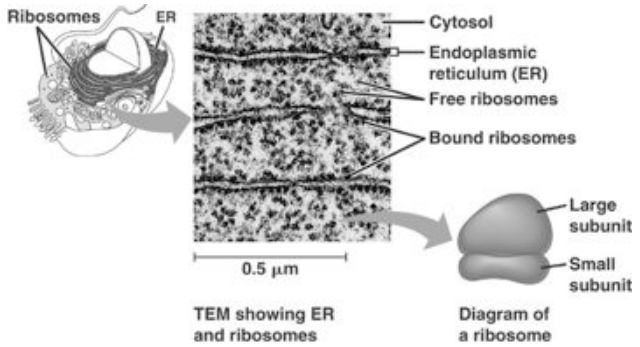
# Topics

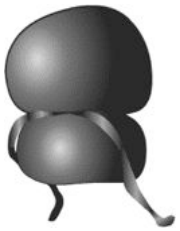
- The Cell
  - Organelles
    - Ribosomes, Mitochondria, Chloroplasts
    - Endomembrane system
    - Cytoskeleton

# Ribosomes



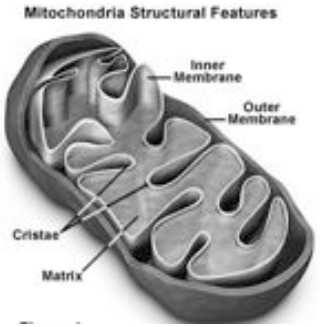

# Ribosomes

- "organelle", but not enclosed in true membrane (ie phospholipid bilayer)
- Contained in both Eukaryotes and Prokaryotes
- Are responsible for manufacturing proteins
- Are composed of a large and a small ribosomal subunit
- Composed of ribosomal RNA (rRNA) and protein
- Ribosome RNA created in nucleolus
- Can be free or fixed (on the ER or nuclear envelope)



# Mitochondria

- In all Eukaryotes, the cell "powerhouse"
- Energy production
  chemical energy to ATP
- Can divide independently
  - Own DNA and ribosomes
- # in a cell can vary, 1-10,000
- Has 2 membranes
  inner highly folded
- Contains numerous enzymes for energy metabolism-discussed later



# Chloroplast

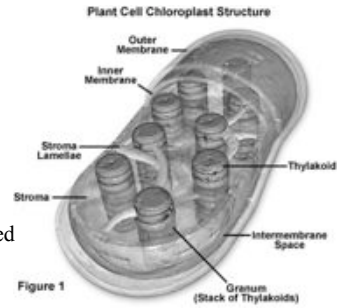
•In plant and algae

•Can divide independently

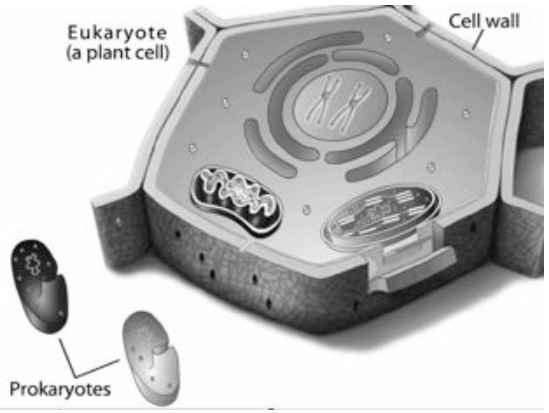
•Where light energy is converted to chemical through **photosynthesis**

•Has 2 membranes and internal membrane discs (**thylakoids**) stacked as **granum**

