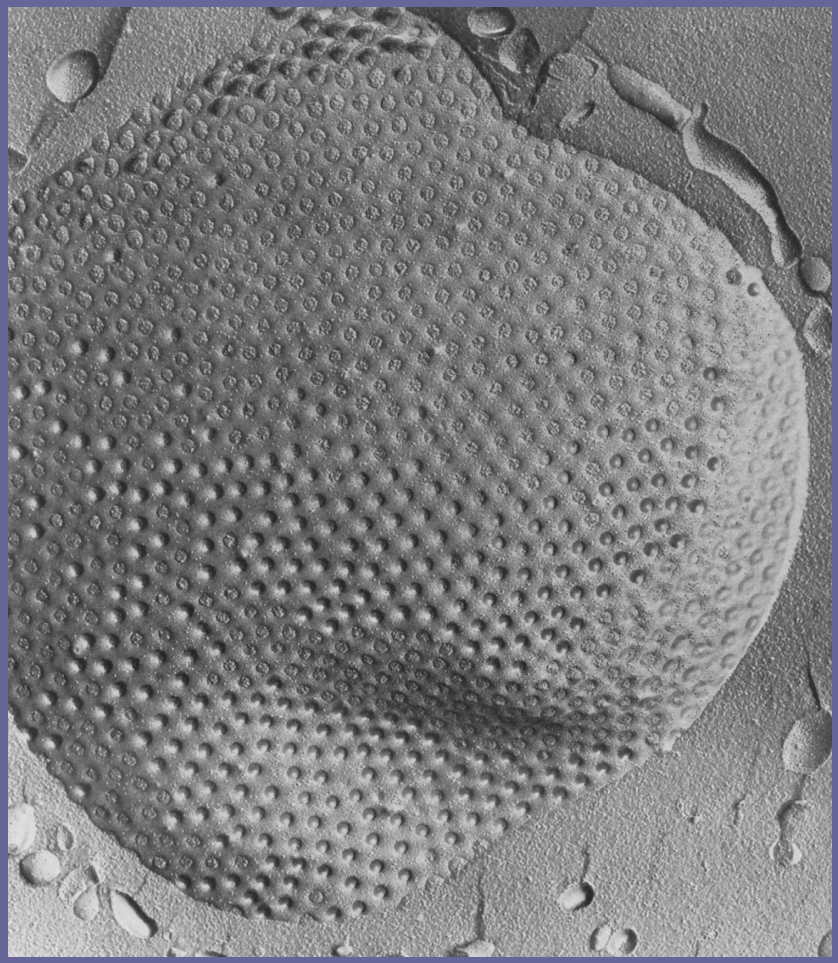


Ribosomes are present in the outer nuclear membrane

Inner Structures of Eukaryotic Cells: The Nucleus

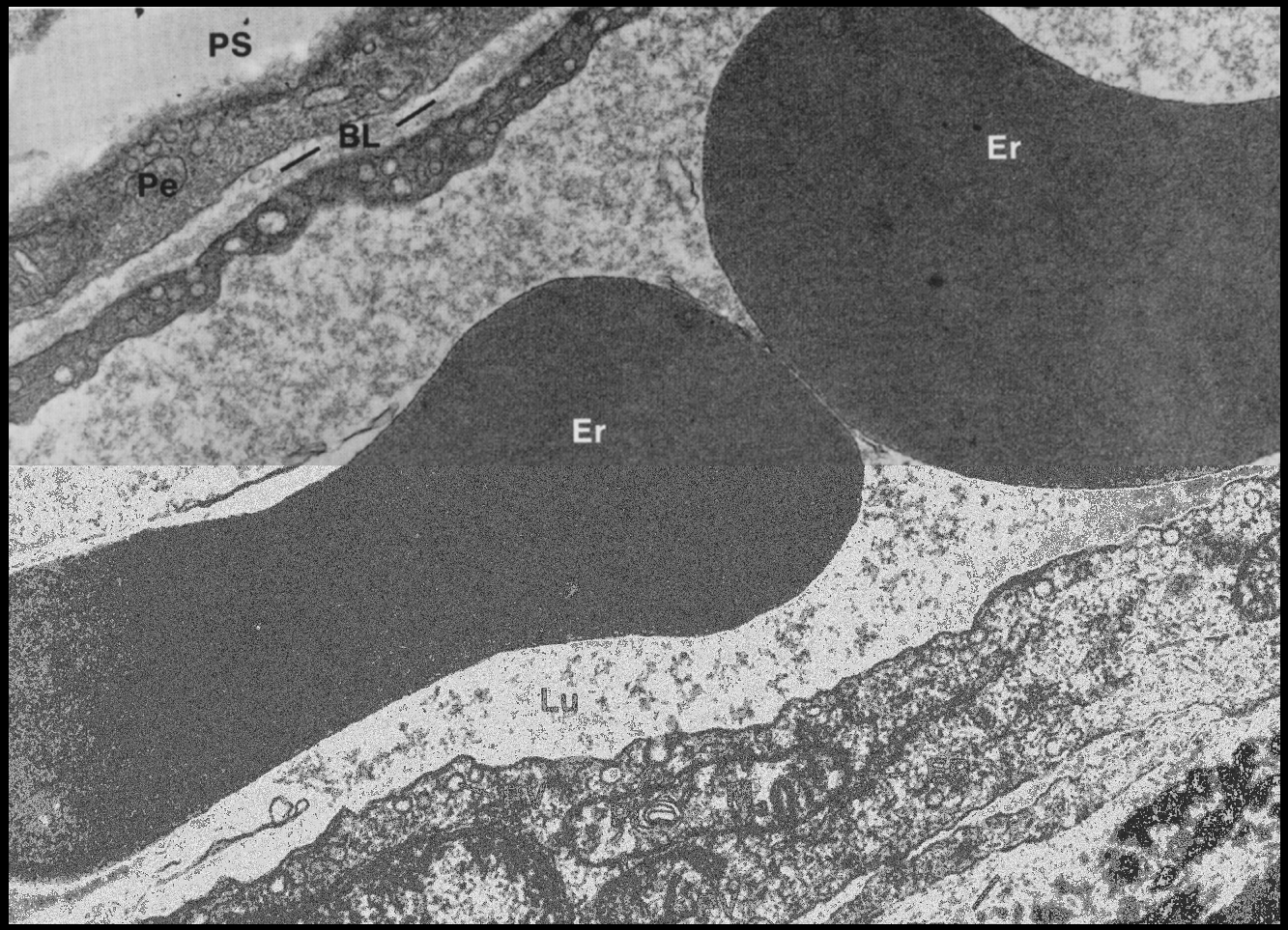


Transmission Electron Micrograph (TEM) of Hemocyte Nucleus



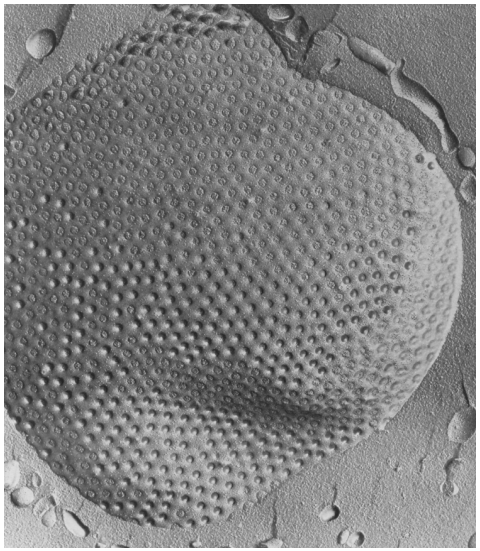
Freeze Fracture Replica of a Nucleus: Outer Membrane and Pore Complexes

Some Eukaryotic Cells Lose Their Nucleus as They Mature

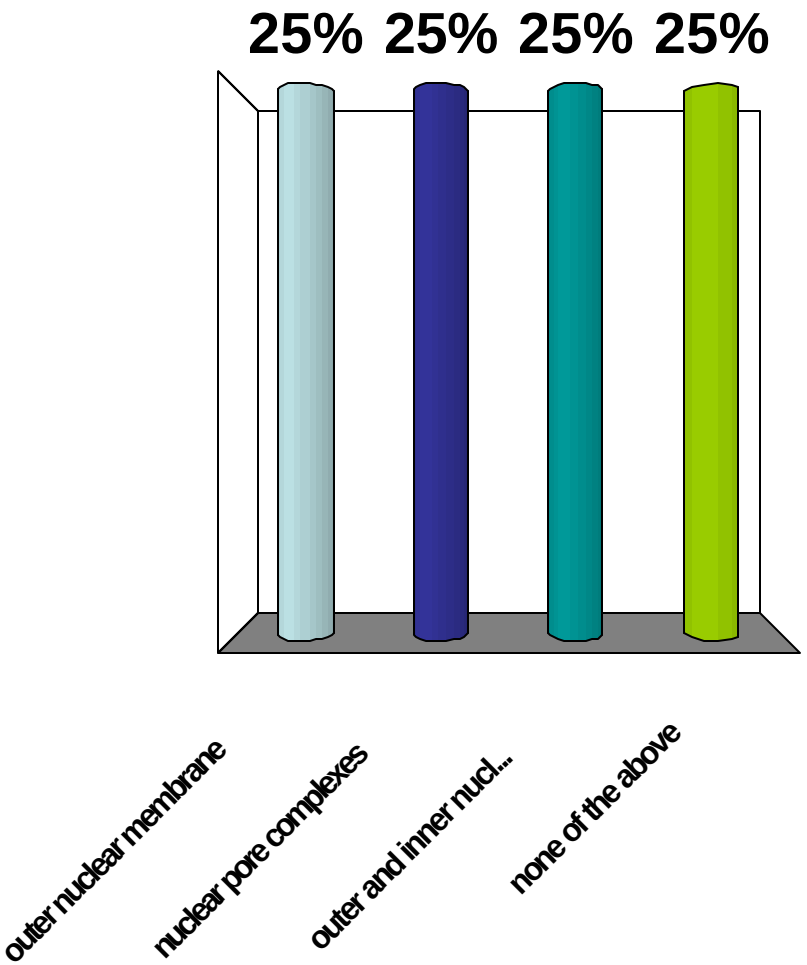


TEM of Human Enucleated Erythrocytes (Er)

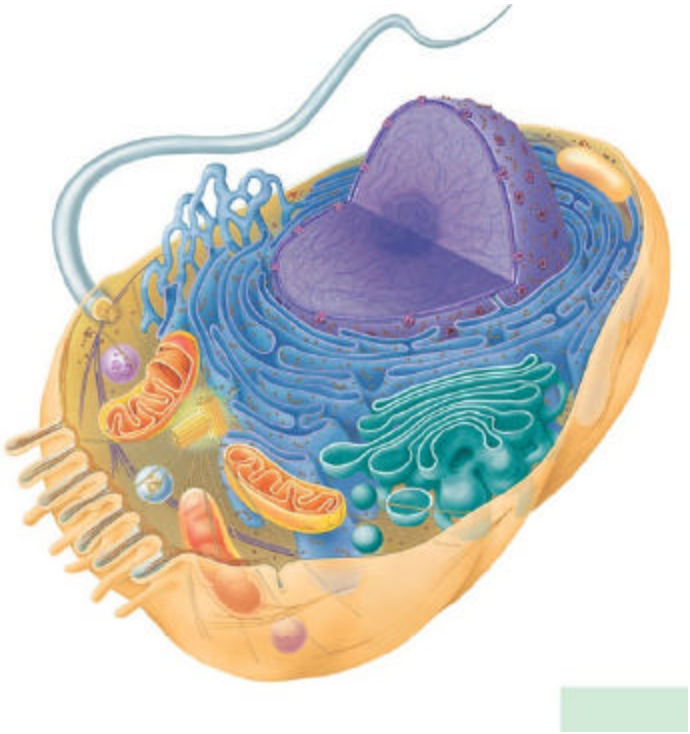
“Nuclear envelope” refers to:



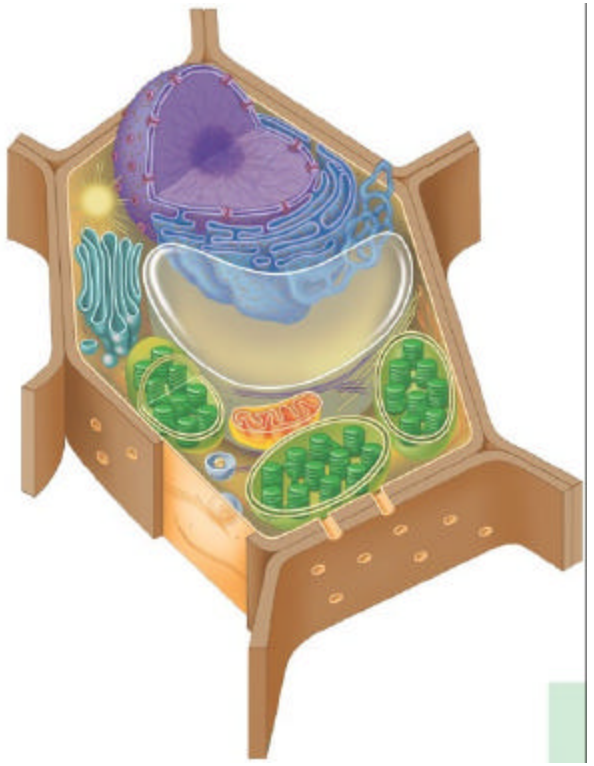
1. outer nuclear membrane
2. nuclear pore complexes
3. outer and inner nuclear membrane and pore complexes
4. none of the above