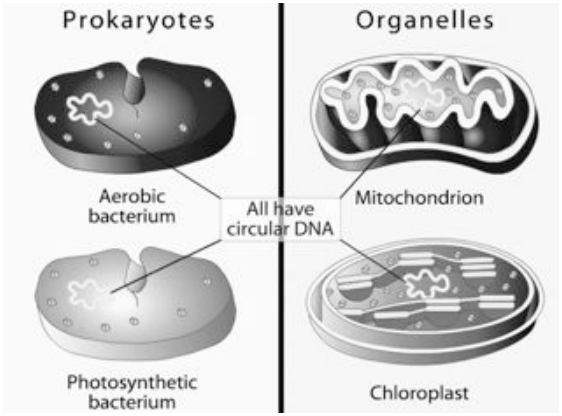
•**Stroma**: the internal fluid containing ribsomes and DNA for protein and carbohydrate synthesis




# Endosymbiont Theory



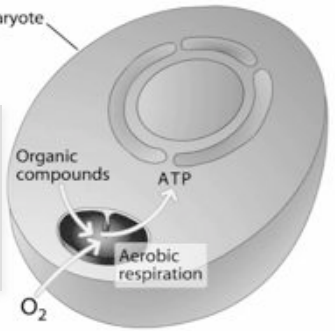

# Evolutionary Symbiosis




# Evolutionary Symbiosis

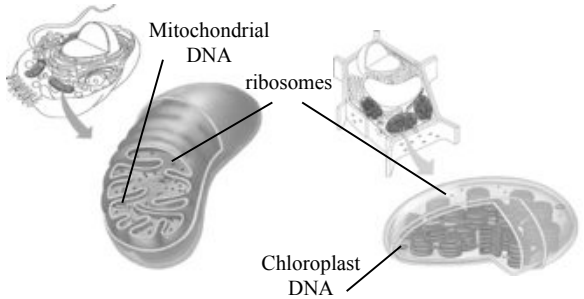
**Cells that can use oxygen to make more ATP will survive to reproduce more often.**

**Eukaryotes that did not digest these bacteria are "selected against"**

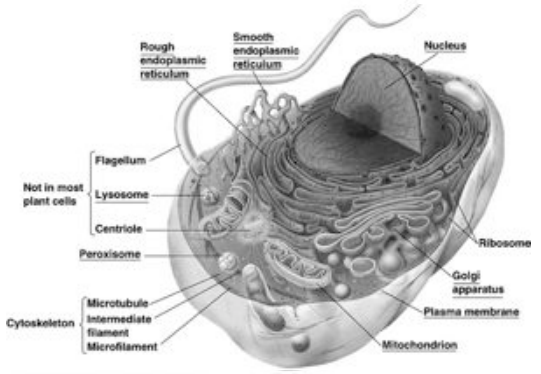


# Endosymbiosis

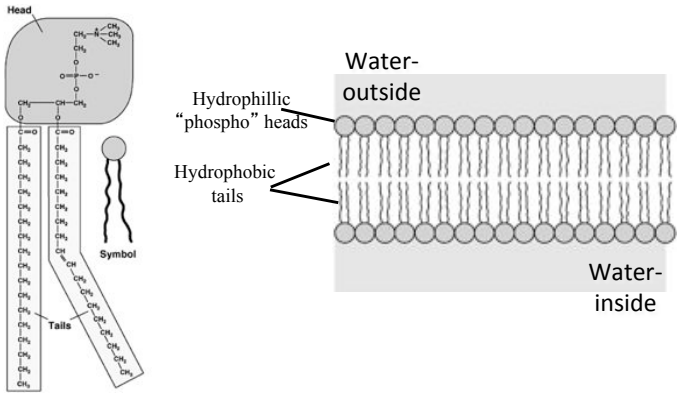
- Circular DNA
- Similar ribosome subunits
- dual membrane



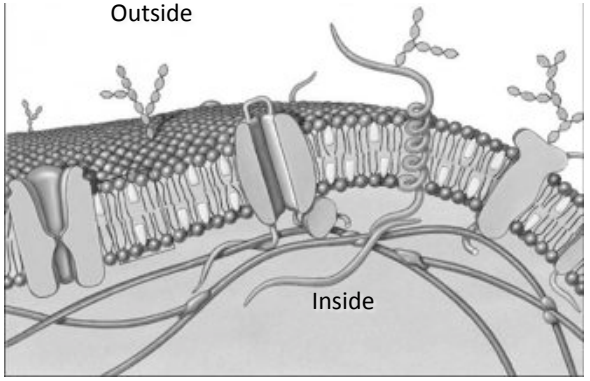

# A Prototypical Eukaryotic Cell with **Organelles**



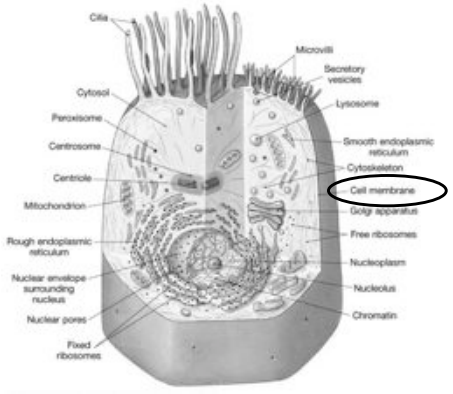

# Phospholipids Create a Bilayer Barrier



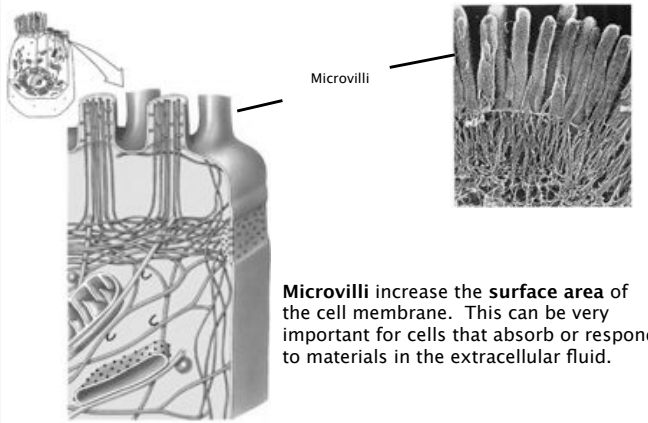

# The Plasma (Cell) Membrane



## A Prototypical Eukaryotic Cell

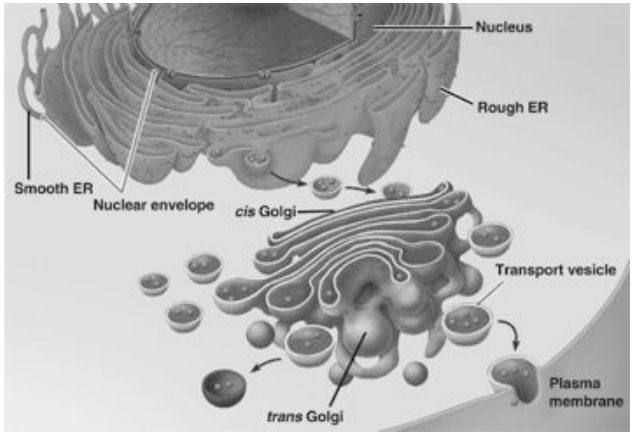



## Microvilli

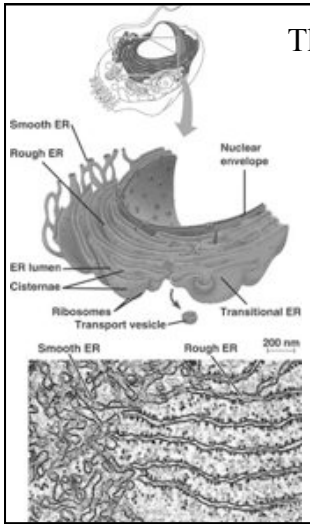



**Microvilli** increase the **surface area** of the cell membrane. This can be very important for cells that absorb or respond to materials in the extracellular fluid.