Inner Structures of Eukaryotic Cells: Cytoplasmic Membrane- bounded Organelles



Animal Cell



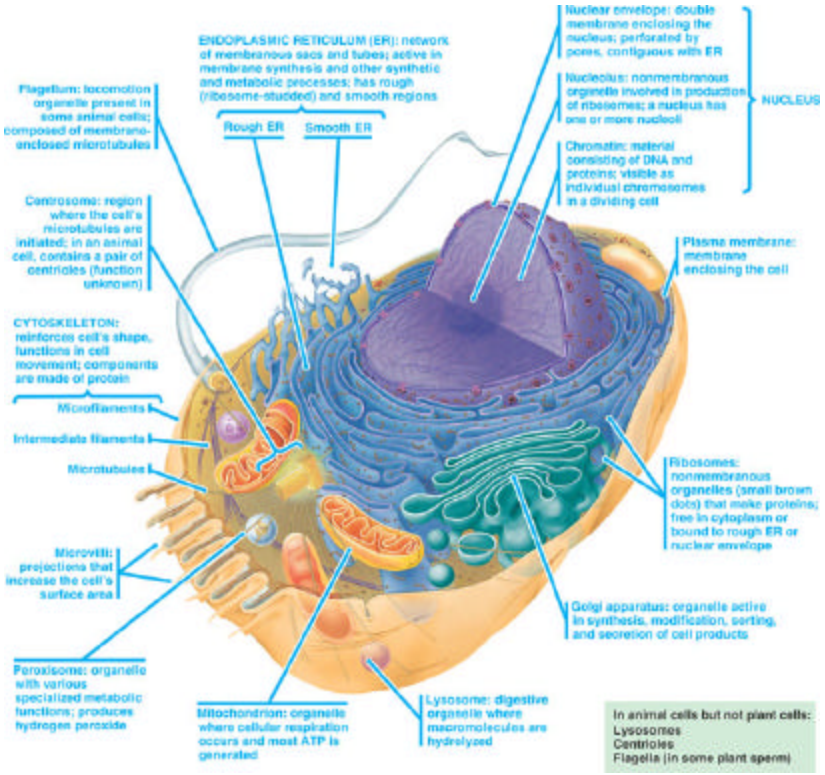
Plant Cell

Different Cytoplasmic Organelles Perform Distinct Cell Functions

- Production, circulation, storage, and delivery of substances produced or taken by the cell (those organelles constitute the *endomembrane system*)
- Production of energy
- Movement and maintenance of the cell's shape

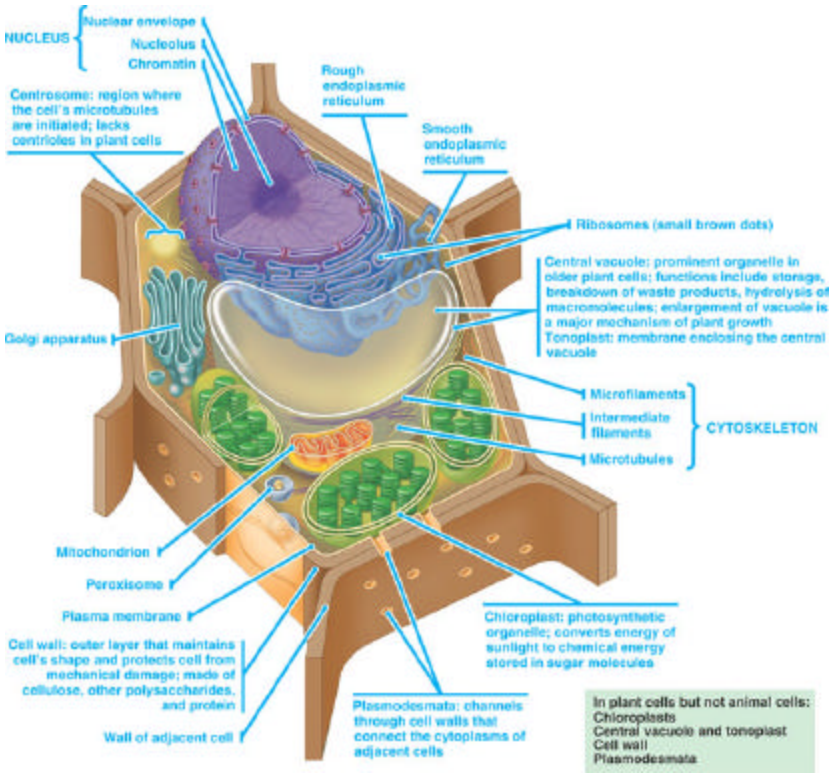
Chloroplasts in Plant Cells

Different Cytoplasmic Organelles Perform Distinct Cell Functions



Organelles of Animal Cells

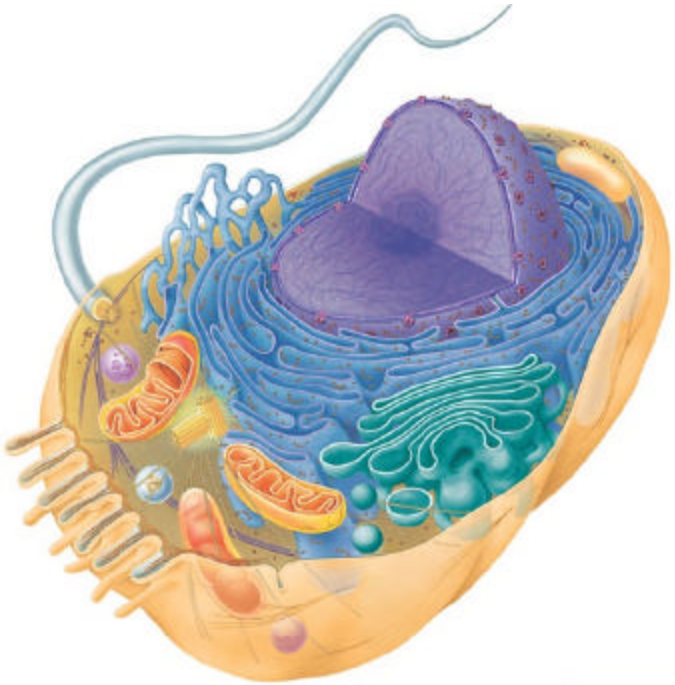
Different Cytoplasmic Organelles Perform Distinct Cell Functions

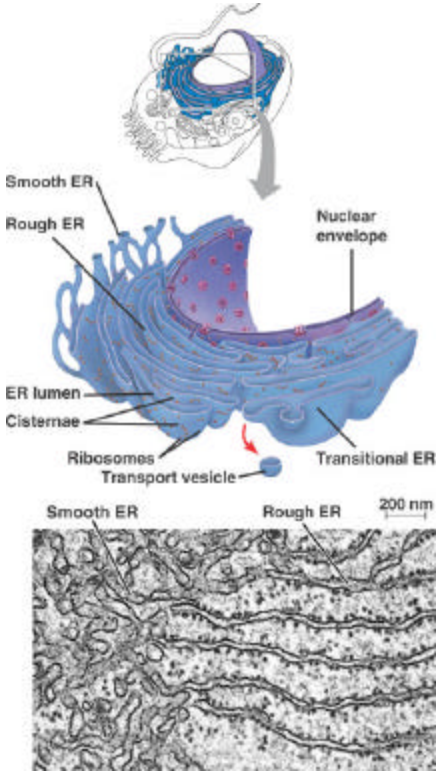


Organelles of Plant Cells

Organelles of the Endomembrane System

Organelles of the Endomembrane System: Endoplasmic Reticulum (ER)

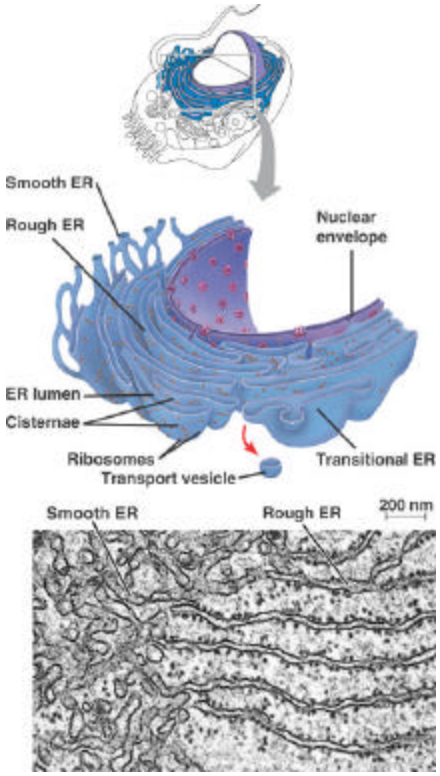




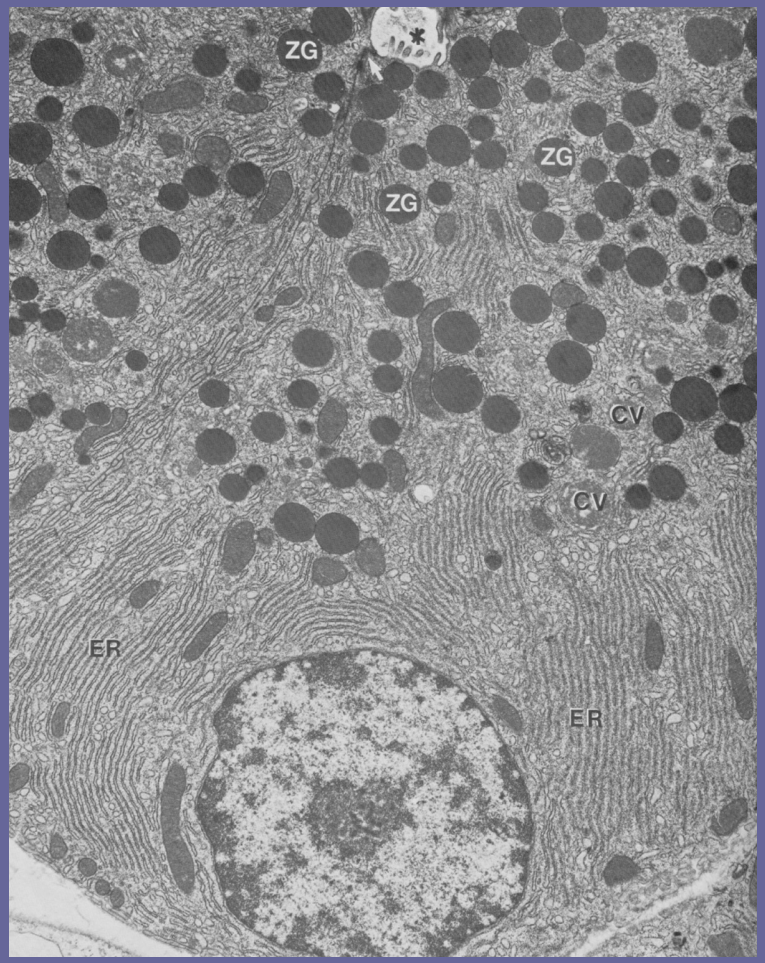
The ER is constituted of smooth (SER) and rough (RER) regions. Both animal and plant cells have SER and RER

Organelles of the Endomembrane System: Endoplasmic Reticulum (ER)

- The ER is a membrane bounded organelle. The smooth and rough regions of the ER are interconnected
- **Smooth ER** lacks ribosomes. It is a network of pipe-like interconnected tubes. Functions of the SER include synthesis of lipids, processing of sugars, and detoxification of drugs and poisons
- **Rough ER** has bound ribosomes attached to the outside. The RER is in fact an extension of the outer nuclear membrane. Functions of the RER include anchorage of newly synthesize proteins, and the finishing of proteins