## The Endomembrane system




## The Endoplasmic Reticulum




- Extensive membrane network, may take up to 10% of cell volume
- Ribosomes (rough ER) attach when actively synthesizing proteins
- Proteins may enter RER after synthesis where further modified and folded before delivery to desired cell locations.
- Smooth ER (no ribosomes) : site of lipid synthesis

# The Endoplasmic Reticulum

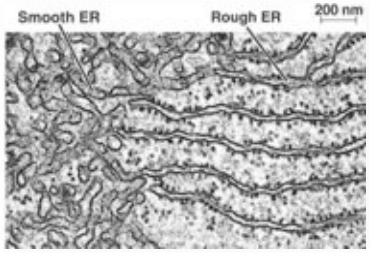
1. *Synthesis.* Specialized regions of the ER synthesize proteins, carbohydrates, and lipids

2. *Storage.* The ER can store synthesized molecules or materials absorbed from the cytosol without affecting other cellular operations

3. *Detoxification.* Drugs or toxins can be absorbed by the ER and neutralized by enzymes within it.

4. *Transport.* Materials can travel across the vast membrane network of the ER or leave as **vesicles.**

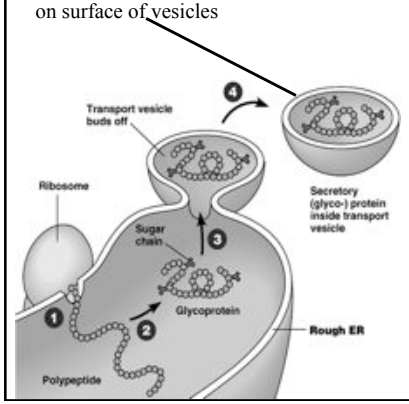
# The Smooth Endoplasmic Reticulum




- Site of lipid synthesis (phospholipids, cholesterol, fatty acids, etc.)
- Site of synthesis and storage of glycogen
- Toxin breakdown (particularly in the liver)
- An internal storage site for ions (e.g. $Ca^{2+}$ in muscle)

# The **Rough** Endoplasmic Reticulum

**Receptor** proteins exist on surface of vesicles




1. Polypeptide synthesized by ribosome

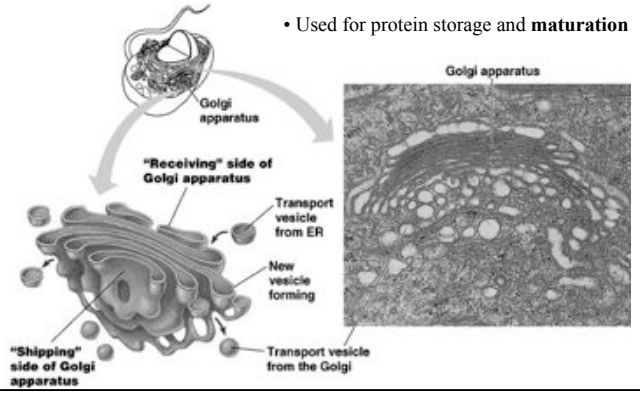
2. Polypeptide folds into protein and is modified

3. **Transport vesicle** "buds" off

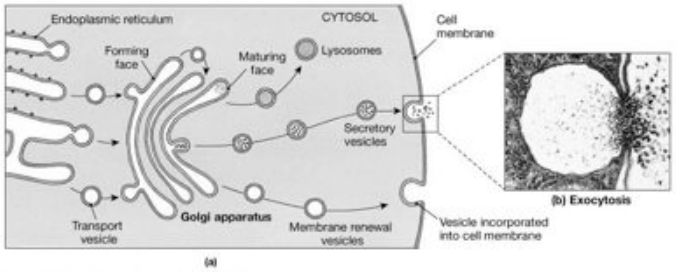
4. **Receptor** proteins tell the cell where to ship the contents

# The Golgi Apparatus

- Flattened "sac-like" membranes
- Used for protein storage and **maturation**

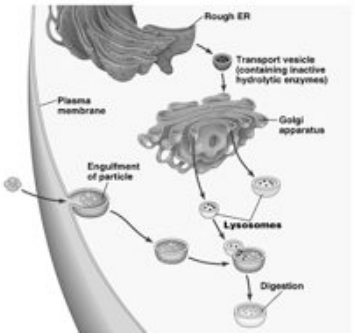


## Golgi Function



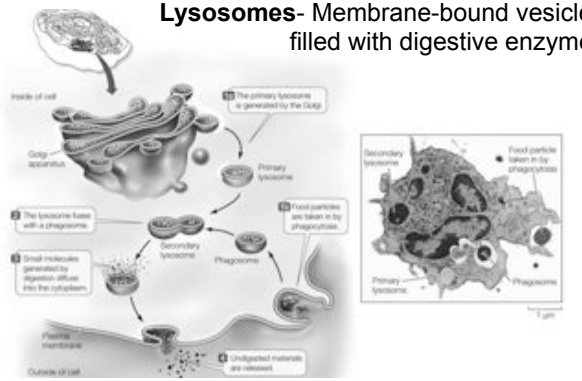

- Packages and sorts proteins for their final cellular destination
- Adds protein modifications, like carbohydrate groups
- Creates **Lysosomes**
- Makes polysaccharides for plant cell walls

## Lysosomes



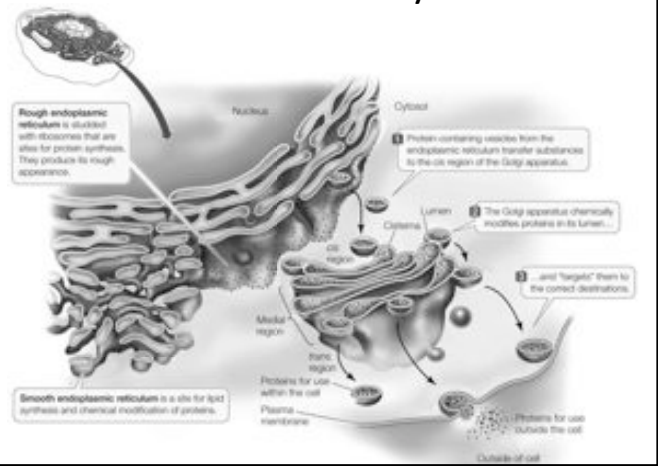

- Created by the Golgi Apparatus
- Lysosomes are inactive until they fuse with another vesicle
- "Autophagy" (self-eating) of cellular particles, for degrading damaged intracellular components

## **Lysosomes**- Membrane-bound vesicles filled with digestive enzymes

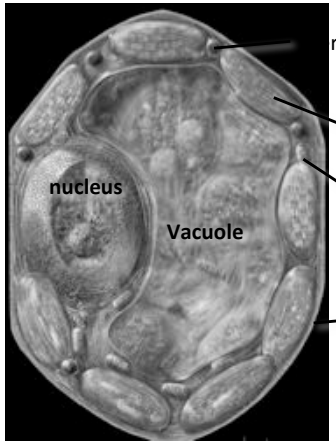


- **Phagocytosis**: process of degrading extracellular components
  - Cellular "eating", Protection from bacteria
- Cleanup and recycling functions- both cellular and foreign materials

## Endomembrane system

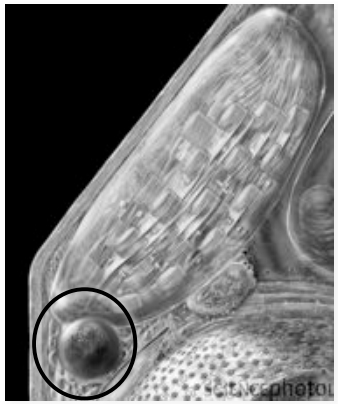


## Plant Cells




## Peroxisomes and Glyoxysomes

- Bud off the **ER** instead of the Golgi (like lysosomes)
- Breakdown of large, excess fatty acids with oxygen creates **$H_2O_2$**
- Breakdown of toxic peroxides (e.g. $H_2O_2$)
- **Glyoxysomes:** plants only, aid breakdown of lipids into carbohydrates for transport to growing cells