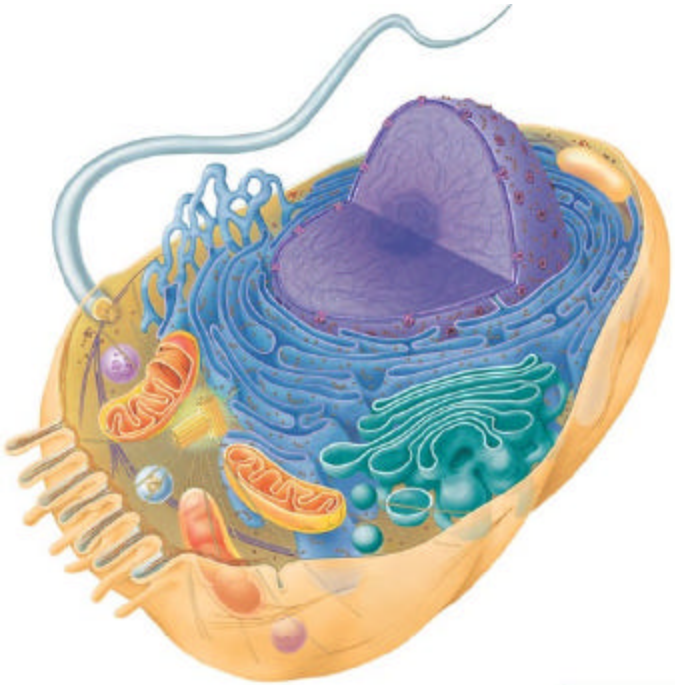


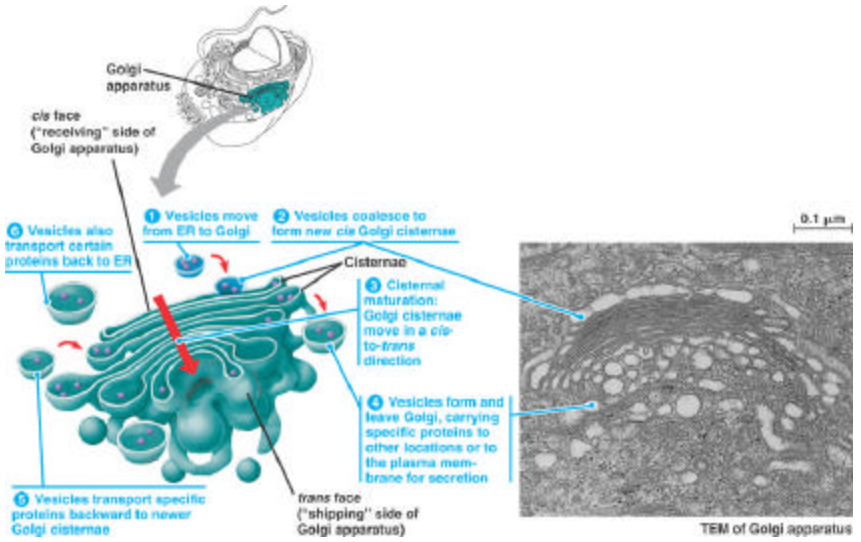
Organelles of the Endomembrane System: Endoplasmic Reticulum (ER)



Pancreatic Cell: In Eukaryotic Cells, Nucleus, Cytoplasm, and Organelles Are Present. ER, Endoplasmic Reticulum

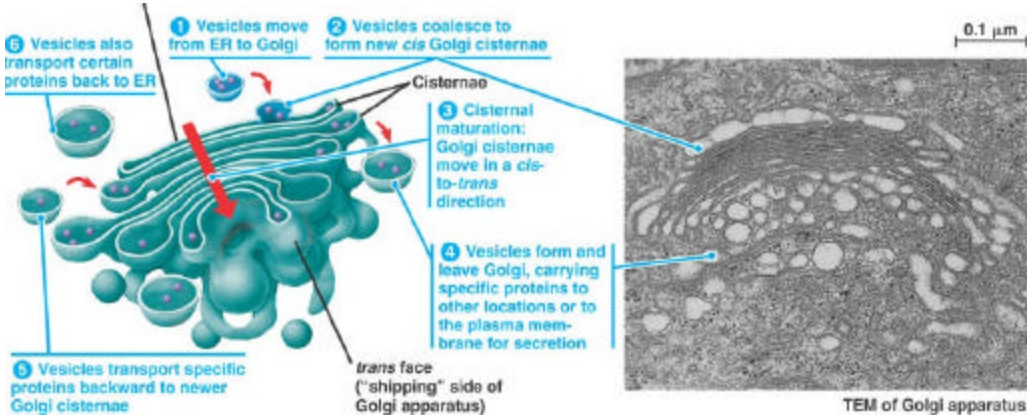
Organelles of the Endomembrane System: Golgi Apparatus





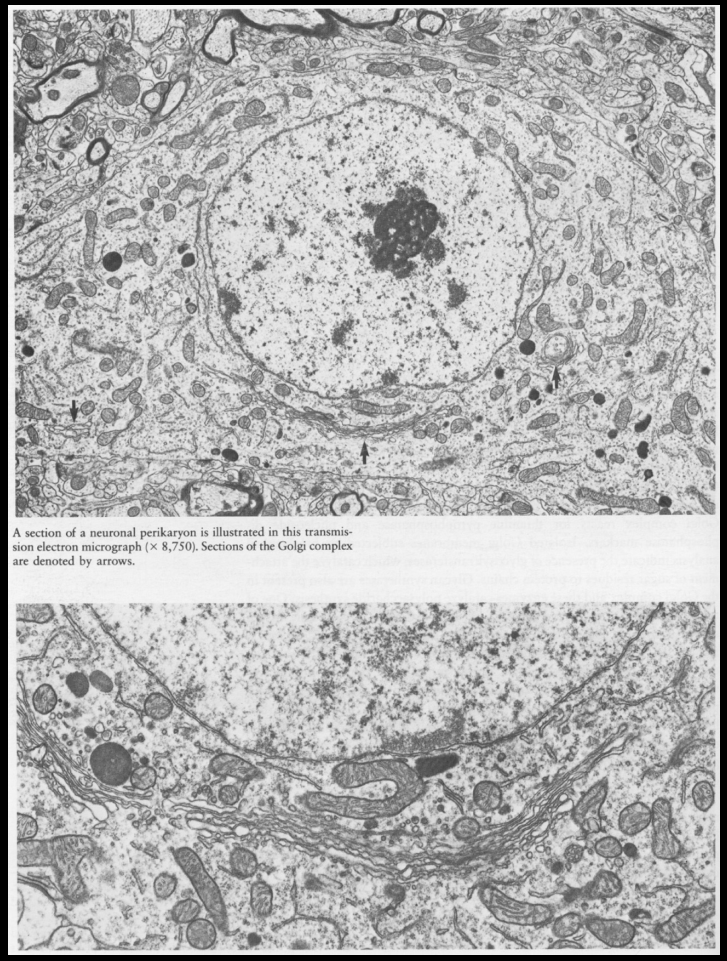
The Golgi Apparatus is a single membrane-bounded organelle constituted of piled sac-like <u>cisternae</u>. Both animal and plant cells have Golgi Apparatus

Organelles of the Endomembrane System: Golgi Apparatus



- The Golgi Apparatus receives, packs, and ships vesicles coming from the ER, or from other parts of the cell back to the ER
- Vesicles arriving from the ER (on *cis* side) coalesce in the Golgi apparatus, where they mature and form new vesicles that would be shipped (from *trans* side) to other cell locations

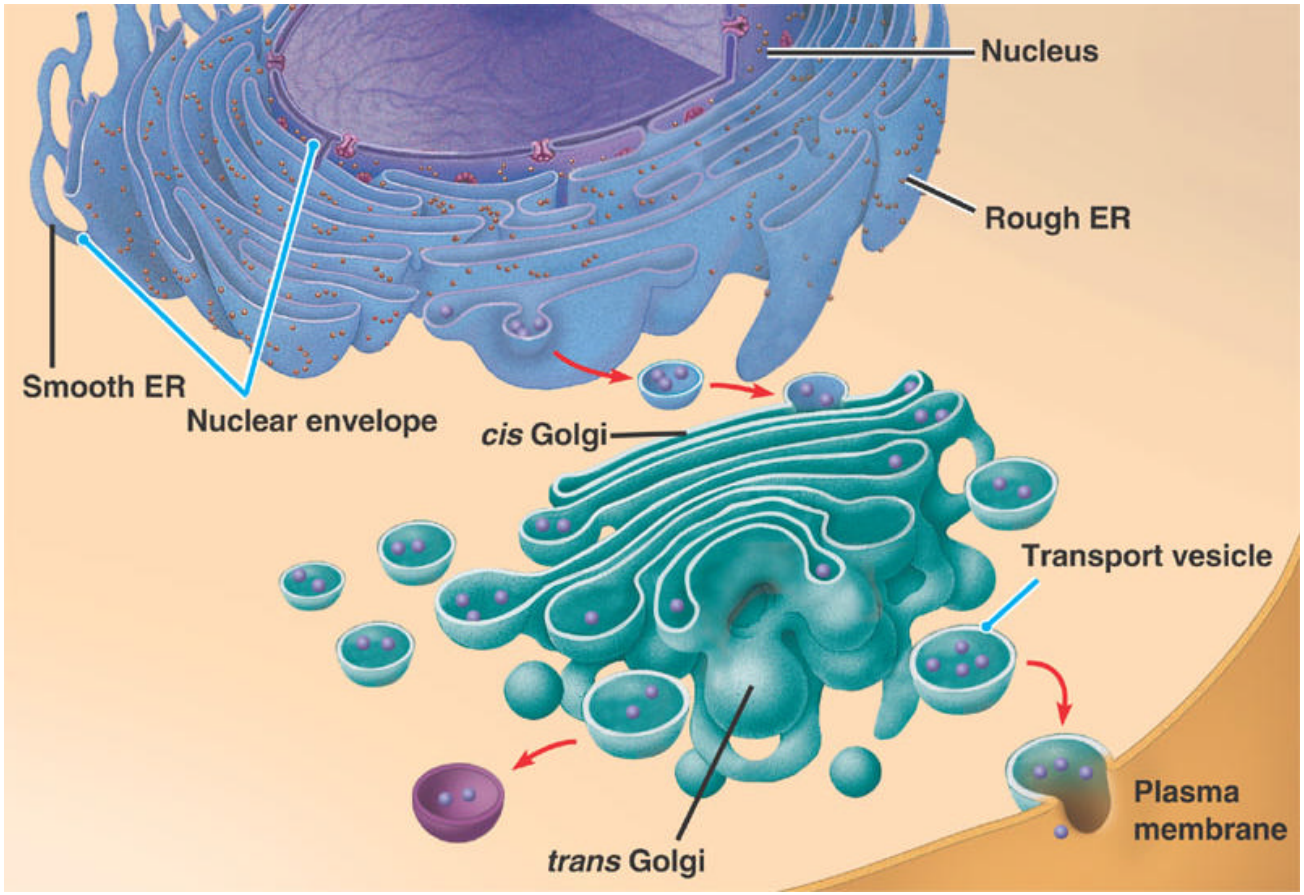
Organelles of the Endomembrane System: Golgi Apparatus



A section of a neuronal perikaryon is illustrated in this transmission electron micrograph (× 8,750). Sections of the Golgi complex are denoted by arrows.