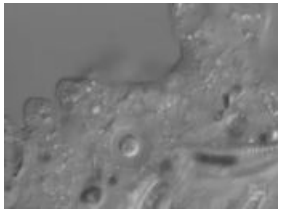
## Vacuoles-Storage and structure

Store toxins and waste, as well as water.
Water creates turgor pressure, helping to physically support the plant

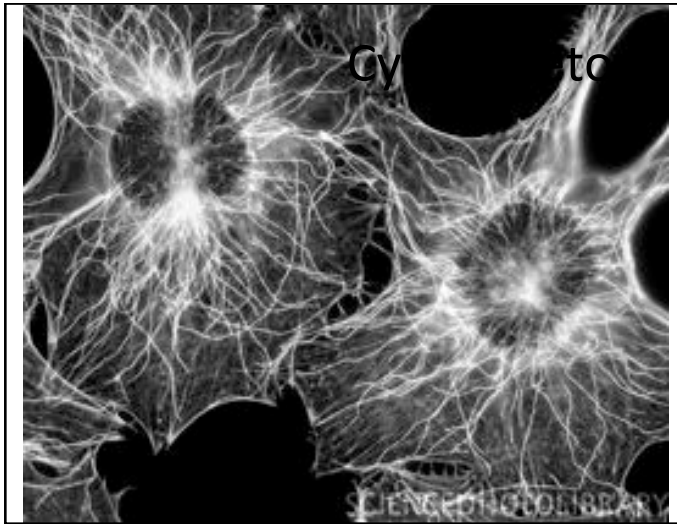
## Vacuoles- reproduction and catabolism

Store pigment-attracting pollinators

Contain enzymes to hydrolyze proteins into monomers for energy



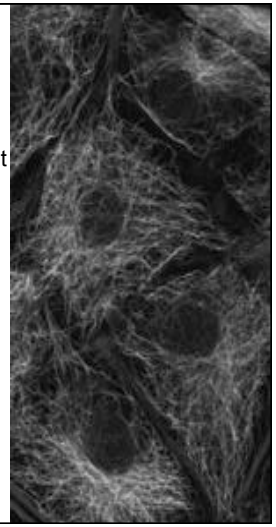
Animals and protists can have vacuoles too...

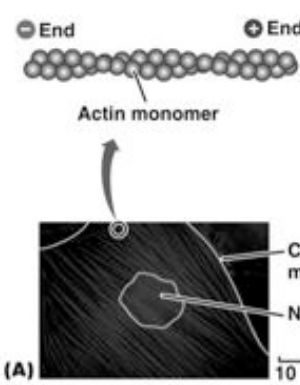



## Cytoskeleton functions:

- Supports the cell and maintains its shape
- Controls organelle position and movement
- Cytoplasmic movement,
  **cytoplasmic streaming**
- Interaction with extracellular structures

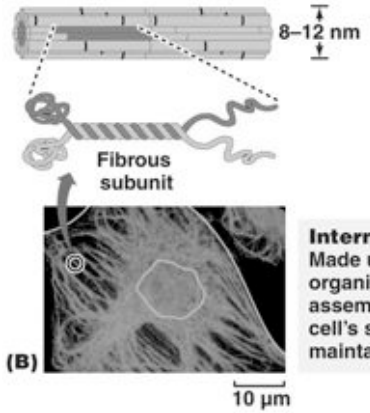
The primary components of the cytoskeleton:





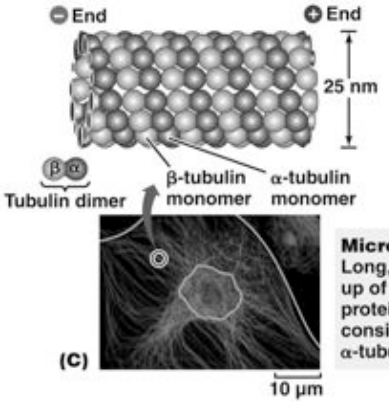

Dynamic instability
Help cells/organelles move
Determine/stabilize shape

**Microfilaments**
Made up of strands of the protein actin; often interact with strands of other proteins.




Anchor cells
Positions the nucleus
Resist tension
Maintain rigidity

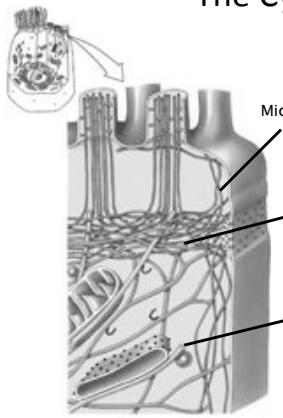
**Intermediate filaments**
Made up of fibrous proteins organized into tough, ropelike assemblages that stabilize a cell's structure and help maintain its shape.




Rigid internal skeleton
Dynamic instability
Framework for motor proteins
Framework for cilia and flagella

**Microtubules**
Long, hollow cylinders made up of many molecules of the protein tubulin. Tubulin consists of two subunits, α-tubulin and β-tubulin.

## The Cytoskeleton

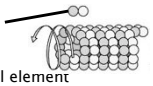


Actin subunits

Microfilaments
Provide a "carpet" layer beneath the plasma membrane

keratin 

Intermediate Filaments
Provide structure and strength to the cytoplasm

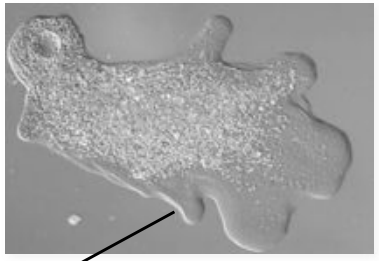
Tubulin 

Microtubules
Largest cytoskeletal element with many functions

- Anchoring and moving other organelles
- Cell division
- Chromosome duplication

## The Cytoskeleton

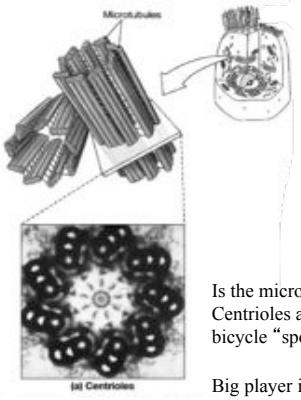
Actin polymerization



Actin subunits 

"**pseudopod**" movement occurs via actin polymerization

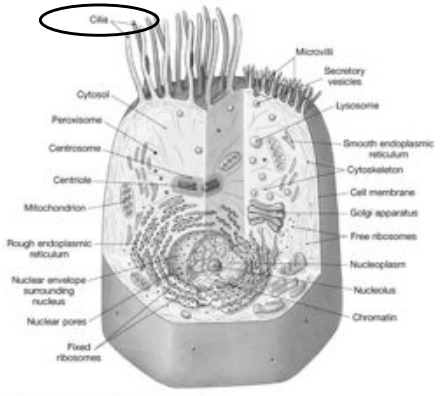
## Centrosomes




Is the microtubule organizing center (MTOC) of the cell. Centrioles are composed of Microtubules arranged like bicycle "spokes".

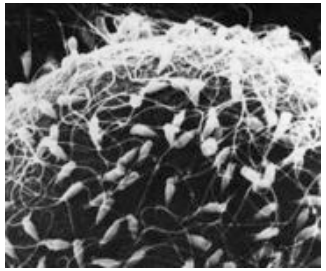
Big player in cell cycle progression.