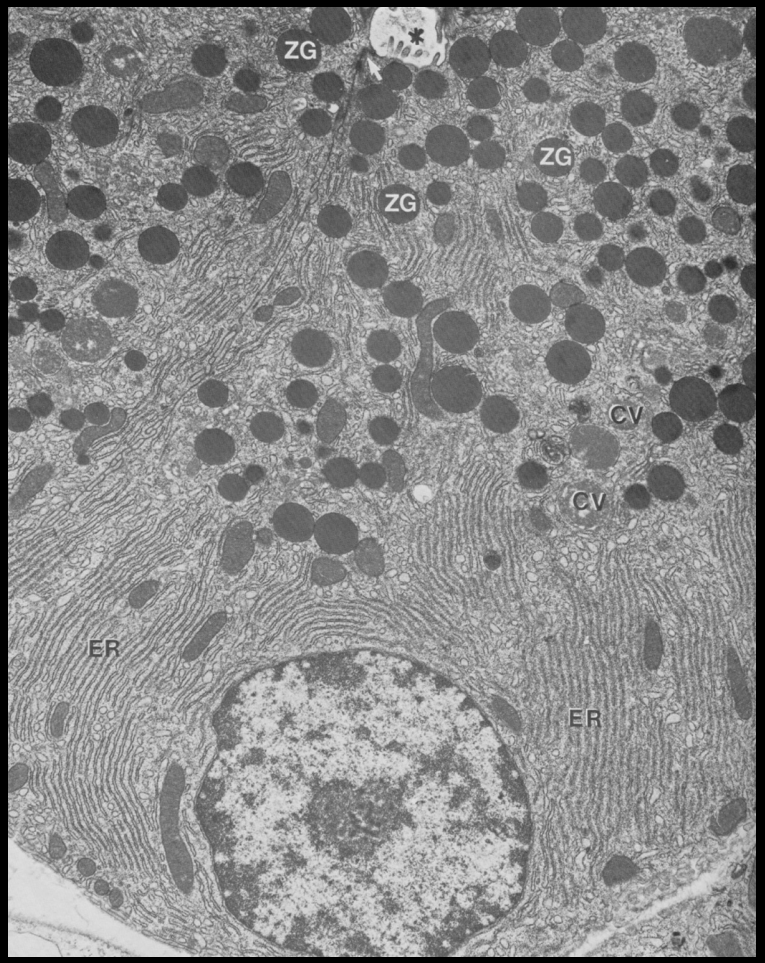
Golgi Apparatus in Neuron

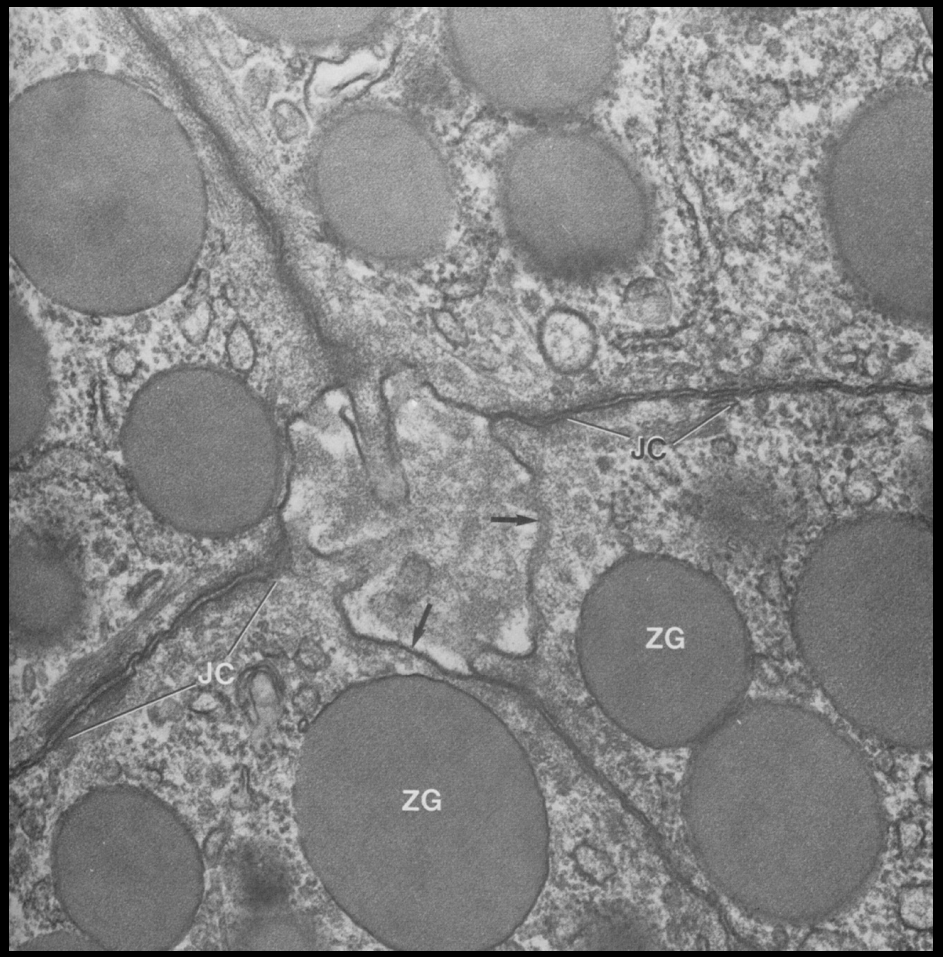
Organelles of the Endomembrane System: Vesicles and Lysosomes



Transport and Secretory Vesicles (single membrane-bounded organelles). Both animal and plant cells have transport vesicles

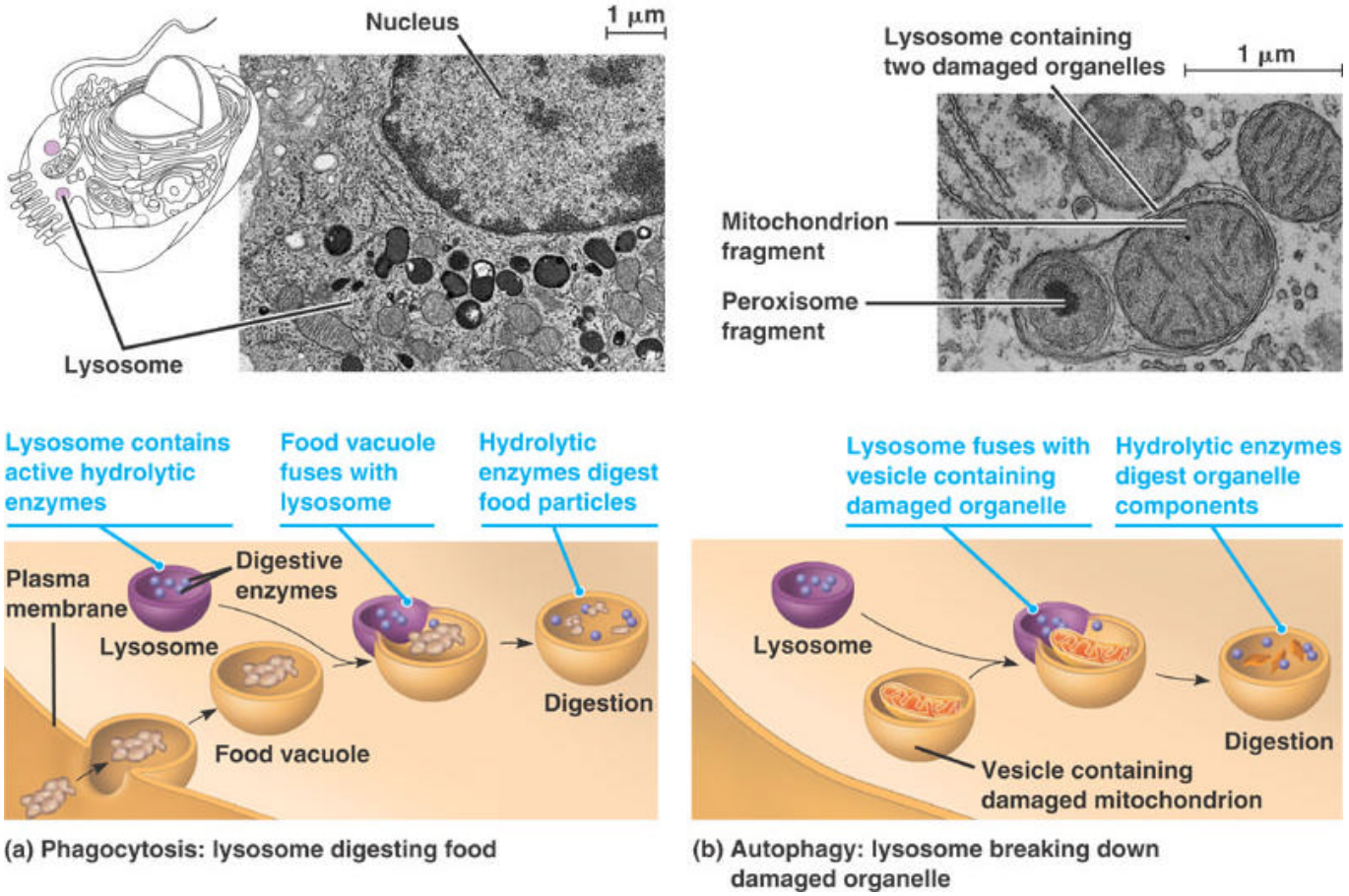
Organelles of the Endomembrane System: Vesicles





Pancreatic Secretory Cell: Basal and Apical Parts

Organelles of the Endomembrane System: Vesicles and Lysosomes

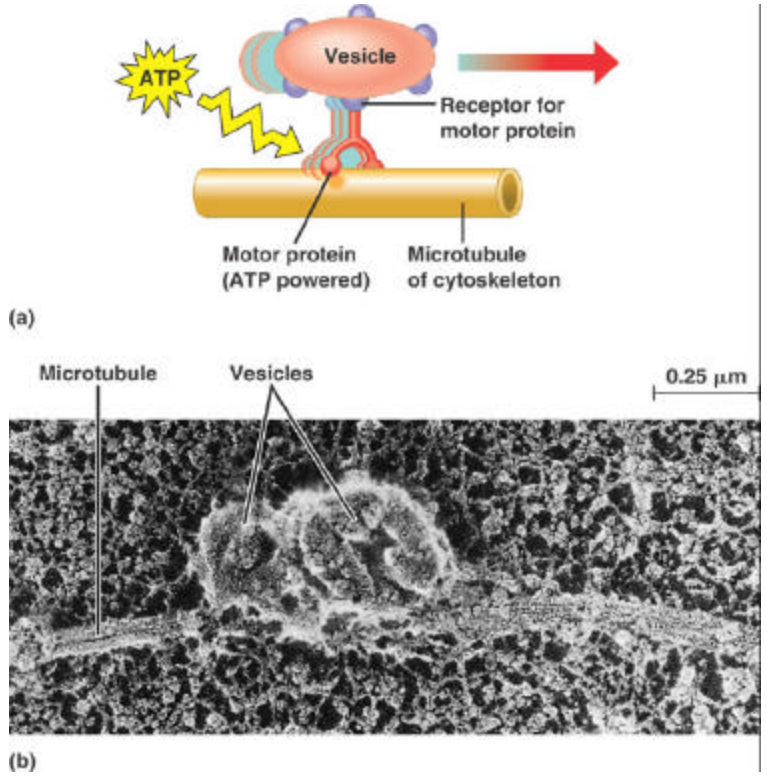


(a) Phagocytosis: lysosome digesting food

(b) Autophagy: lysosome breaking down damaged organelle

Lysosomes are typical of animal cells; lysosomes are vesicles that contain hydrolytic enzymes. Tay-Sachs is an autosomal recessive disease caused by mutations in lysosomal enzymes

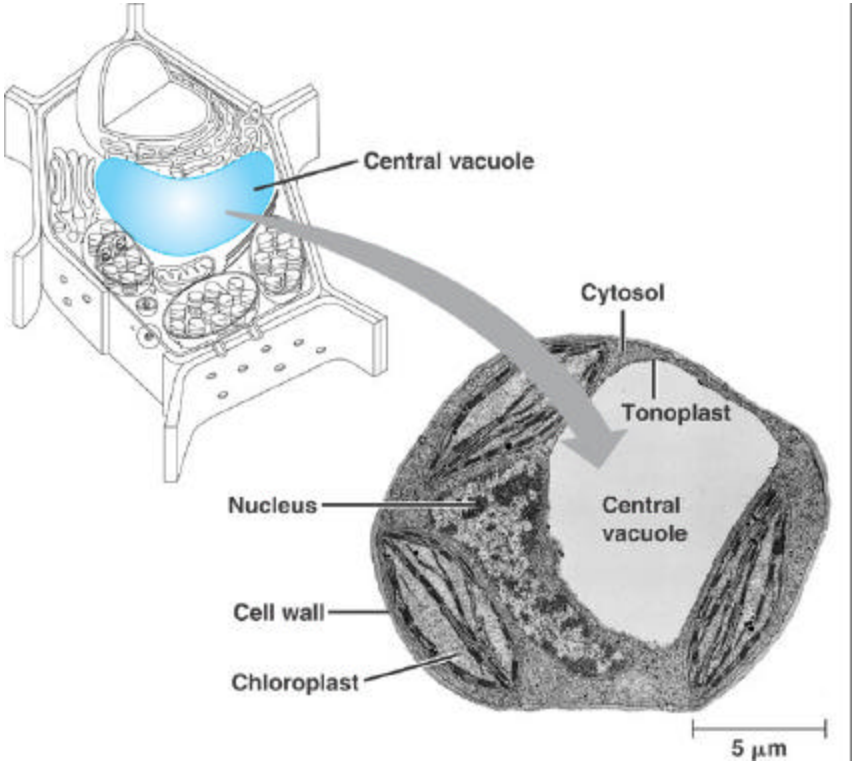
How Do Vesicles, Lysosomes, and Vacuoles Move?



Cytoskeletal elements and motor proteins interact with the vesicle's surface receptor proteins. Such interaction leads to vesicle movement.

Organelles of the Endomembrane System: Central Vacuole

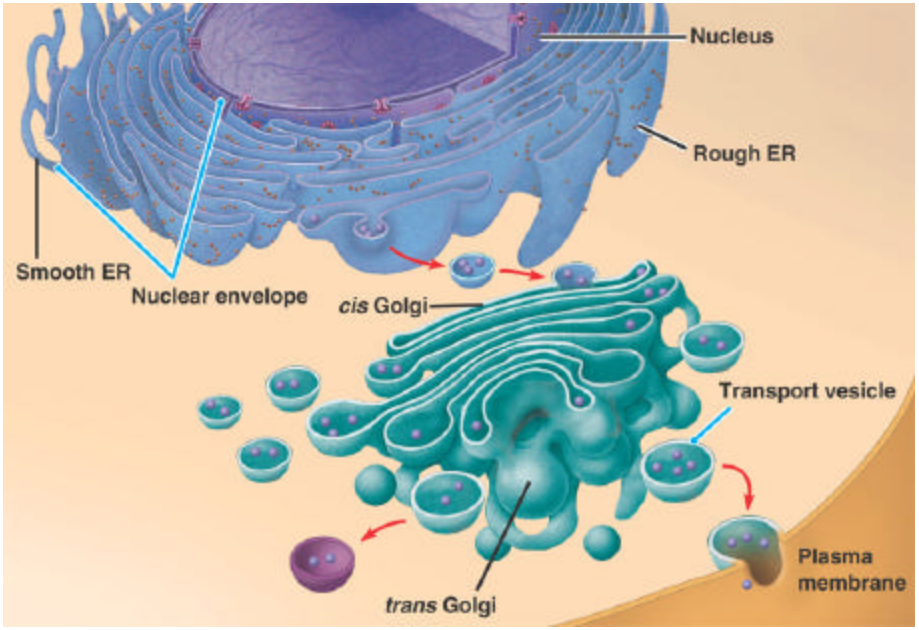
- Mature plants generally contain a large *central vacuole* that may occupy 50-90% of the cell's interior
- The central vacuole is a single membrane-bounded organelle. Such cell membrane is termed *tonoplast*
- The central vacuole stores a variety of organic and inorganic compounds



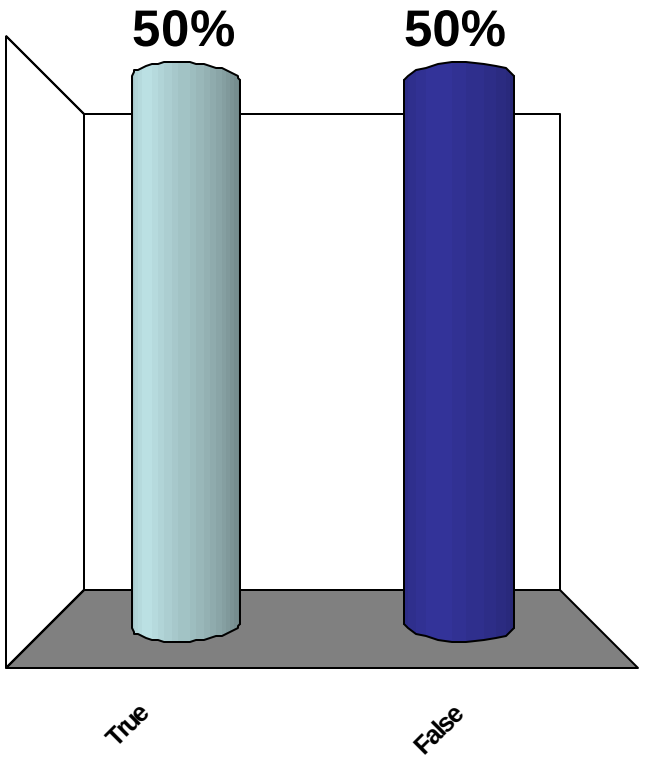
Organelles of the Endomembrane System

- Plasma Membrane and Nuclear Envelope
- Endoplasmic Reticulum (SER, RER)
- Golgi Apparatus
- Transport, Secretory Vesicles, and Vacuoles
- Lysosomes (only in animal cells)
- Central Vacuole (only in plant cells)

Organelles of the endomembrane system control production, circulation, storage, and delivery of substances produced or taken by the cell

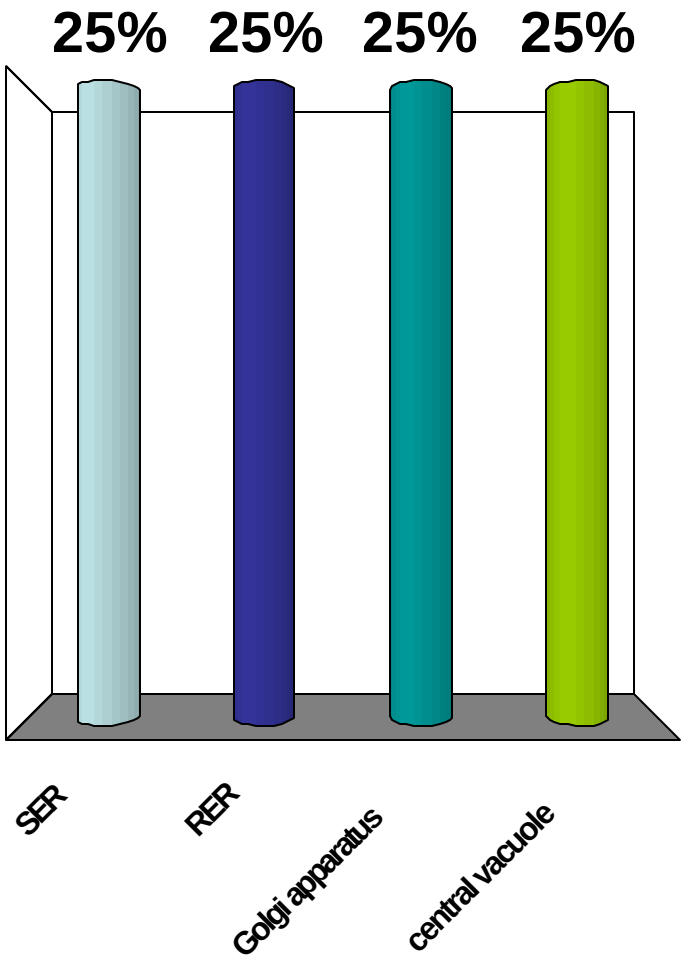


1. True
2. False



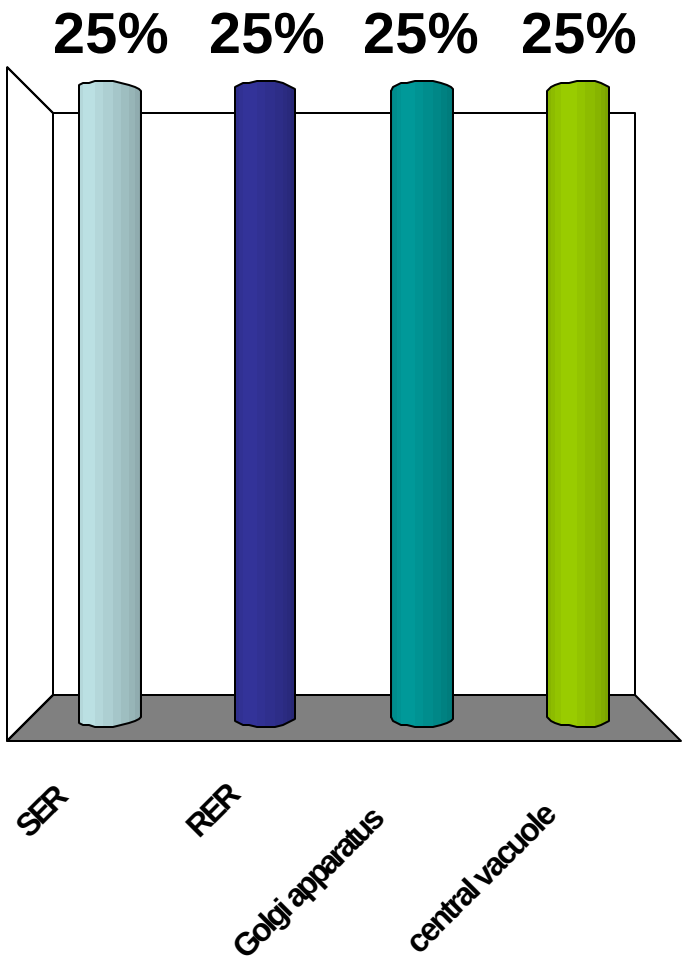
trans side : sorting of vesicles :secretion of vesicles

1. SER
2. RER
3. Golgi apparatus
4. central vacuole



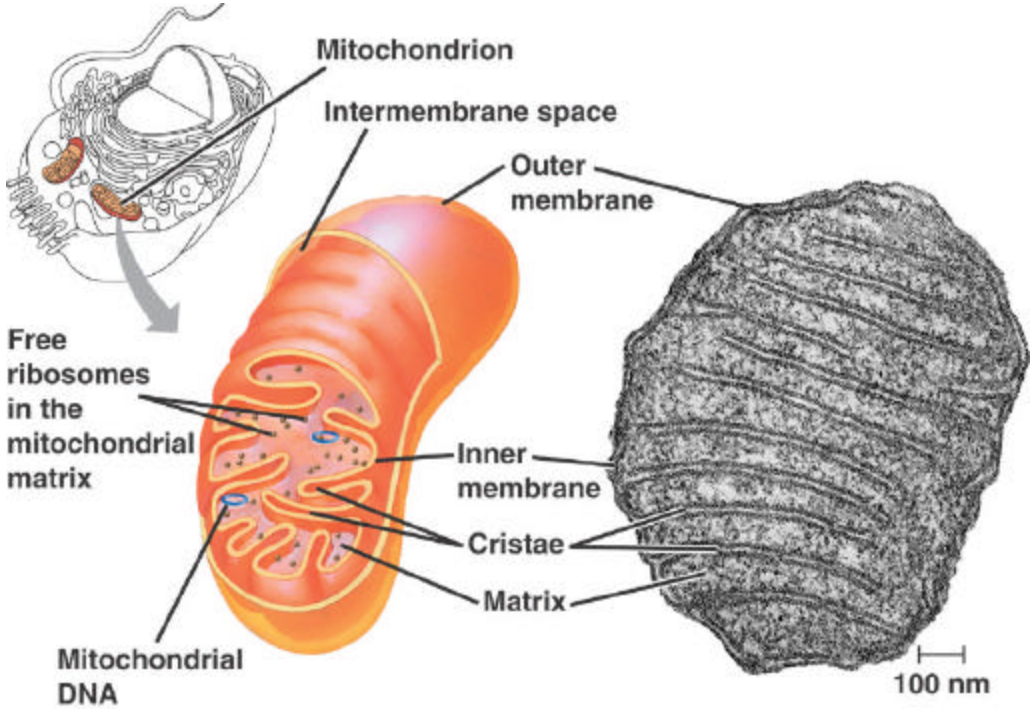
cell storage: tonoplast :endomembrane system

1. SER
2. RER
3. Golgi apparatus
4. central vacuole



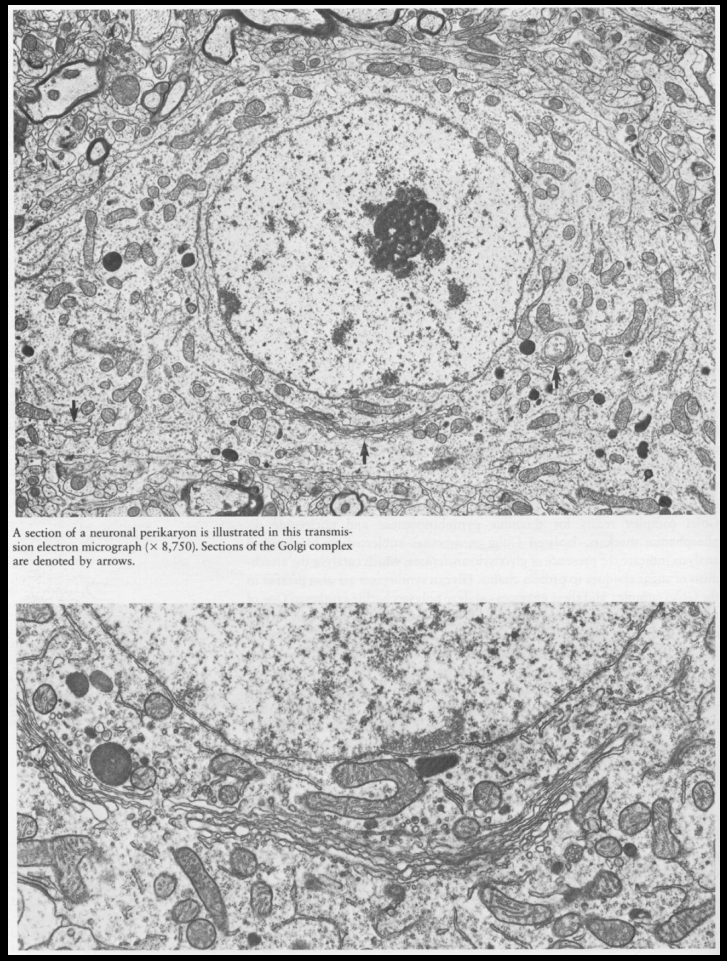
Energy- Producing Organelles

Energy- Producing Organelles: Mitochondria



Mitochondria are double membrane- bounded organelles present in nearly all eukaryotic cells (plant, animals, fungi, etc.). Mitochondria process macromolecules to obtain energy through a process termed <u>aerobic respiration</u>. Mitochondria have their own DNA (mitochondrial DNA, mDNA) and ribosomes in their matrix.

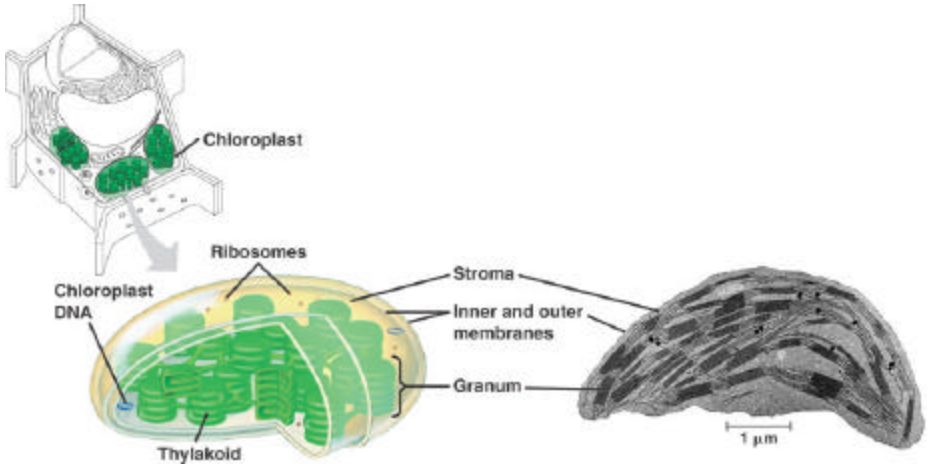
Energy- Producing Organelles: Mitochondria



A section of a neuronal perikaryon is illustrated in this transmission electron micrograph (× 8,750). Sections of the Golgi complex are denoted by arrows.

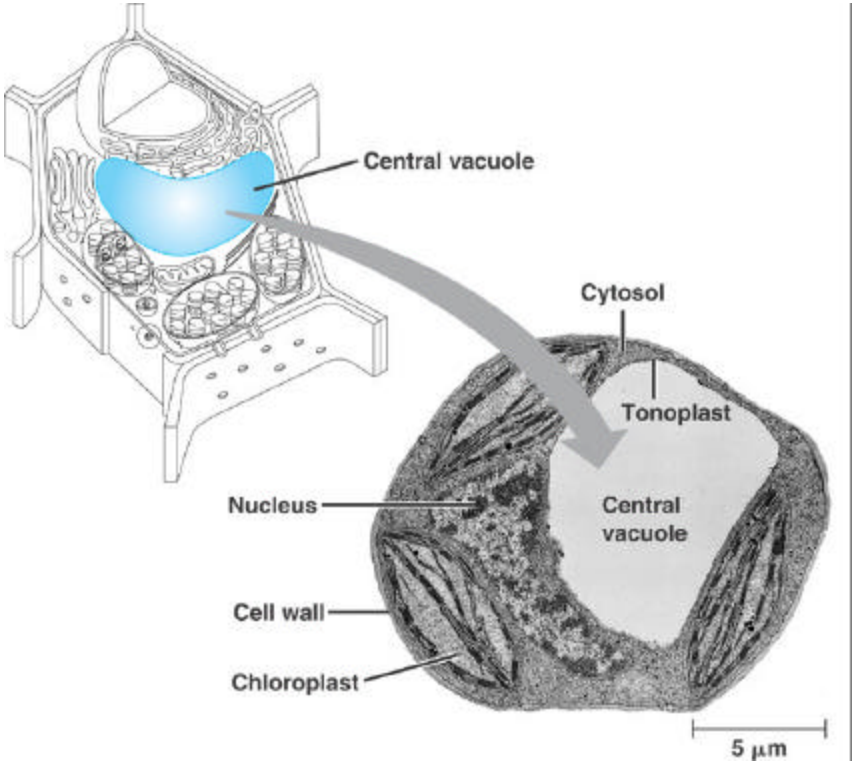
Mitochondria in Neurons

Energy- Producing Organelles: Chloroplasts

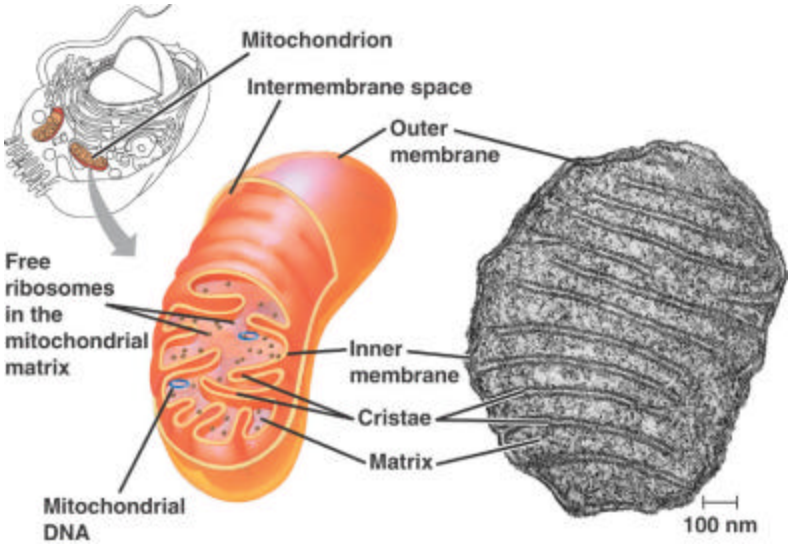


- Chloroplast are *plastids* that contain the green pigment chlorophyll along with other photosynthetic pigments. Chloroplasts perform photosynthesis
- Chloroplasts are double membrane-bounded organelles present in plant cells.
- In the *stroma,* chloroplast DNA and ribosomes can be found

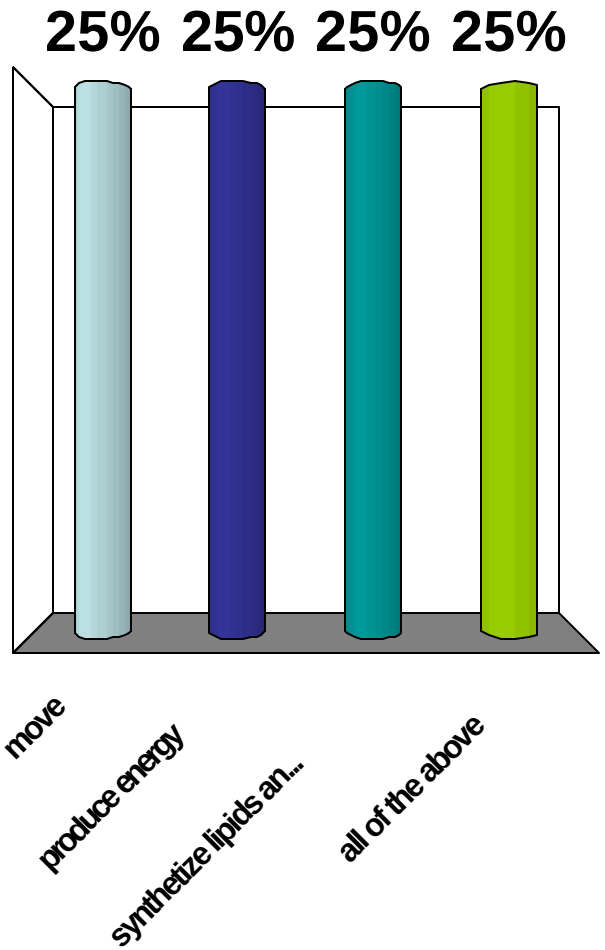
Energy- Producing Organelles: Chloroplasts



If a cell did not have mitochondria, it would be unable to:

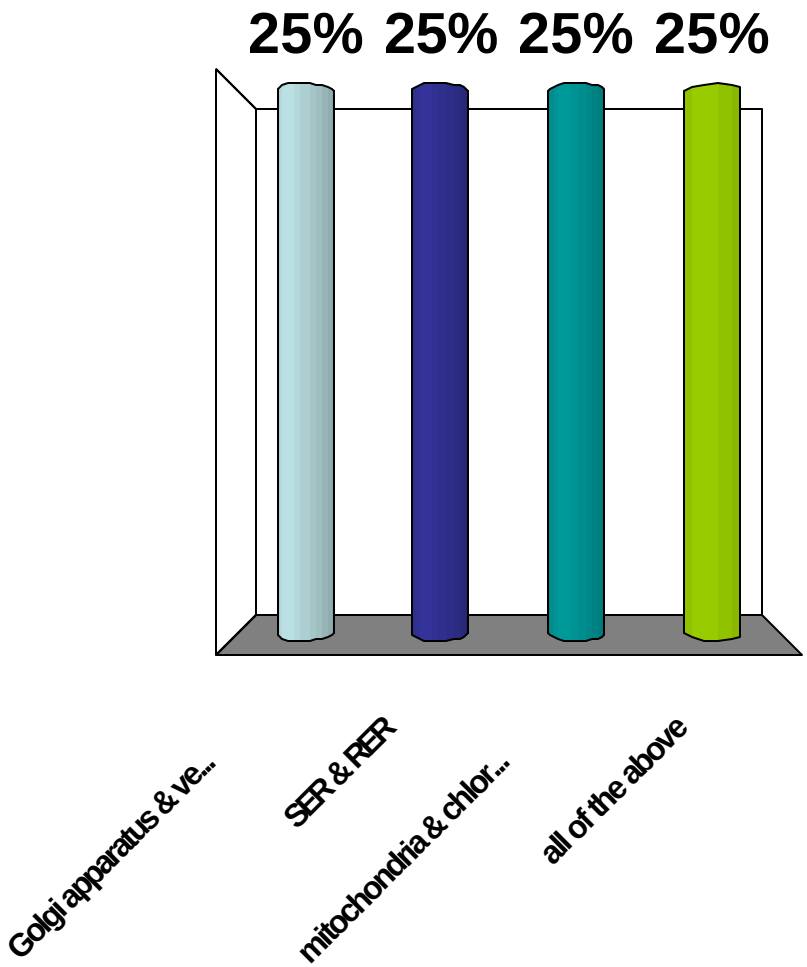


1. move
2. produce energy
3. synthetize lipids and move vesicles
4. all of the above

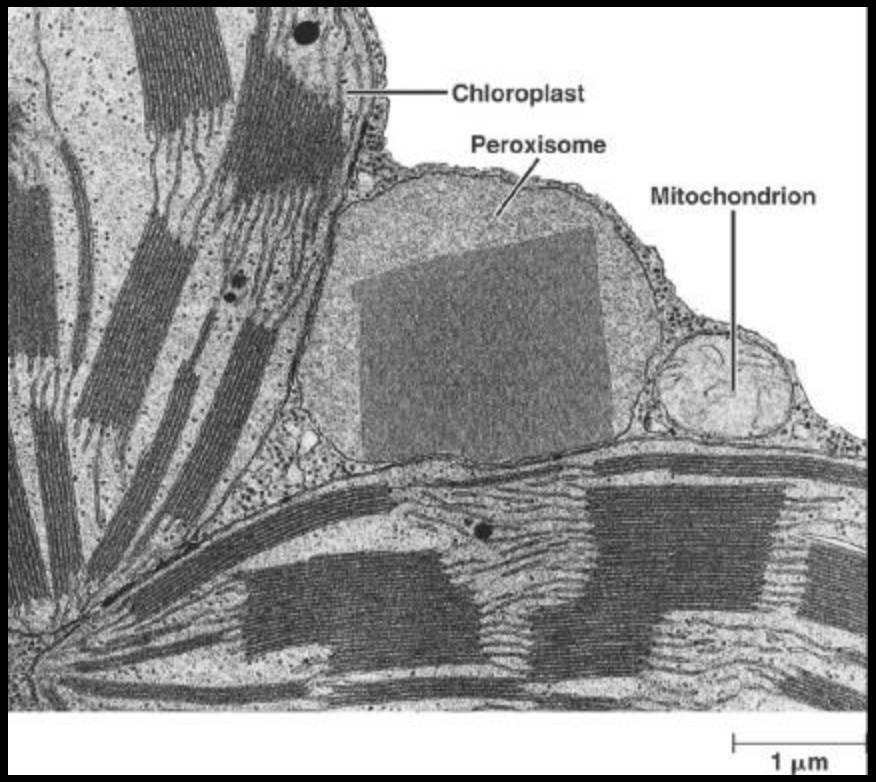


Select the choice that indicates organelles bounded by a double membrane

1. Golgi apparatus & vesicles
2. SER & RER
3. mitochondria & chloroplasts
4. all of the above

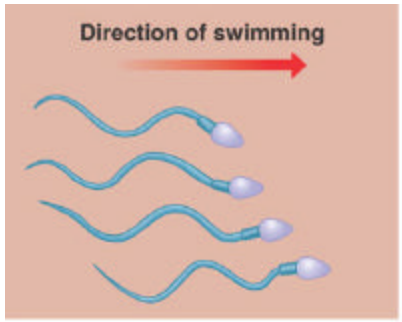


Energy- Producing Organelles: Chloroplasts

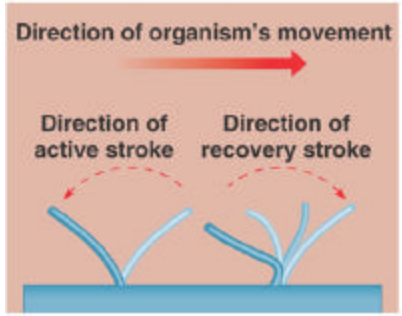


Shape Maintenance and Movement- Producing Organelles

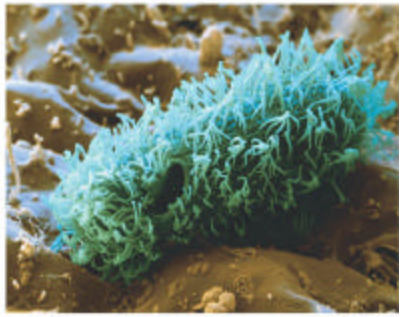
Movement- Producing Organelles and Cytoskeleton



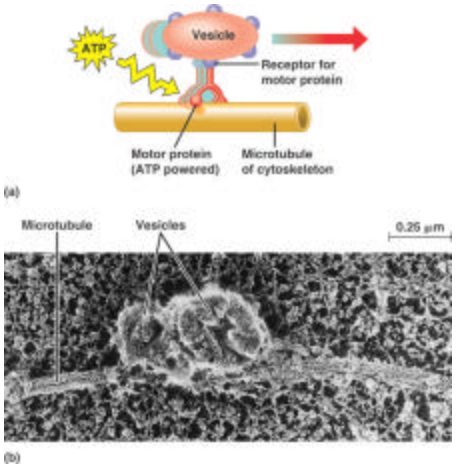
(a) Motion of flagella



(b) Motion of cilia



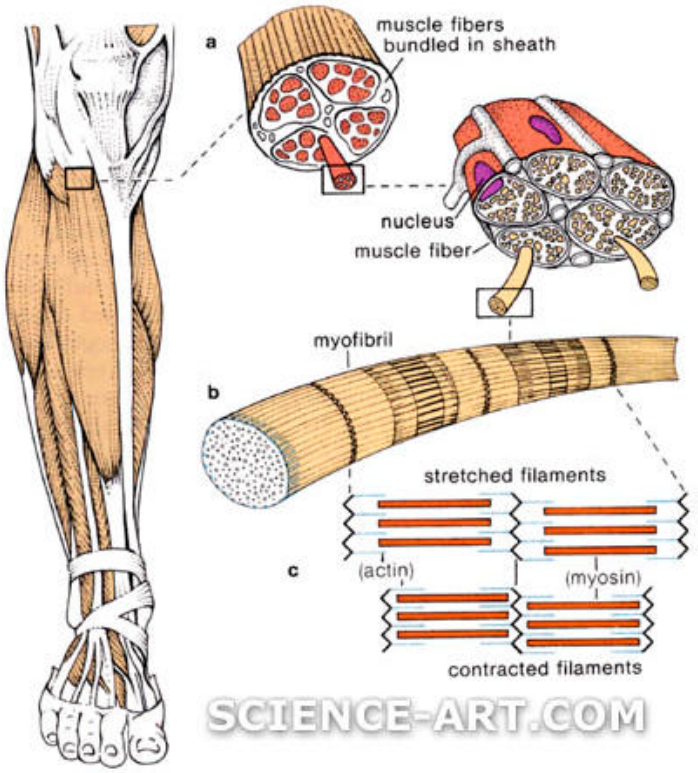
Motion produced by cilia or flagella

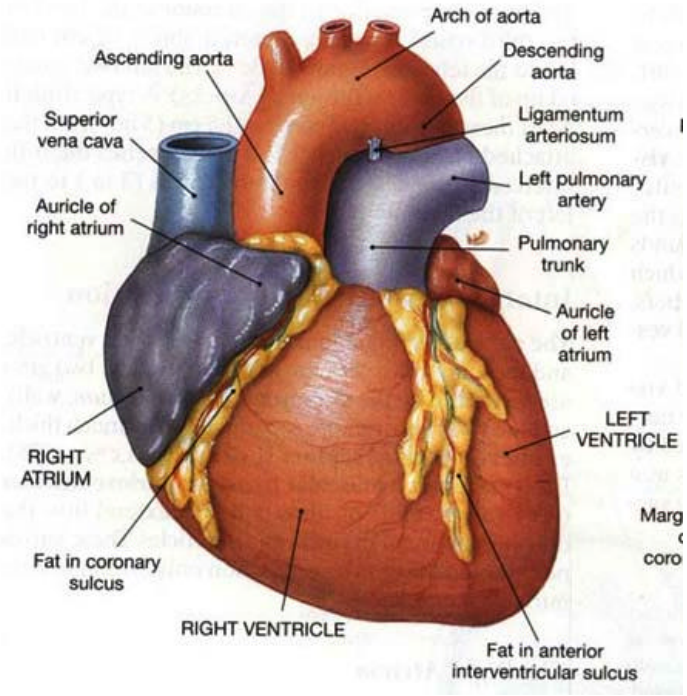


Motion of vesicles provided by cytoskeleton

Amoeboidal movement provided by cytoskeleton

Movement- Producing Organelles and Cytoskeleton

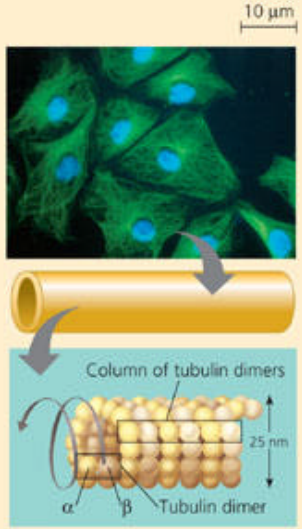
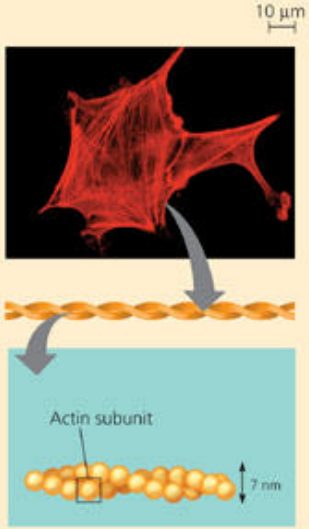
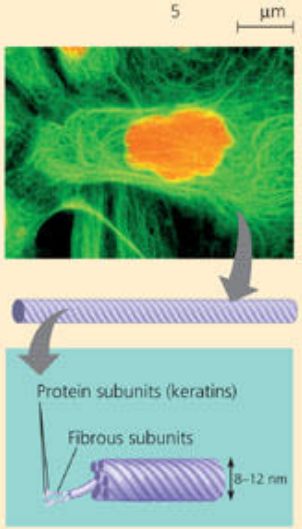




Skeletal Muscle and Cardiac Muscle

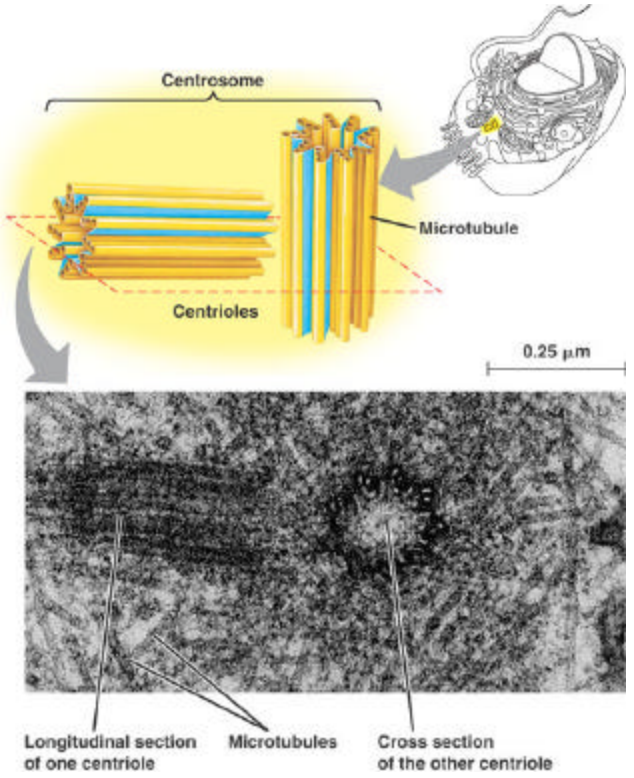
Shape Maintenance and Movement- Producing Organelles and Cytoskeleton: The Cytoskeleton

Table 6.1 The Structure and Function of the Cytoskeleton

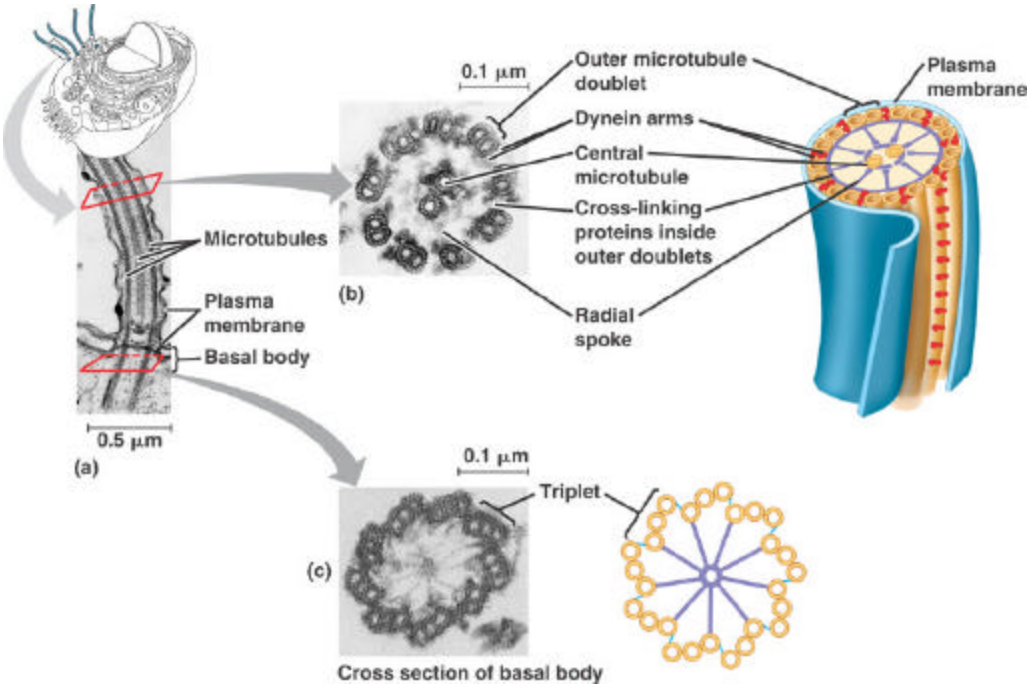
Property	Microtubules (Tubulin Polymers)	Microfilaments (Actin Filaments)	Intermediate Filaments
Structure	Hollow tubes; wall consists of 13 columns of tubulin molecules	Two intertwined strands of actin, each a polymer of actin subunits	Fibrous proteins supercoiled into thicker cables
Diameter	25 nm with 15-nm lumen	7 nm	8–12 nm
Protein subunits	Tubulin, consisting of α-tubulin and β-tubulin	Actin	One of several different proteins of the keratin family, depending on cell type
Main functions	Maintenance of cell shape (compression-resisting "girders") Cell motility (as in cilia or flagella) Chromosome movements in cell division Organelle movements	Maintenance of cell shape (tension-bearing elements) Changes in cell shape Muscle contraction Cytoplasmic streaming Cell motility (as in pseudopodia) Cell division (cleavage furrow formation)	Maintenance of cell shape (tension-bearing elements) Anchorage of nucleus and certain other organelles Formation of nuclear lamina
Micrographs of fibroblasts, a favorite cell type for cell biology studies. Each has been experimentally treated to fluorescently tag the structure of interest.			

Movement- Producing Organelles and Cytoskeleton: The Cytoskeleton

- Microtubules grow out from a *centrosome*, a microtubule-organizing region. In animal cells, the centrosome contains a pair of *centrioles*
- Centrioles are made of nine triplets of microtubules



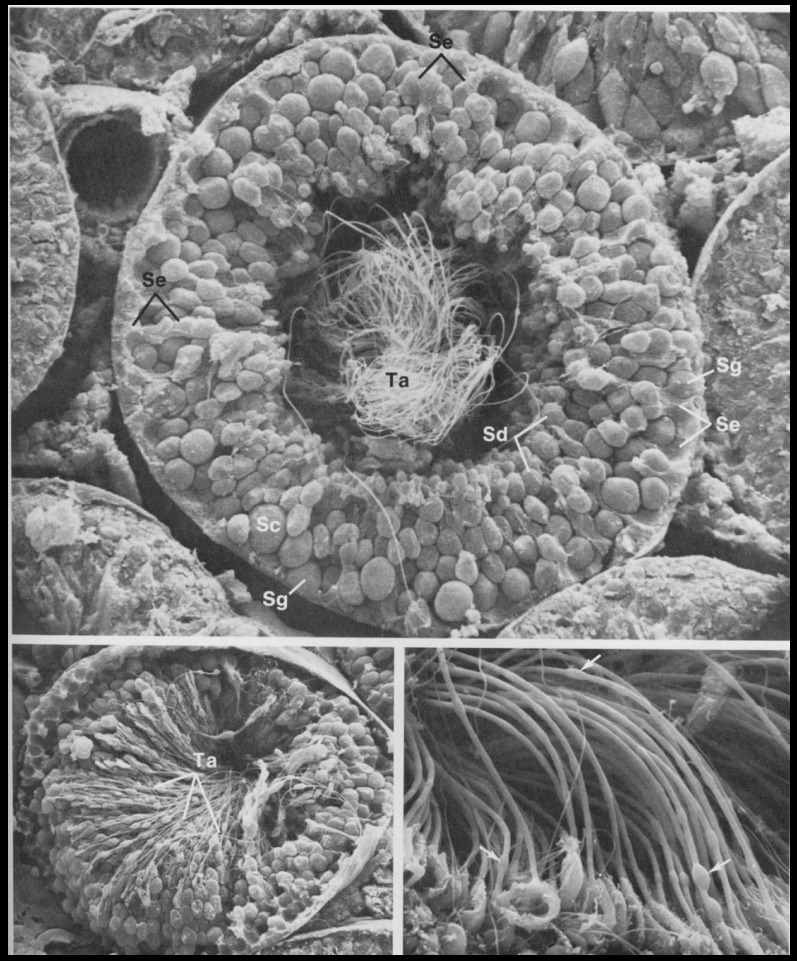
Movement- Producing Organelles and Cytoskeleton: Cilia and Flagella



Cilia and flagella are extensions of the plasma membrane that contain an array of nine pairs of peripheral microtubules and a central one (9+2 array). Cilia and flagella are rooted on the <u>basal body</u>, constituted of nine peripheral triplets of microtubules. Cilia are shorter than flagella

Movement- Producing Organelles and Cytoskeleton: Flagella

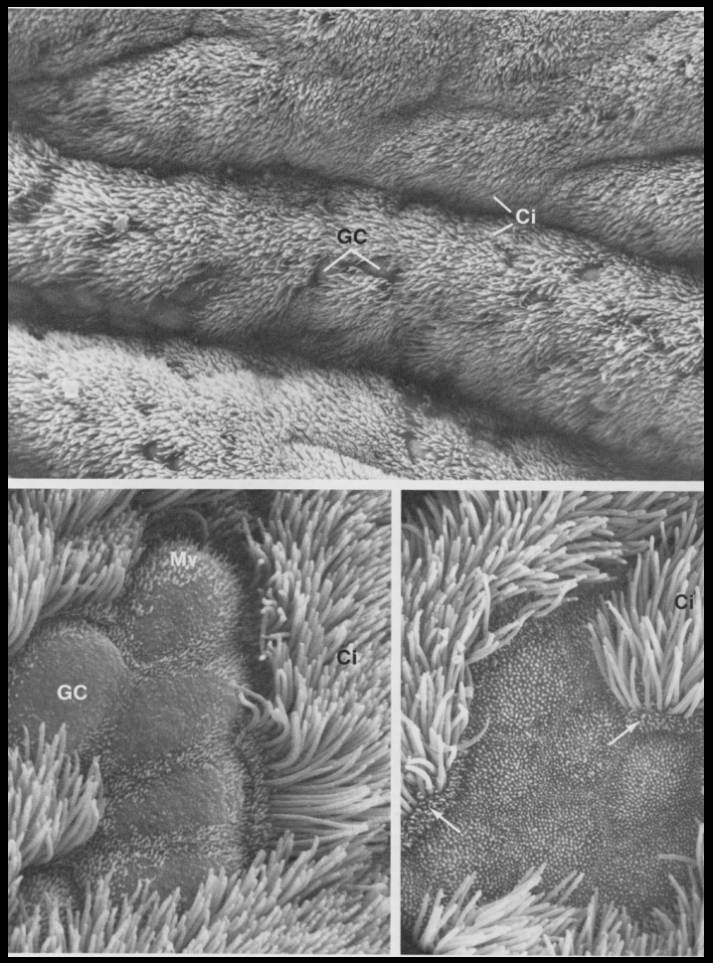
- Flagella propel the cell (*flagellated* cell) in a whip-like motion
- Sperm cells of animals, plants, and algae are flagellated



Sperm Cells in Seminiferous Tubules

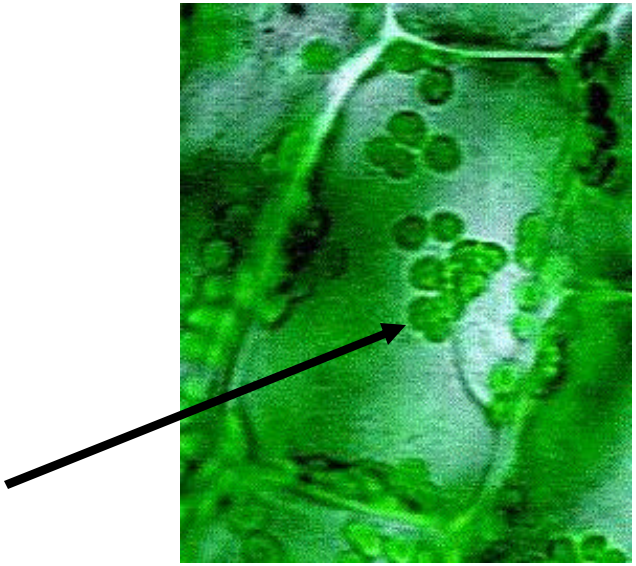
Movement- Producing Organelles and Cytoskeleton: Cilia

- Cilia provide movement to free-swimming eukaryotic unicellular organisms (i.e. *Paramecium)*
- In multicellular organisms, they generally constitute *ciliated* epithelia (i.e. trachea and oviducts). What is the function of these ciliated epithelia?

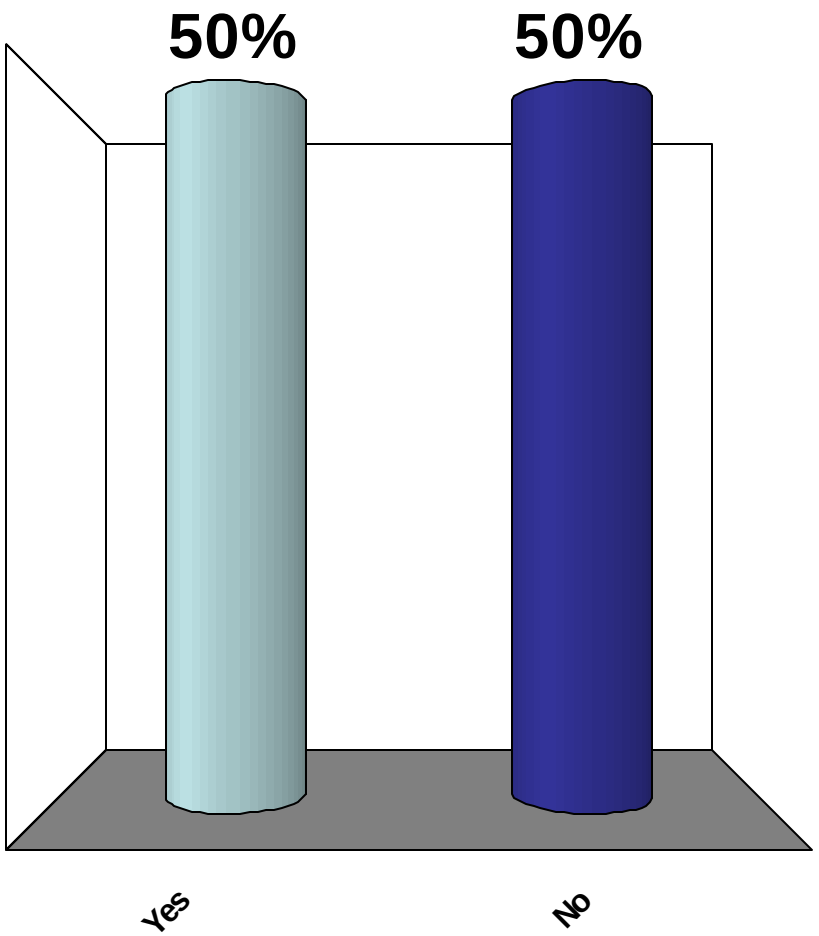


Ciliated Cells in Tracheal Epithelia

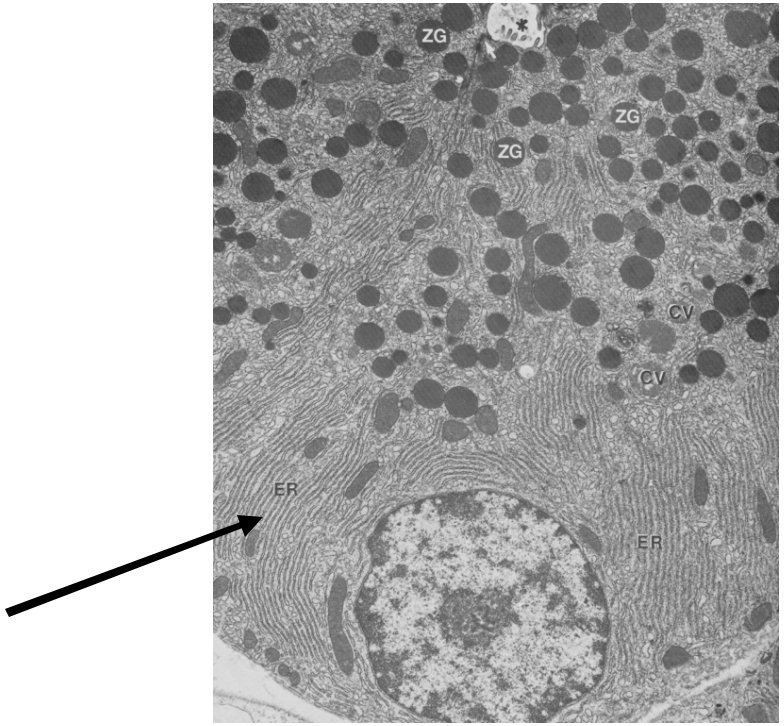
This organelle belongs to the endomembrane system. Do you agree?



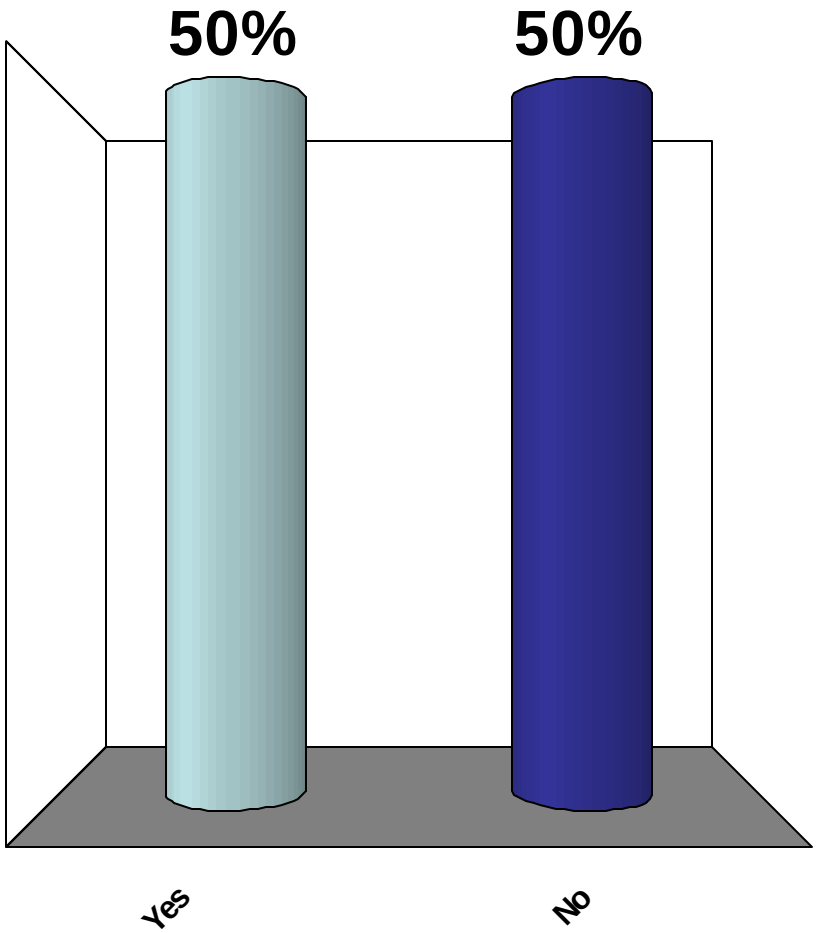
1. Yes
2. No



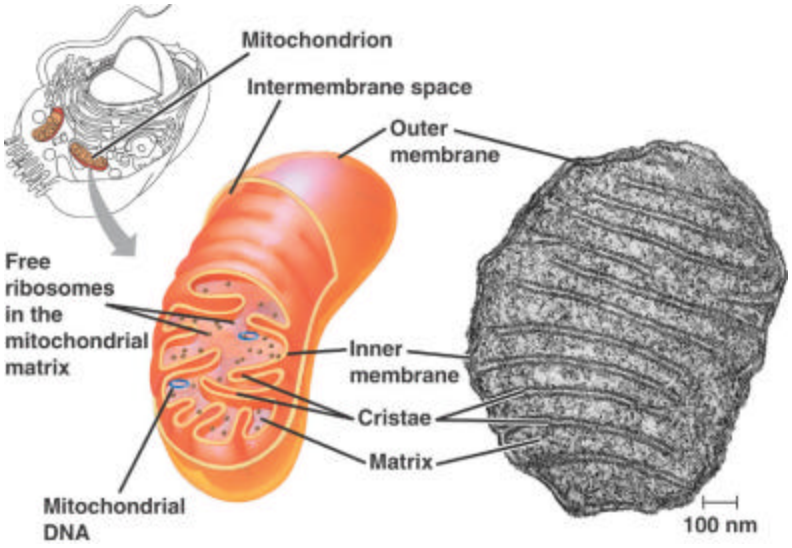
This organelle belongs to the endomembrane system. Do you agree?



1. Yes
2. No



This organelle belongs to the endomembrane system. Do you agree?



1. Yes
2. No