## A Prototypical Eukaryotic Cell

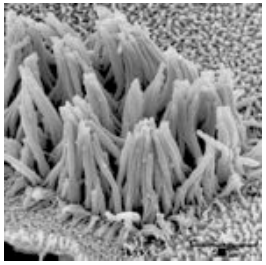



## Flagella

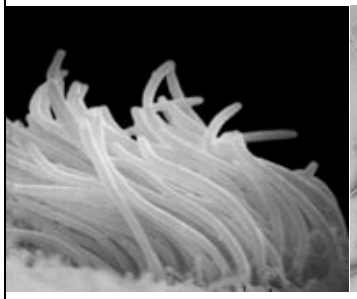
Prokaryotic and Eukaryotic cells: allow locomotion

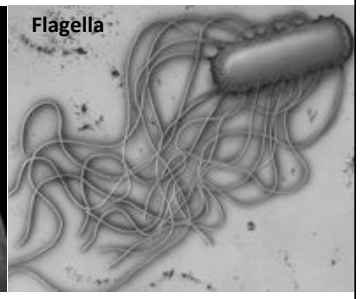


## Cilia



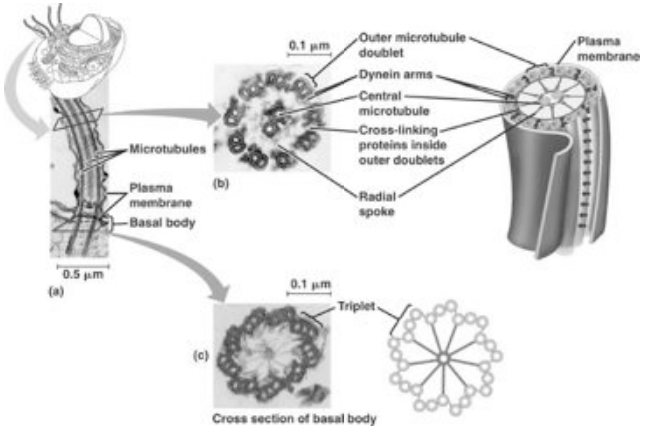
## Microtubules: Cilia and Flagella



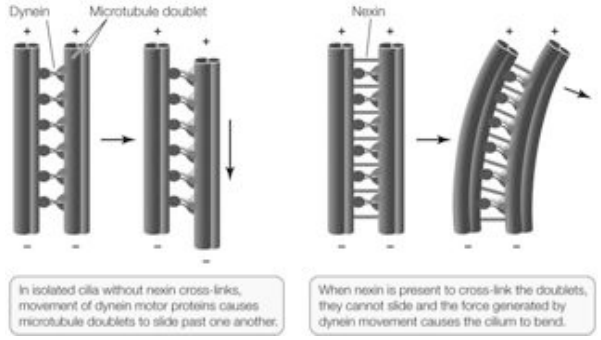



Their movements are due to the sliding of microtubule doublets past each other.

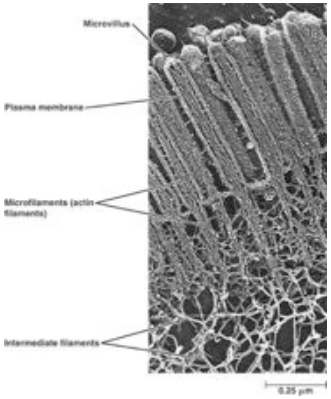
## How they function:

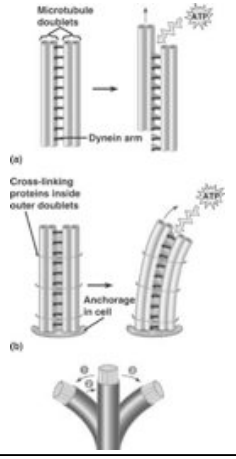



## How they function:




## How they function:




## How they function: