



review: history and introduction

1: Why do we study Microbiology?

Microbes in water, air, food and our body.



2: What did the famous microbiologists do?

Anthony van Leeuwenhoek, Louis Pasteur, Alexander Fleming

3: How many different kind of microbes?

Prokaryotes and eukaryotes

4: What's the major applications for microbiology?

food, medical, industrial, research

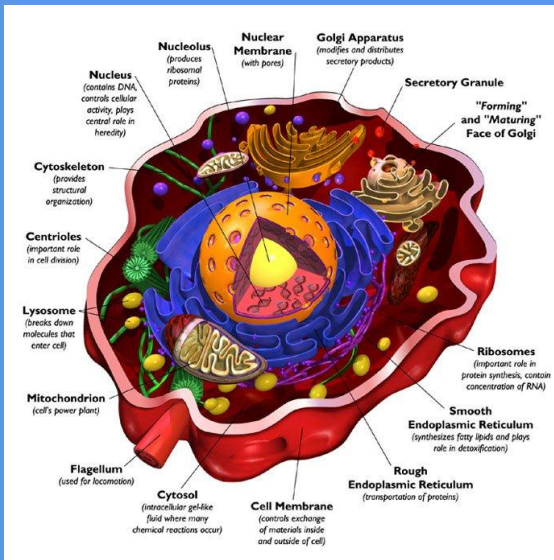
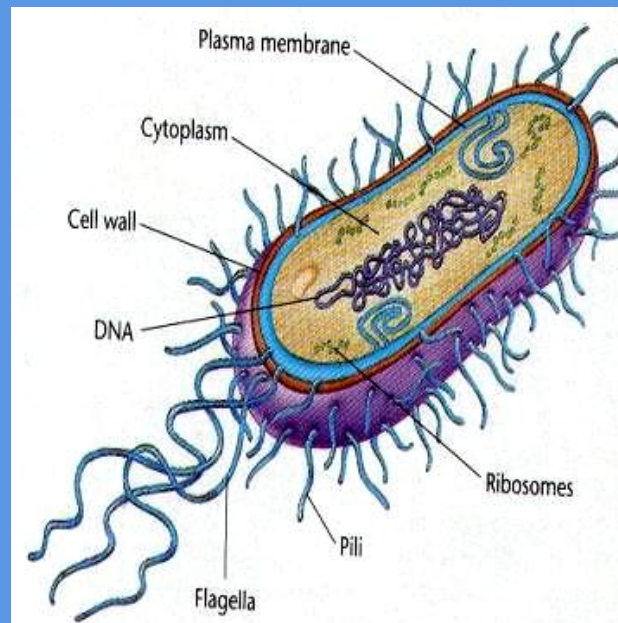
Preview:

1. The cell theory
2. Prokaryotic cells
3. Eukaryotic cells

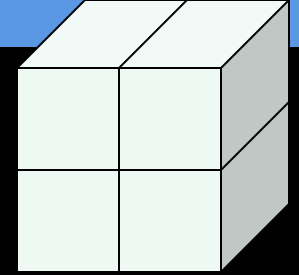


Cell theory:

1. Cell is the basic Unit of all living Organisms
2. All living organism are make up of cells
3. New cells arise only from existing cells



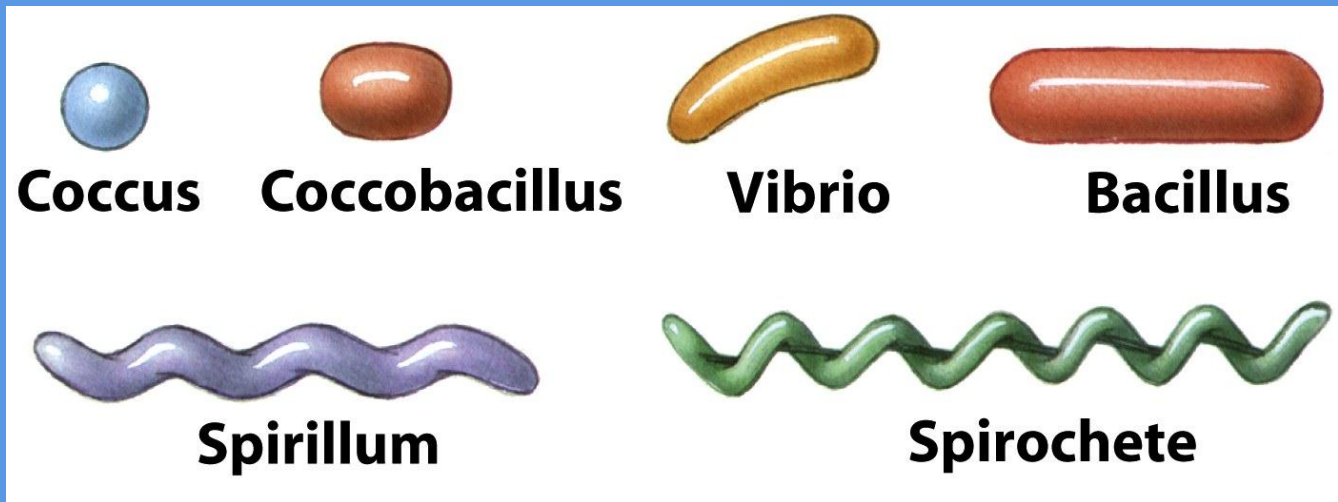
Prokaryotic Cells



Sizes

0.1-10 μm (2-10 μm for eukaryote)

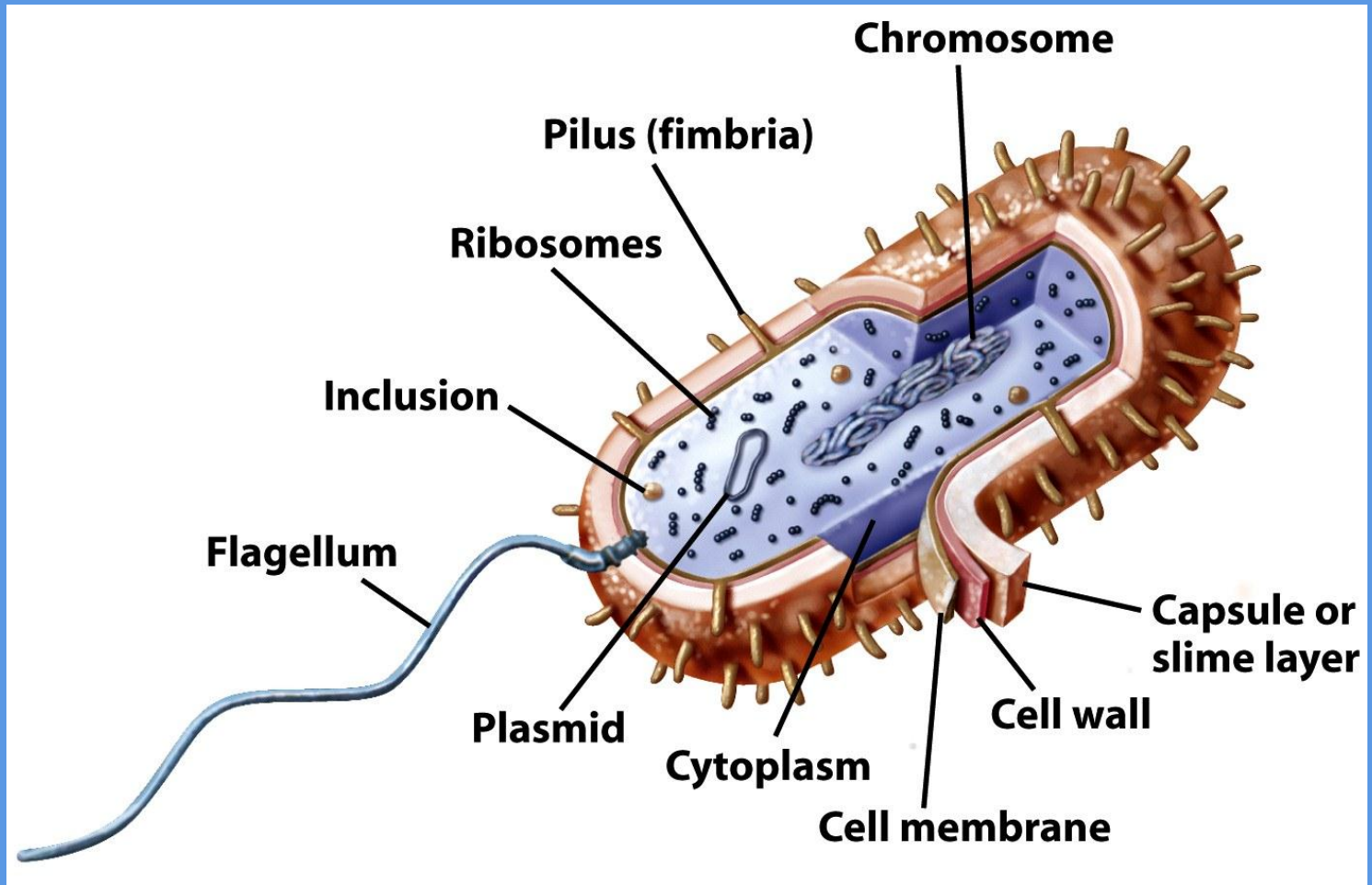
Shapes



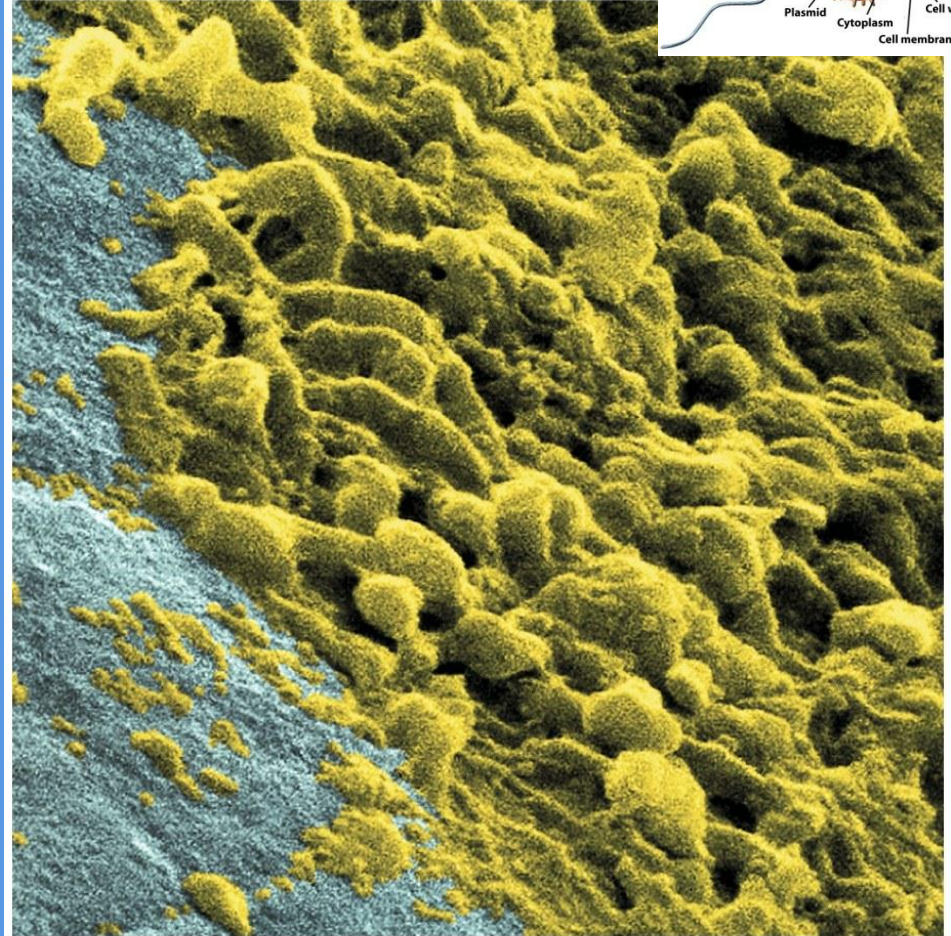
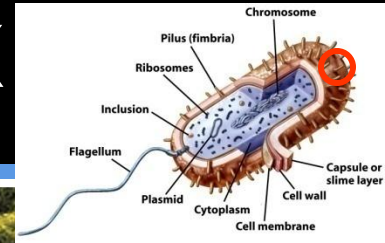
Arrangement

Size does matter: what's the benefits to be small for microbes?

Typical Prokaryotic Cell



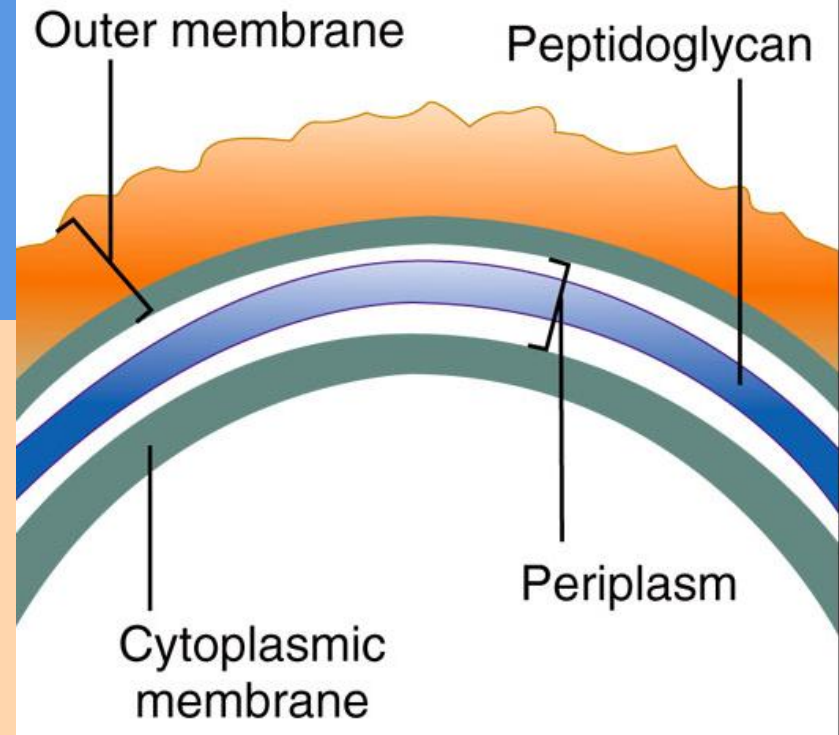
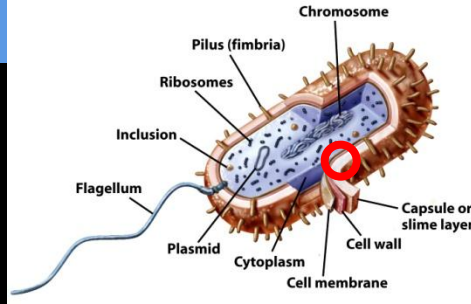
Cell Structures — Glycocalyx



SEM 5

- **Capsule**: a protective layer outside the cell wall, secreted by the bacteria, distinct gelatinous layer
- **Slime Layer**: outside layer, irregular diffuse layer
- **Protection/attachment**

Cell Wall

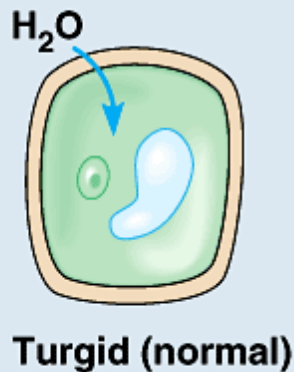
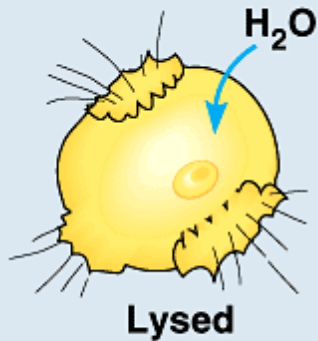


Outer membrane

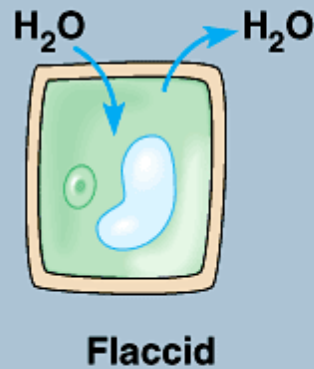
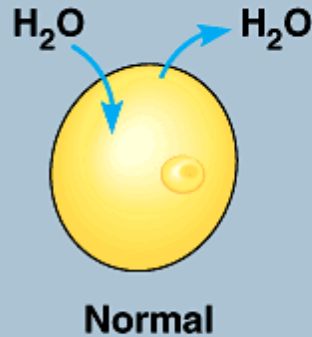
- Constructed of lipid bilayer
 - Much like cytoplasmic Membrane but outer leaflet made Of lipopolysaccharides not phospholipids
 - Outer membrane also called the lipopolysaccharide layer or LPS layer
- LPS serves as barrier to a large number of molecules
 - Small molecules or ions pass through channels called porins
- Portions of LPS medically significant
 - O-specific polysaccharide side chain
 - Lipid A

Function of cell wall: **osmosis**

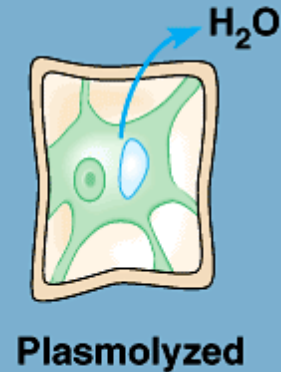
Hypotonic solution



Isotonic solution



Hypertonic solution



Animal cell

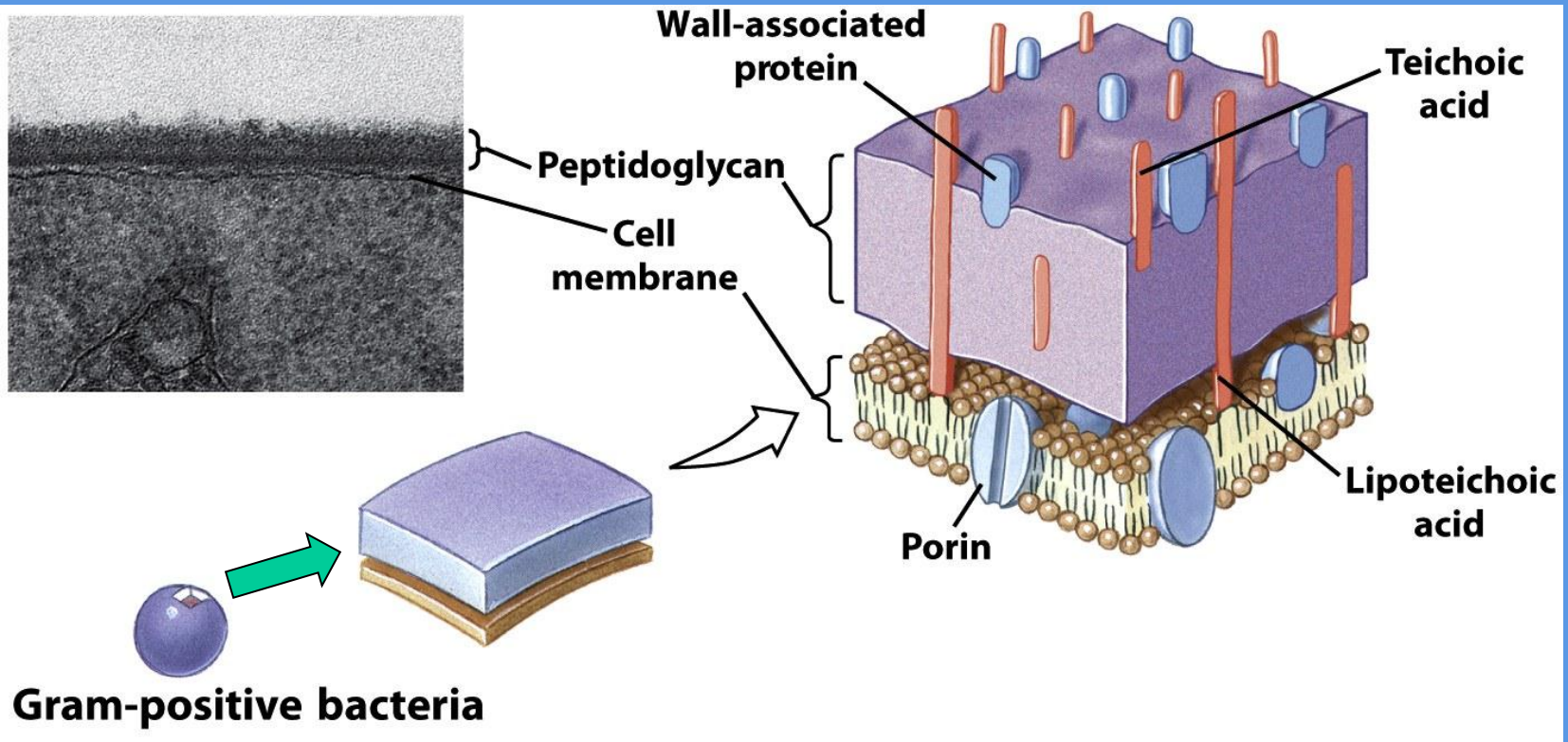
Plant cell

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the diffusion of water through a semi-permeable membrane

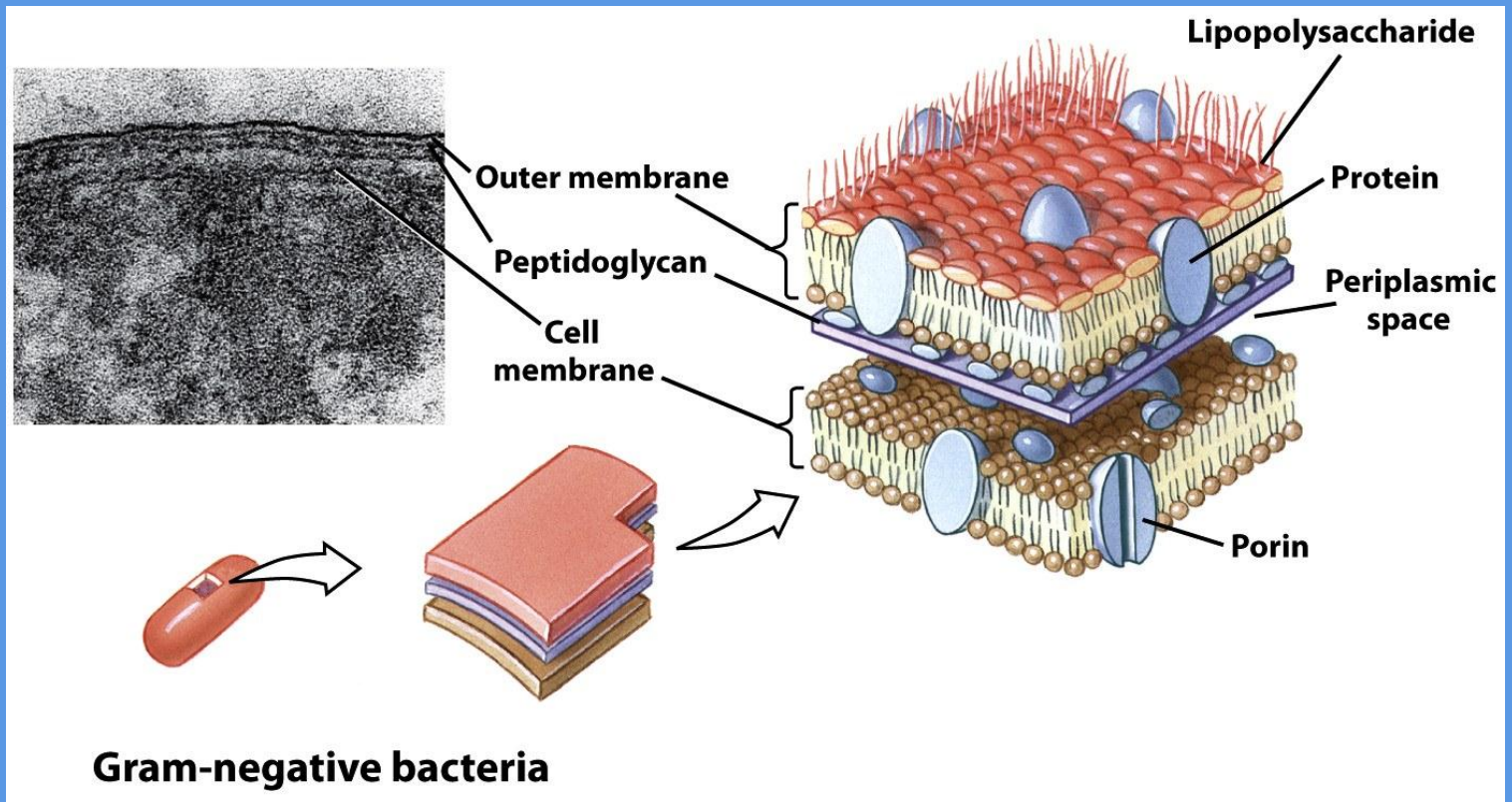
Gram Positive Cell Wall

■ Gram positive



Gram Negative Cell Wall

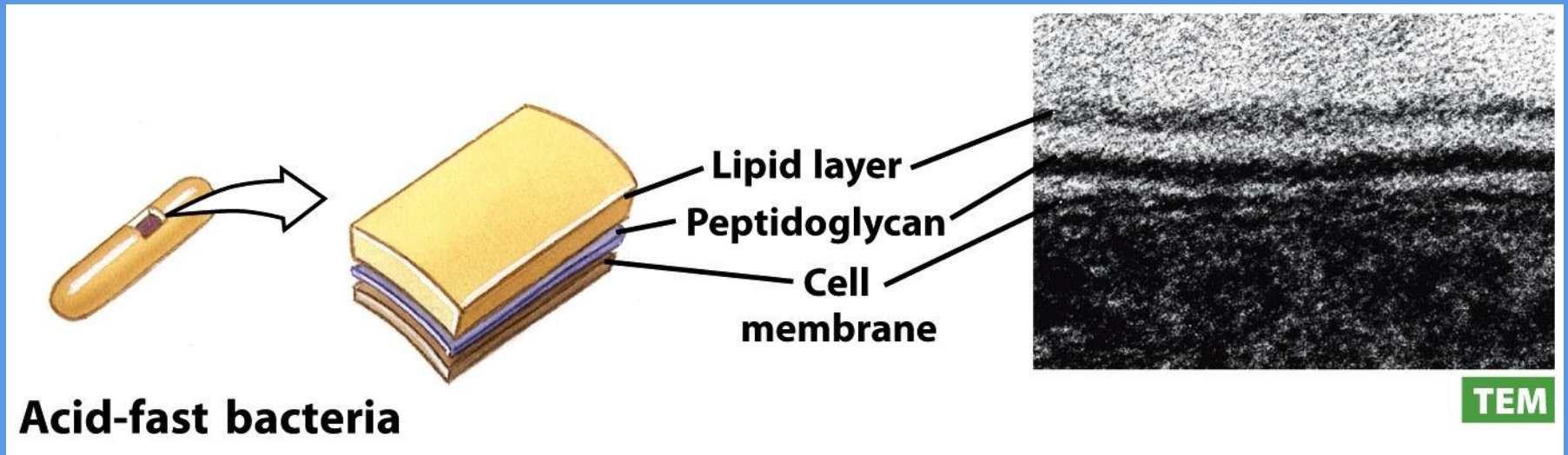
■ Gram negative

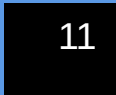


Acid Fast Cell Wall

- Acid Fast

- Wall deficient





The diagram illustrates the structure of a cell membrane, showing a phospholipid bilayer with various embedded and attached molecules. Labels include:

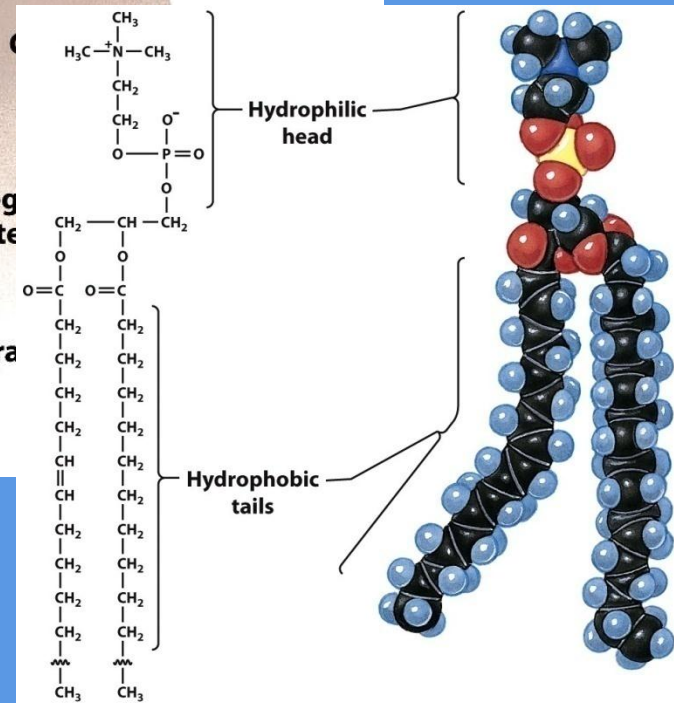
- Extracellular fluid**: The fluid above the membrane.
- Pore**: A channel through the membrane.
- Lipid bilayer membrane**: The overall structure of the membrane.
- Glycoprotein: Carbohydrate Protein**: A protein with carbohydrate chains attached.
- Peripheral protein**: A protein attached to the surface of the membrane.
- Glycolipid: Carbohydrate Lipid**: A lipid with carbohydrate chains attached.
- Phospholipids:**
 - Polar head (hydrophilic)**: The head of the phospholipid.
 - Fatty acid tails (hydrophobic)**: The tails of the phospholipid.
 - Polar head (hydrophilic)**: The head of the phospholipid.
- Integral protein**: A protein embedded within the membrane.
- Peripheral protein**: A protein attached to the surface of the membrane.

Chemical structures are provided for the hydrophilic head and the fatty acid tails:

Hydrophilic head:

$$\begin{array}{c} \text{CH}_3 \\ | \\ \text{H}_3\text{C}-\text{N}^+-\text{CH}_3 \\ | \\ \text{CH}_2 \\ | \\ \text{CH}_2-\text{O}^--\text{P}(=\text{O}) \\ | \\ \text{O}-\text{CH}_2 \end{array}$$

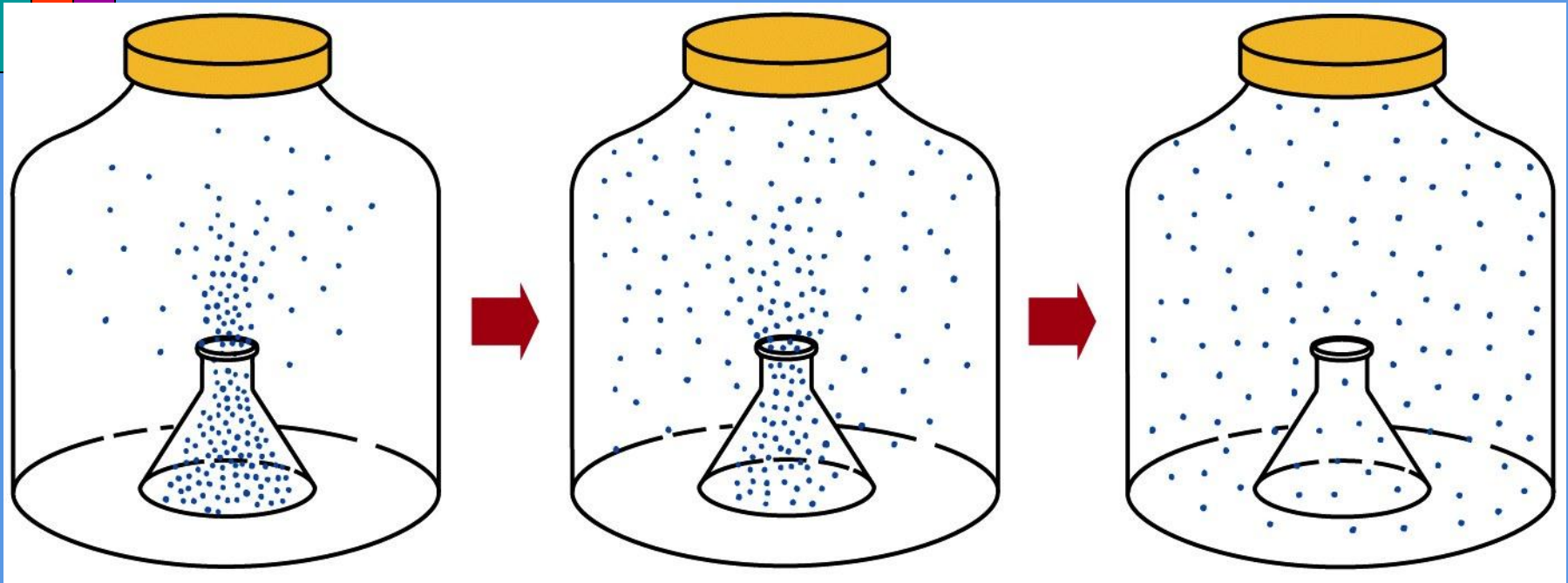
Fatty acid tails:

$$\begin{array}{c} \text{O} \\ || \\ \text{CH}_2-\text{O}-\text{C} \\ | \\ \text{CH}_2 \\ | \\ \text{CH}_2 \\ | \\ \text{CH}_2 \end{array} \quad \begin{array}{c} \text{O} \\ || \\ \text{CH}-\text{O}-\text{C} \\ | \\ \text{CH}_2 \\ | \\ \text{CH}_2 \\ | \\ \text{CH}_2 \end{array}$$


Movement Across Membranes

■ Diffusion

<http://www.youtube.com/watch?v=H7QsDs8ZRMl>



Diffusion: no energy needed (automatic)
Concentration gradient needed
no barrier

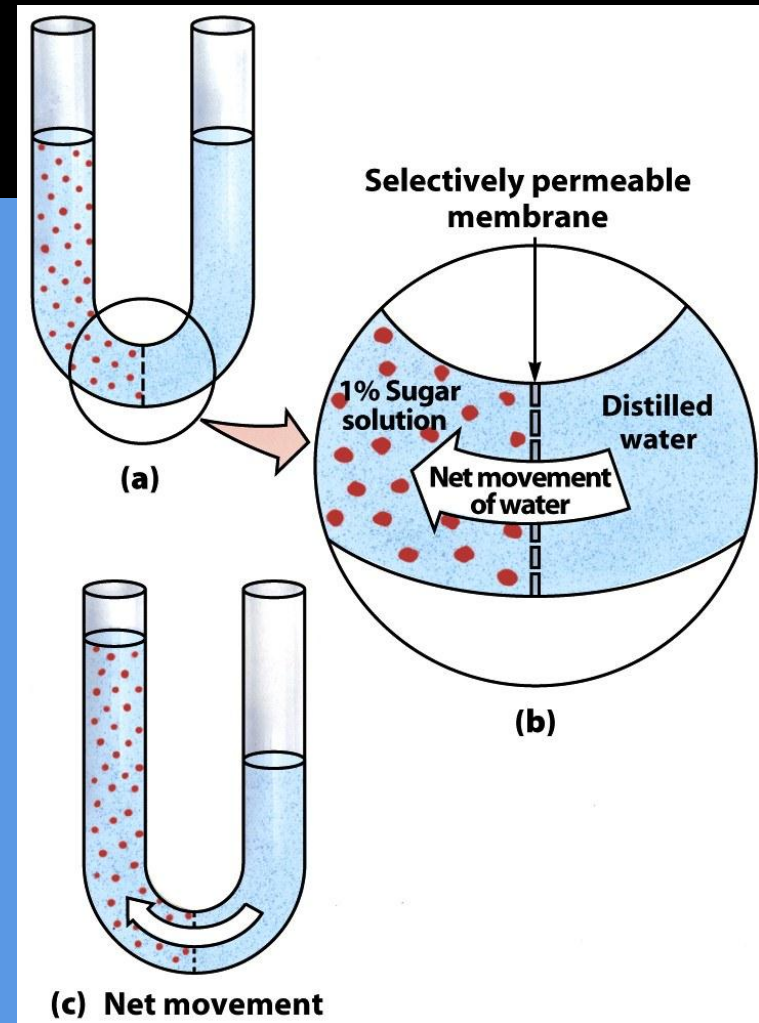
Osmosis

■ Water movement

Osmosis: no energy needed (automatic)
Concentration gradient needed
Barrier exists

Osmosis

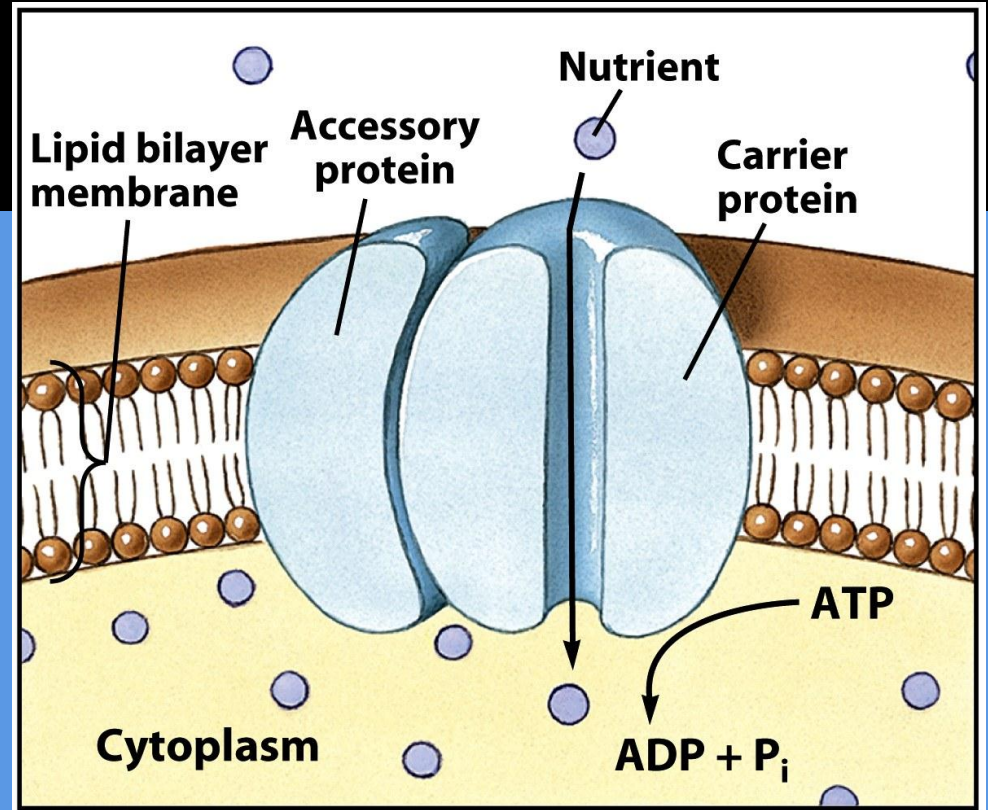
<http://www.youtube.com/watch?v=sdiJtDRJQEc&feature=related>



Active Transport

Active transport:

<http://www.youtube.com/watch?v=owEgqrq51zY&feature=related>



Active transport: energy needed (automatic)
Concentration gradient NOT needed
Barrier exists

Internal Cell Structures: chromosome

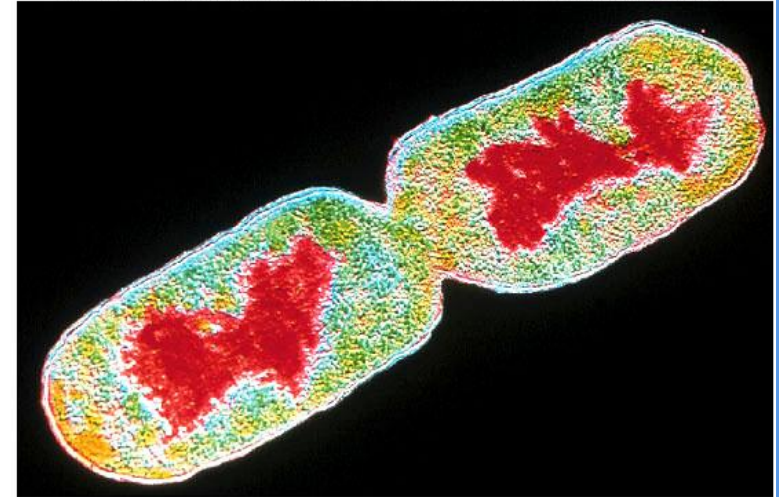
Chromosome

- Resides in cytoplasm
 - In nucleoid space
- Typically single chromosome
- Circular double-stranded molecule
- Contains all genetic information

Plasmid

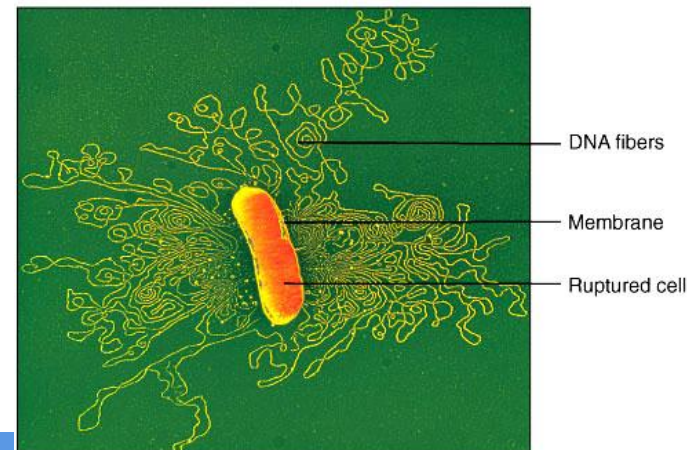
- Circular DNA molecule
 - Generally 0.1% to 10% size of chromosome
- Extrachromosomal
 - Independently replicating
- Encode characteristic
 - Potentially enhances survival
 - Antimicrobial resistance

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(a)

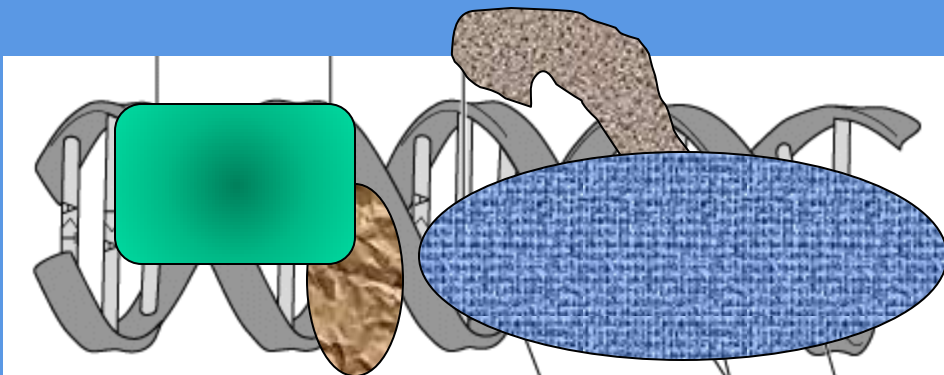
0.5 μm



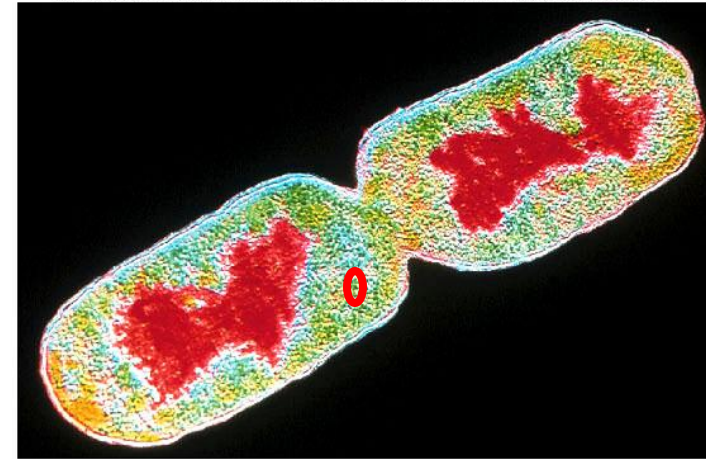
(b)

Q: Chromosome and plasmid are

- A. the same
- B. different in size
- C. different in location
- D. different in structure

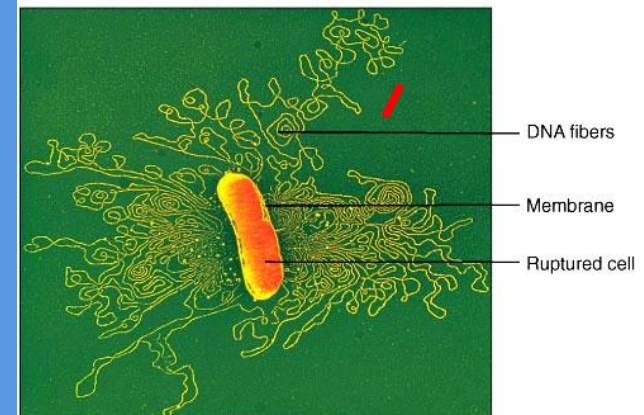


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(a)

0.5 μm



(b)

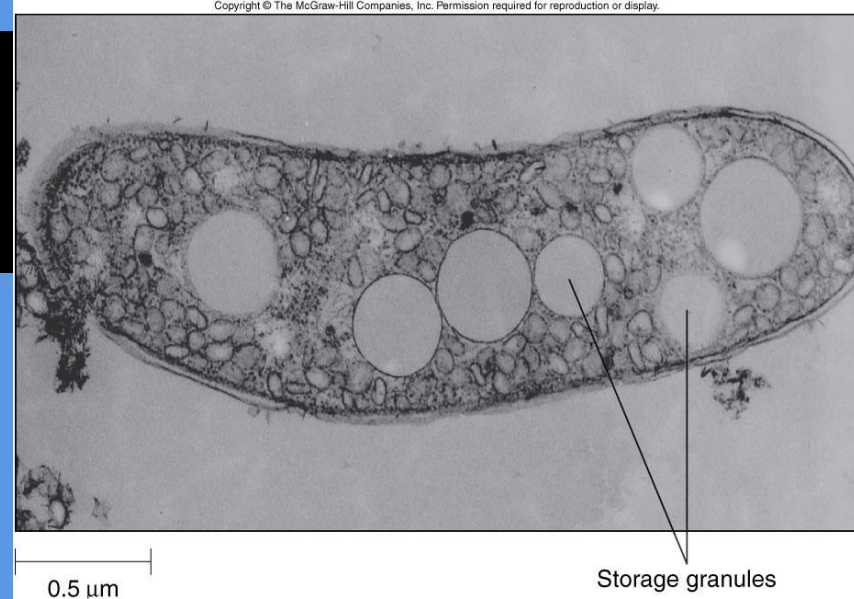
Internal Structures

■ Storage granules

- Accumulation of polymers
 - Synthesized from excess nutrient
 - Example = glycogen
 - » Excess glucose in cell is stored in glycogen granules

■ Gas vesicles

- Small protein compartments
 - Provides buoyancy to cell
 - Regulating vesicles allows organisms to reach ideal position in environment



Ribosome/inclusions

Cyanobacterium synechocystis

photo-synthetic membrane

carbohydrate granules

0.5 μm



5 ribosomes reading same RNA sequentially

Growing polypeptide chains

Complete polypeptide

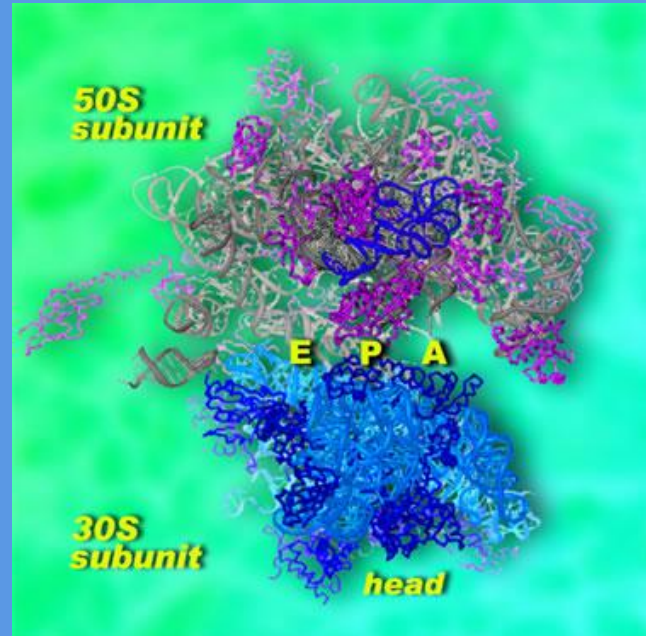
(Initiator codon)
AUG

UAG
Stop codon

50S

30S

Ribosome movement

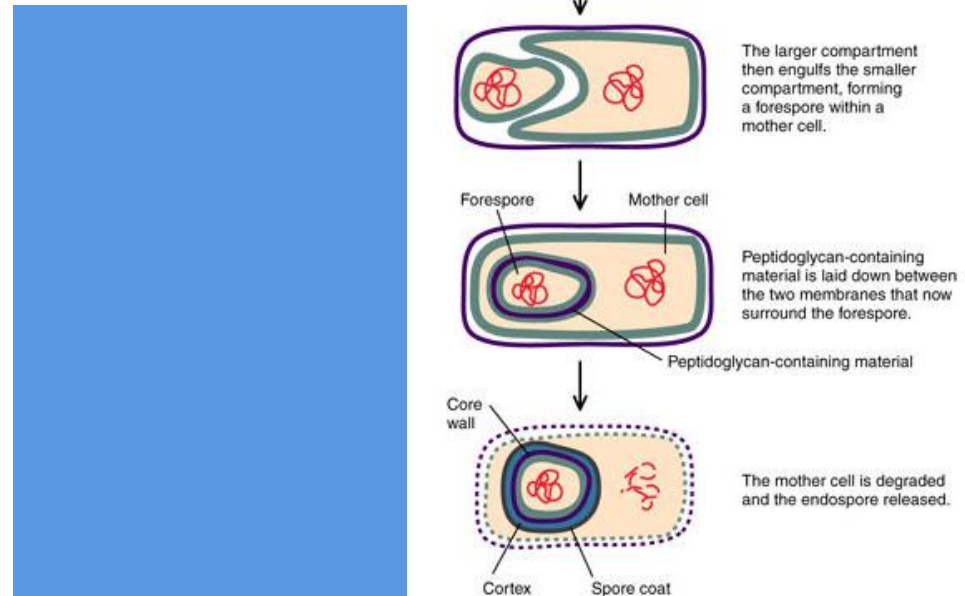
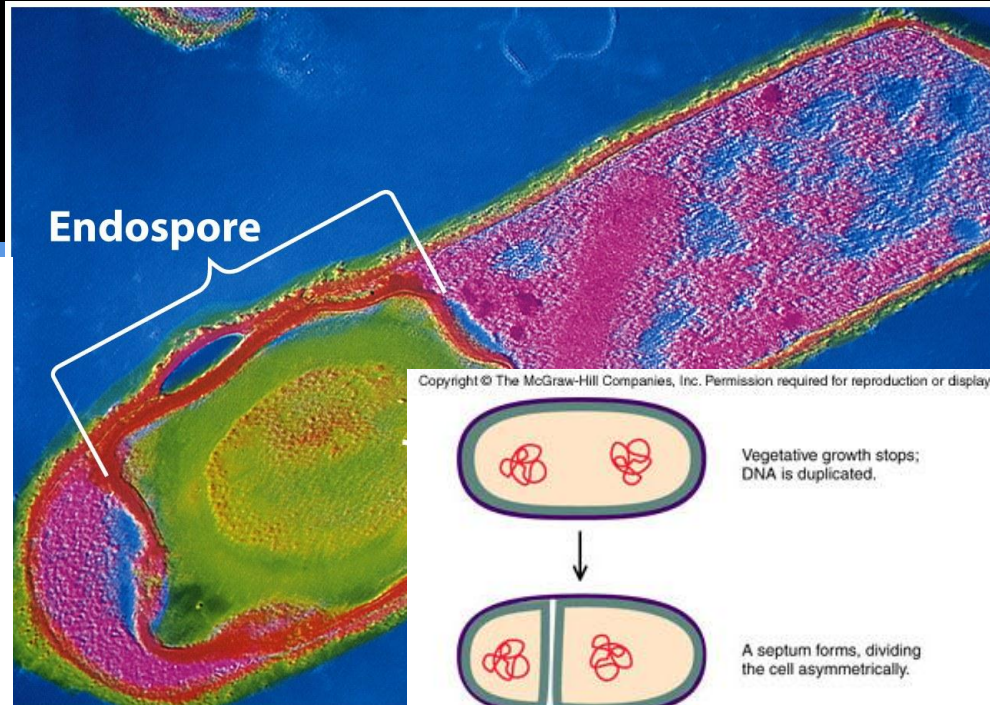


Factory to make proteins

Endospores

■ Endospores

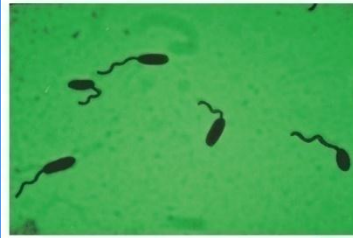
- **Dormant cell types**
 - Produced through sporulation
 - Theoretically remain dormant for 100 years
- **Resistant to damaging conditions**
 - Heat, desiccation, chemicals and UV light
- **Vegetative cell produced through germination**
 - Germination occurs after exposure to heat or chemicals
 - Germination not a source of reproduction



Cell Structures — External

■ Flagellae

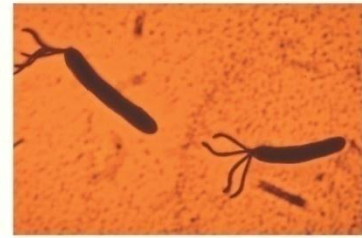
- Long protein structure
- Responsible for motility
 - Use propeller like movements to push bacteria
 - Can rotate more than 100,000 revolutions/minute
 - 82 mile/hour
- Some important in bacterial pathogenesis
 - *H. pylori* penetration through mucous coat



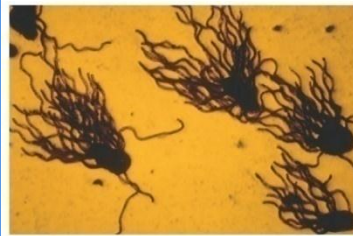
LM



LM



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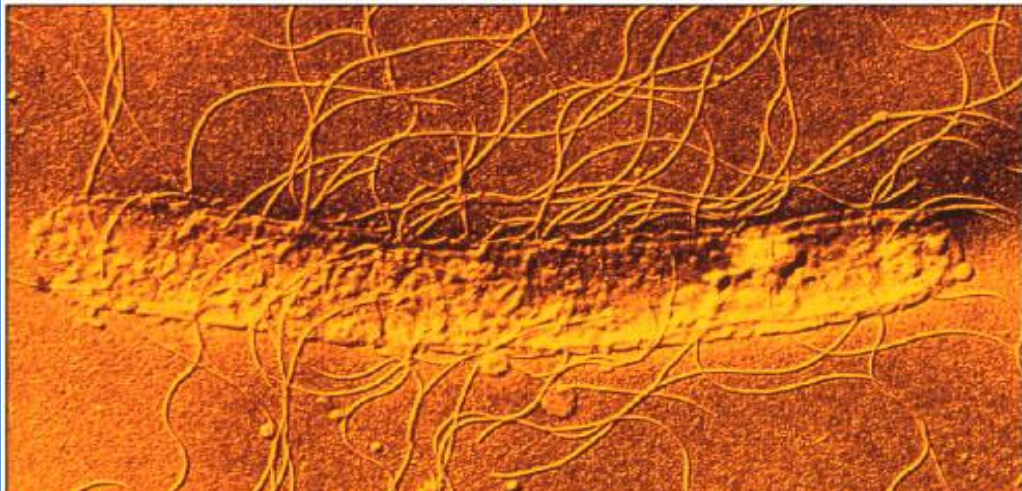


LM

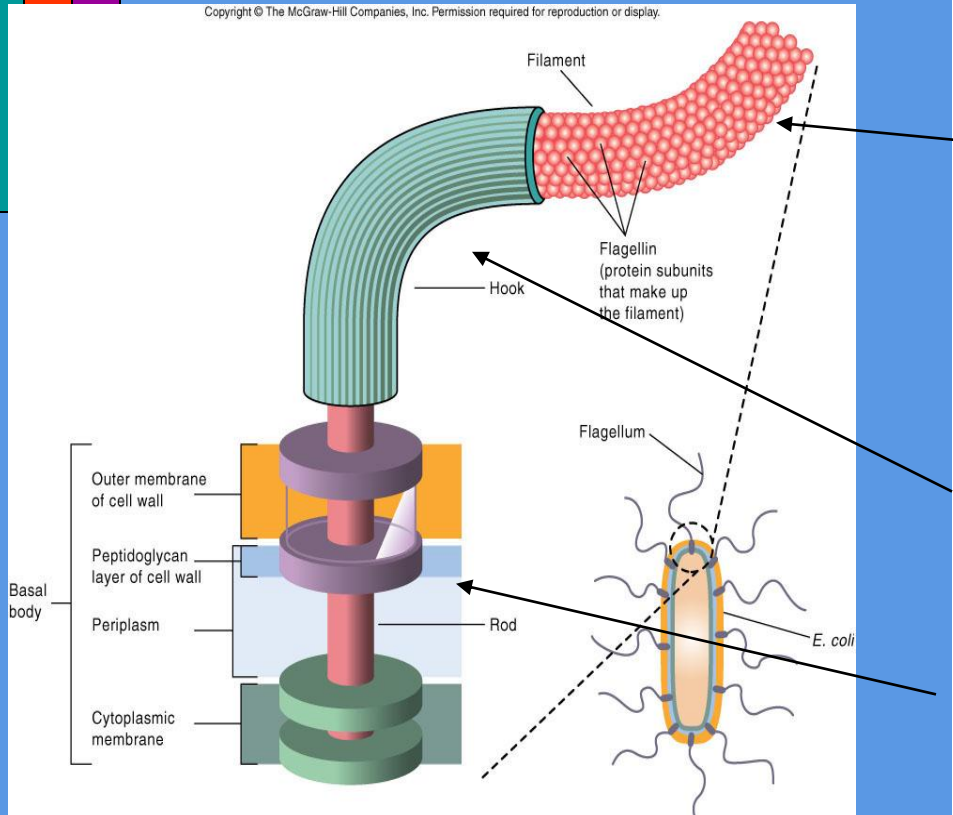


LM

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Flagella and Pili



■ Flagella structure has three basic parts

– Filament

- Extends to exterior
- Made of proteins called flagellin

– Hook

- Connects filament to cell

– Basal body

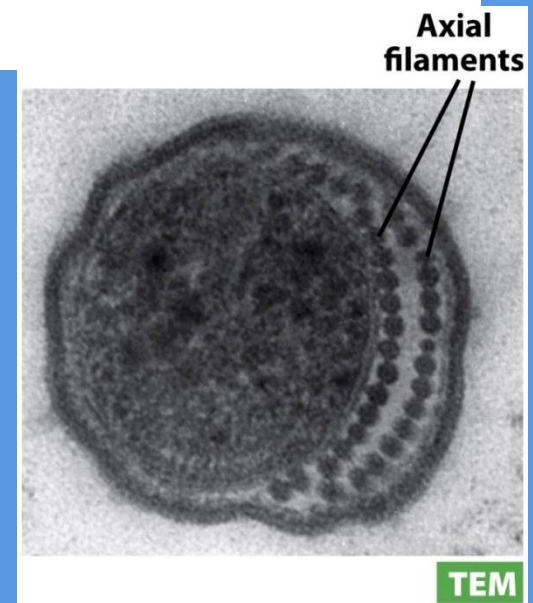
- Anchors flagellum into cell wall

Flagella and cilia

<http://www.youtube.com/watch?v=QGAm6hMysTA&feature=Playlist&p=F12CD7C8ABFEF1EF&index=12>

Cell Structures — Axial filaments

- **Axial Filaments** (endoflagella, between out-sheath and cell wall, its twisting induce bacteria to rotate)



[Swimming spirochete](http://www.youtube.com/watch?v=iJSfW3XmEdw)

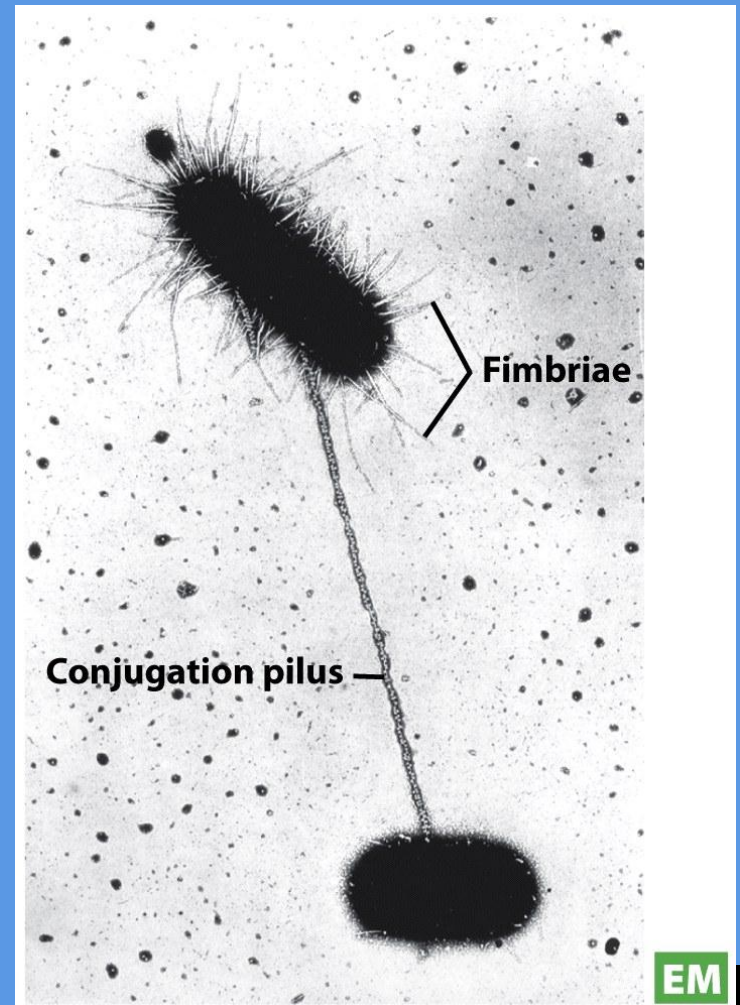
<http://www.youtube.com/watch?v=iJSfW3XmEdw>

Cell Structures — Attachment

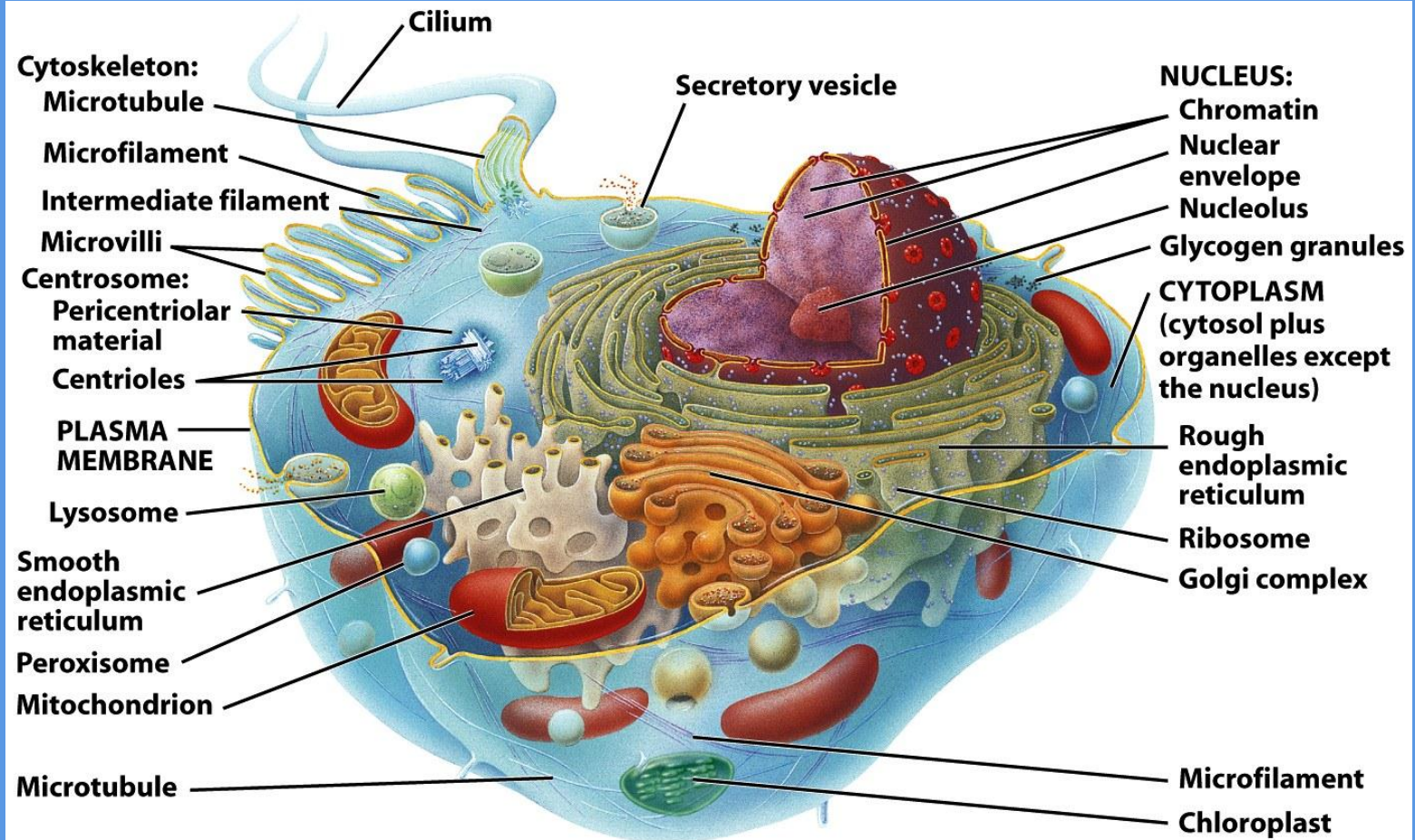
- **Pili:** tiny, hollow projections
- **Fimbriae:** short attachment pili

Bacteria conjugation:

<http://www.youtube.com/watch?v=IYW6wwEAnqs&feature=related>



Eukaryotic Cell Structure

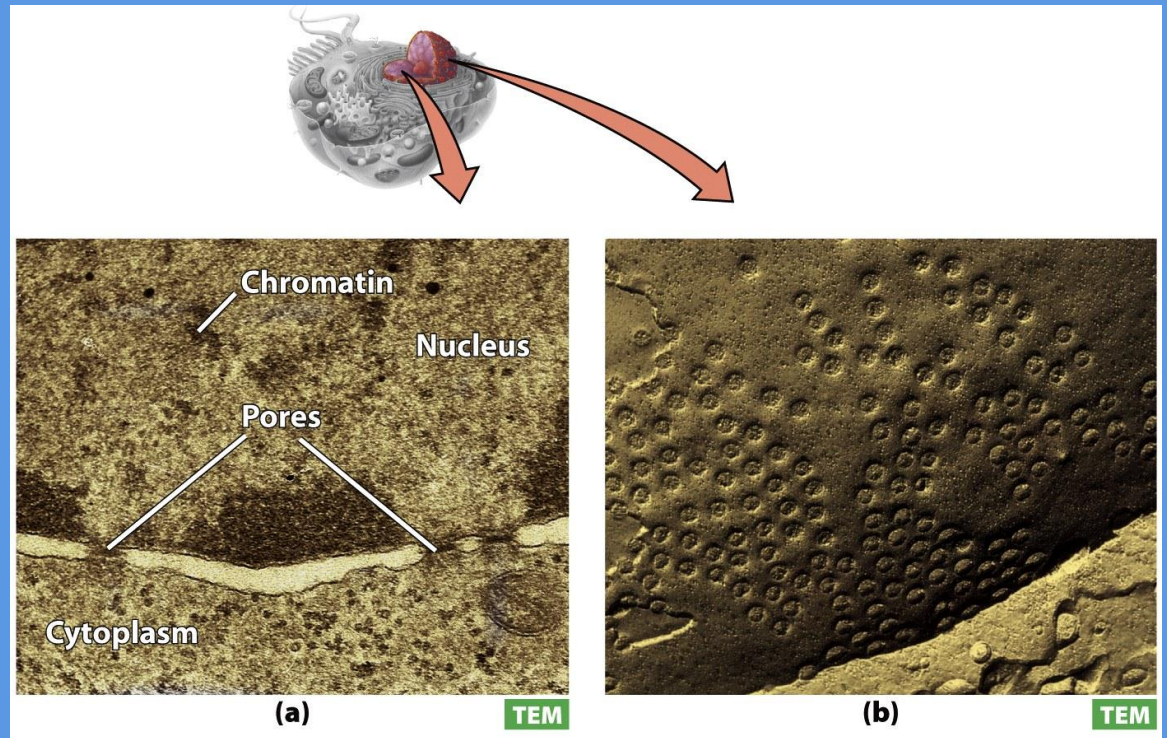


Eukaryotic Cells

- Plasma membrane

- Cytoplasm

- Nucleus



Endo/Exocytosis

Endocytosis

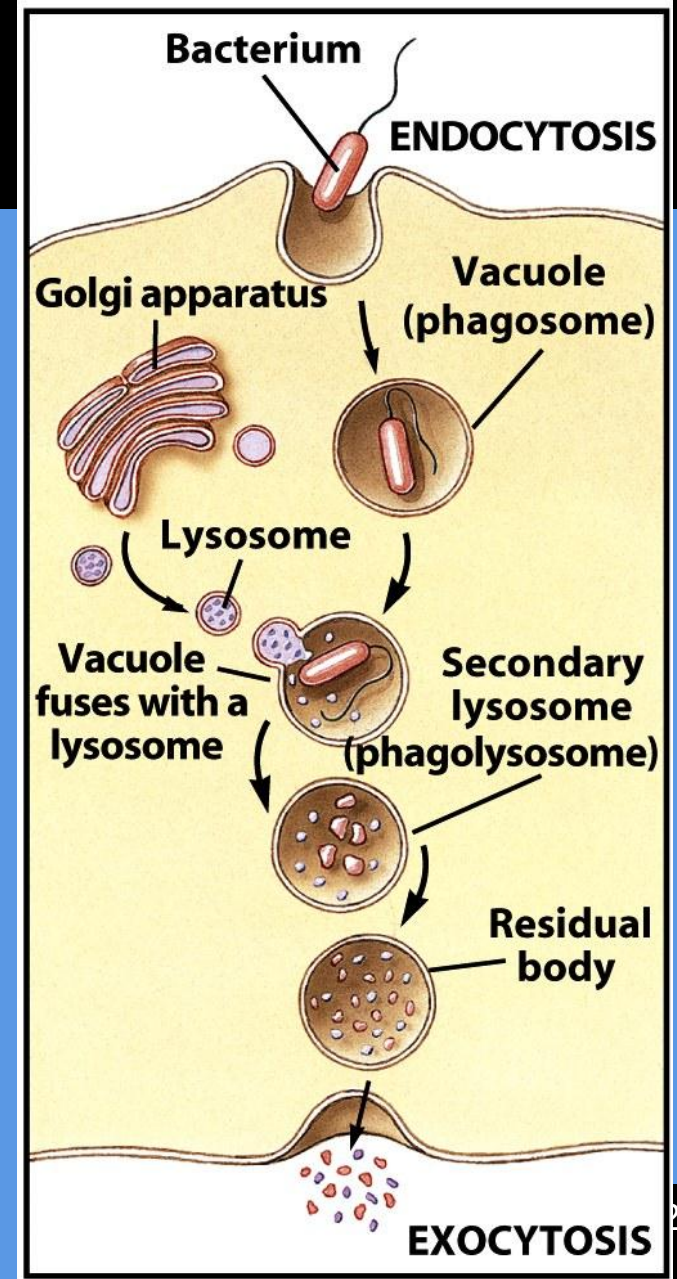
- Process by which eukaryotic cells bring in material from surrounding environment
 - Pinocytosis most common type in animal cell
 - Pinch off small portions of own membrane along with attached material
 - » Internalize vesicle and contents
 - Vesicle called endosome

Exocytosis

Reverse process of endocytosis

Vesicles inside cell fuse with plasma membrane

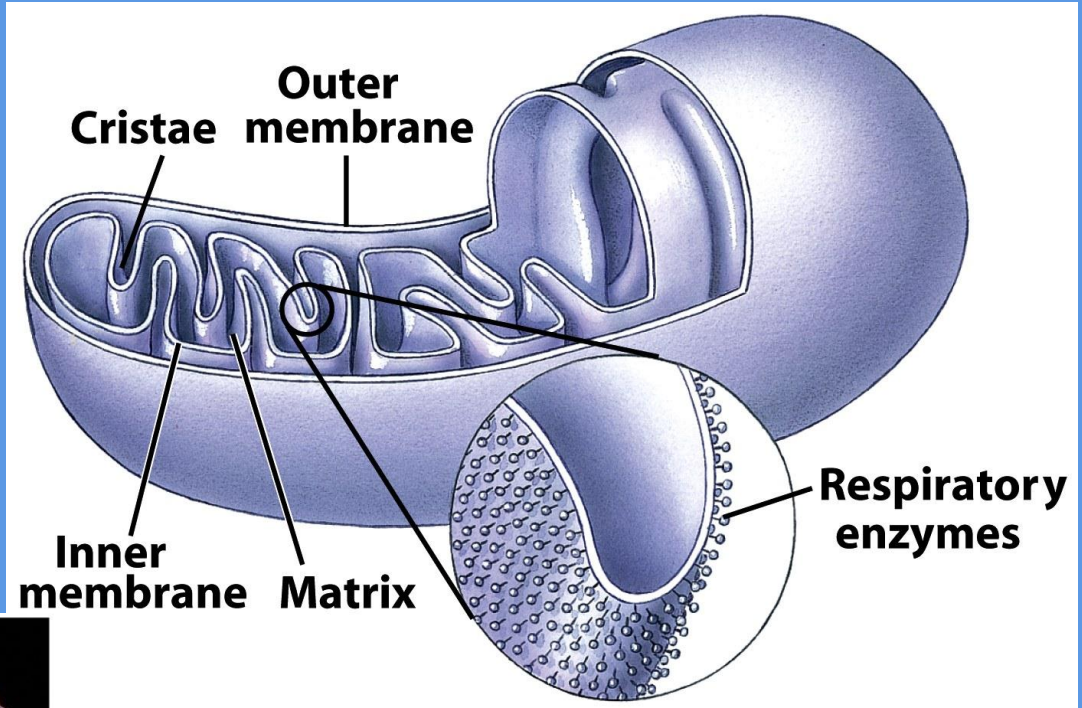
Releases contents into external environment



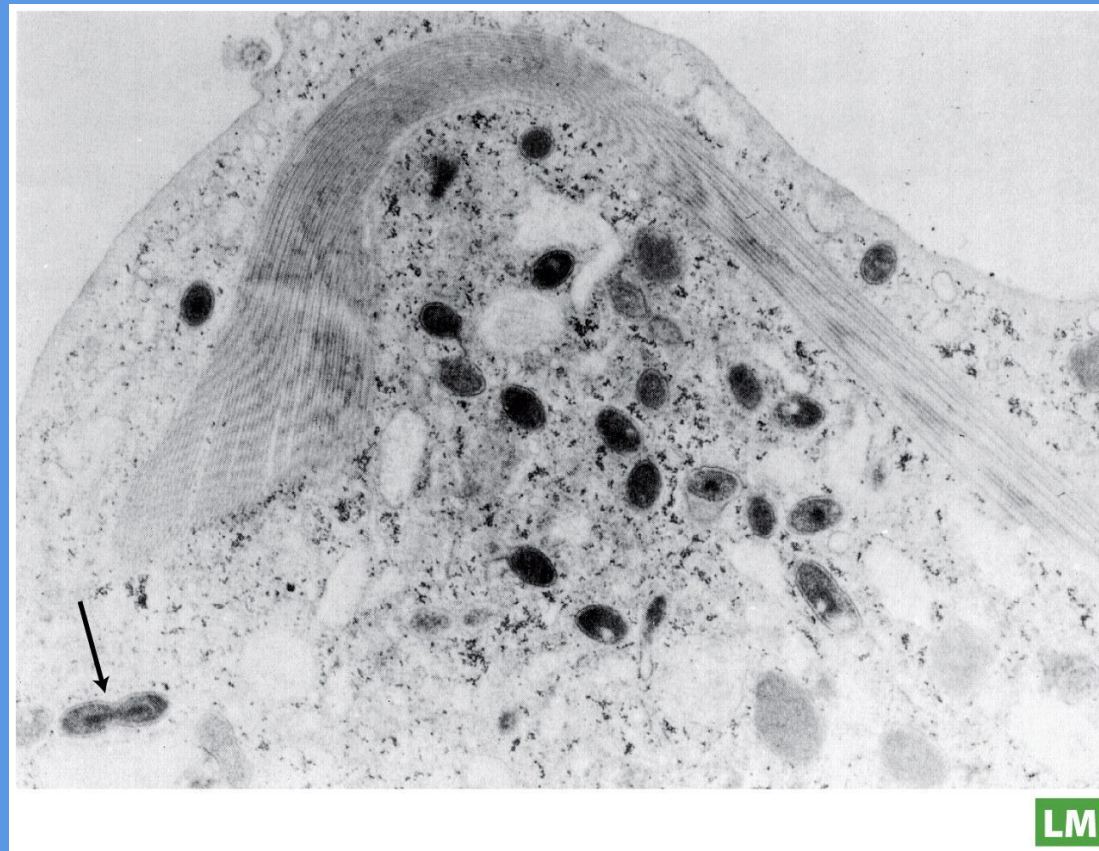
Eukaryotic Organelles — Mt

■ Mitochondria

Power house



Endosymbiotic Theory: mitochondrion is the prokaryotic cell that lives inside the eukaryotic cell



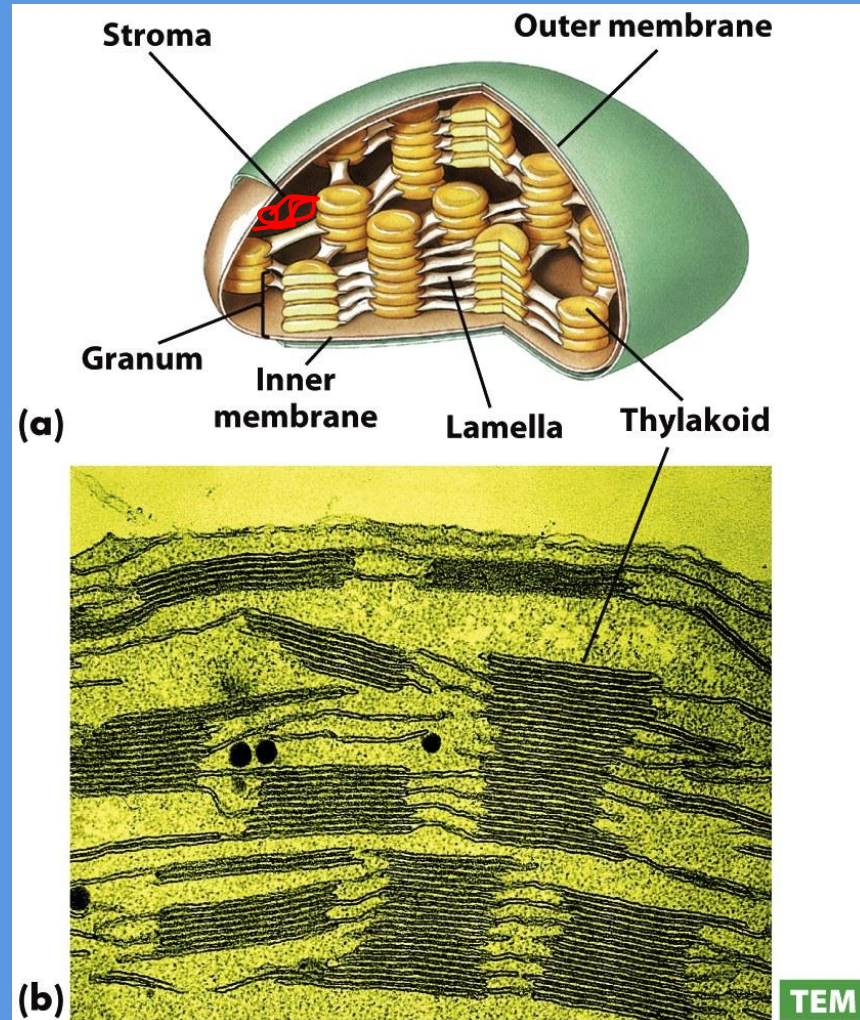
Eukaryotic Organelles — Chloroplasts

■ Chloroplasts

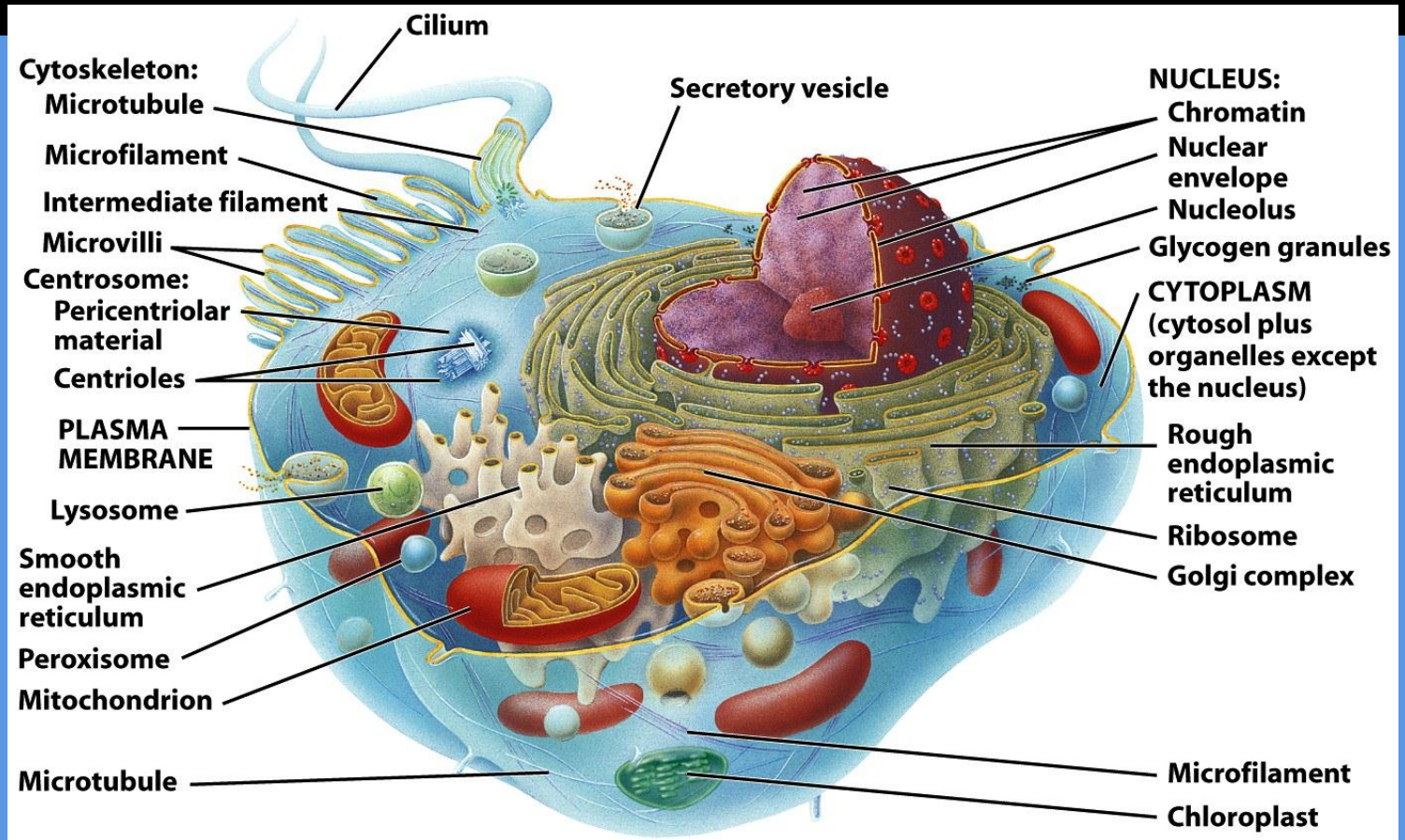
**Energy
transformer**

Photosynthesis:

<http://www.youtube.com/watch?v=v590JJV96lc&feature=related>

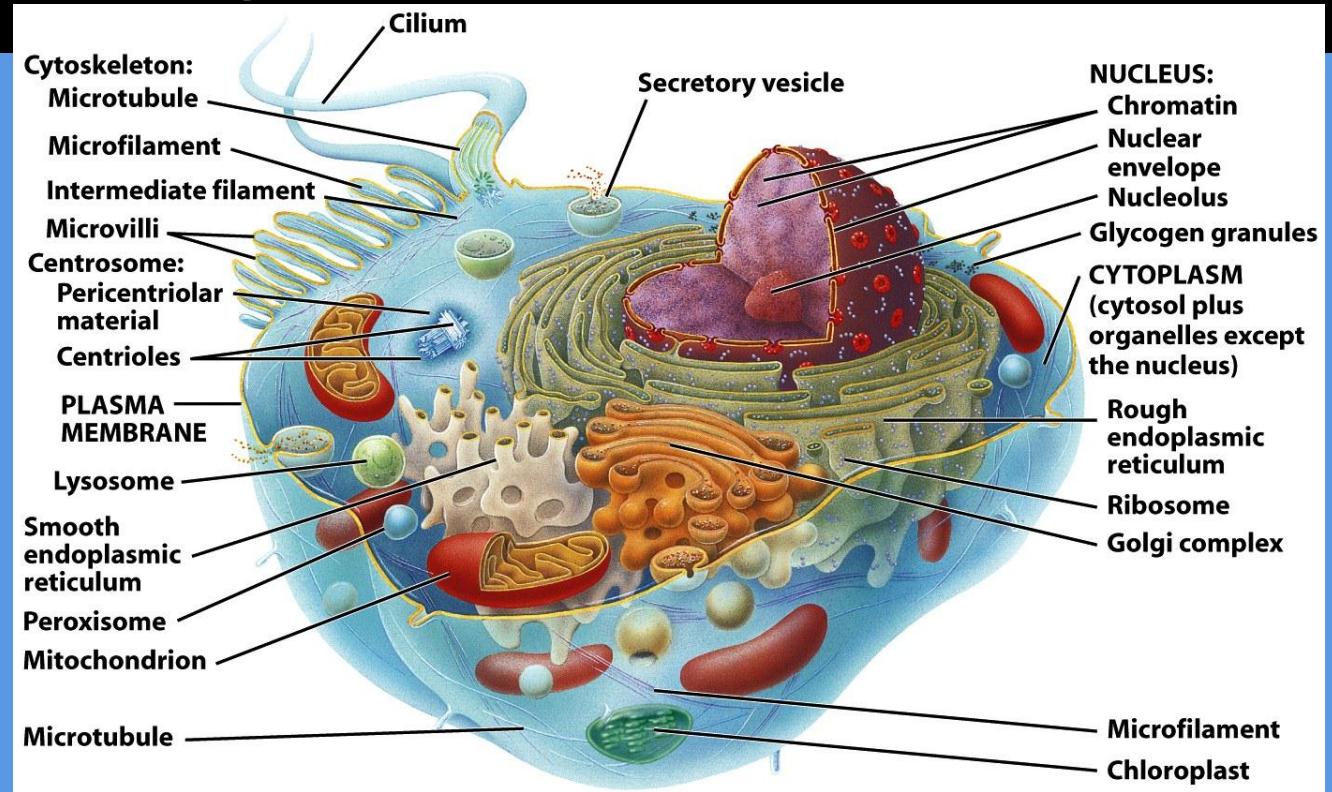
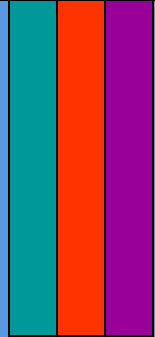


Eukaryotic Organelles



- **Ribosomes: factory to make proteins**
- **Endoplasmic Reticulum: provide membrane network for biochemical reactions**

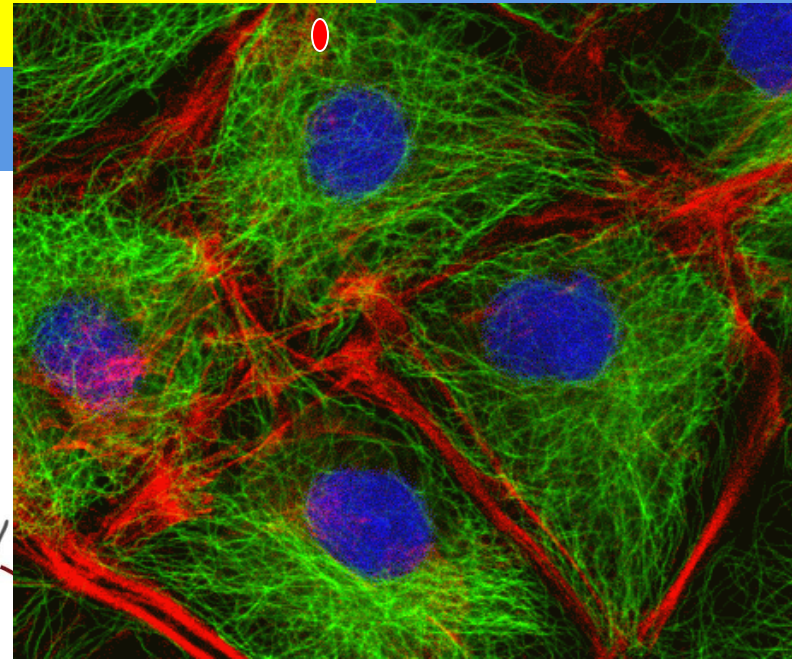
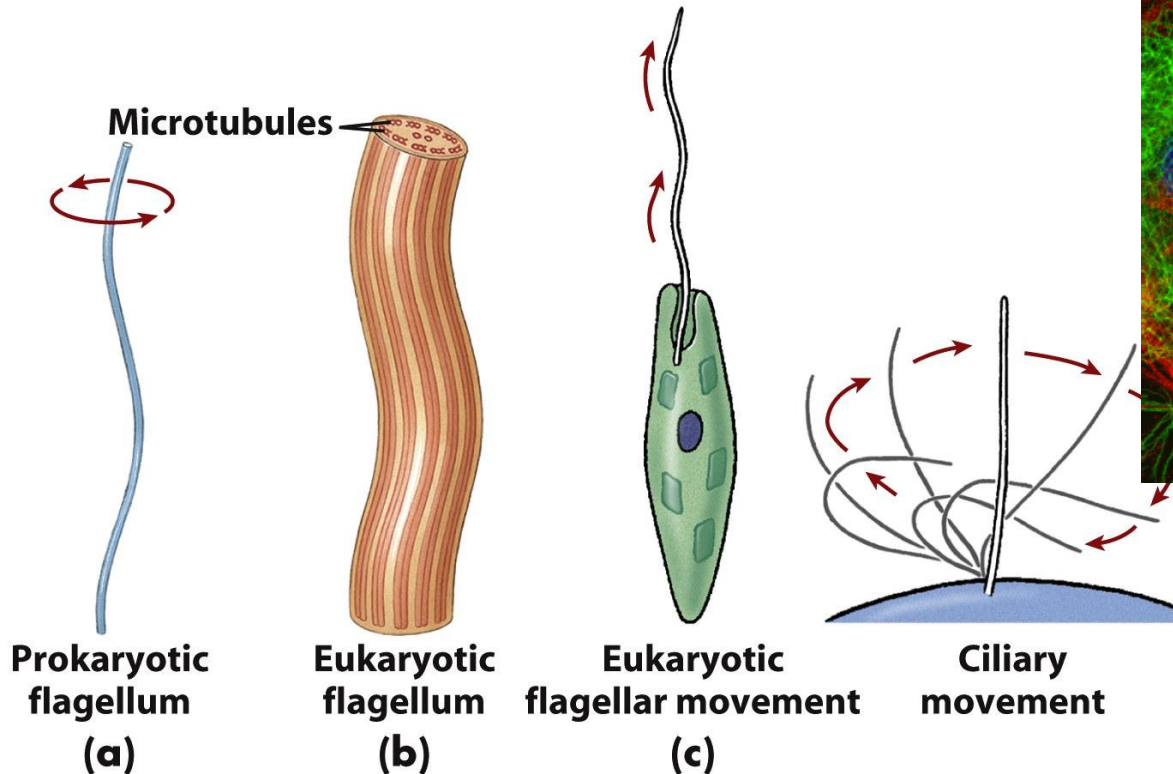
Eukaryotic Organelles



- Golgi Apparatus: protein modification
- Peroxisome: oxidation
- Lysosomes: protein degradation
- Vacuoles: storage

Cytoskeleton and Motility

- Cytoskeleton: support/movement
- Flagellae: movement



Motility — Cilia

■ Cilia



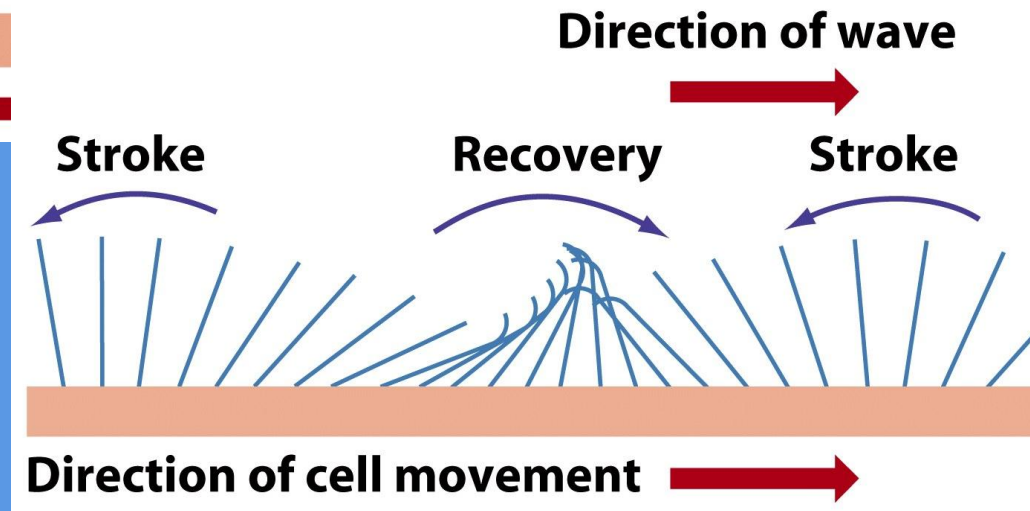
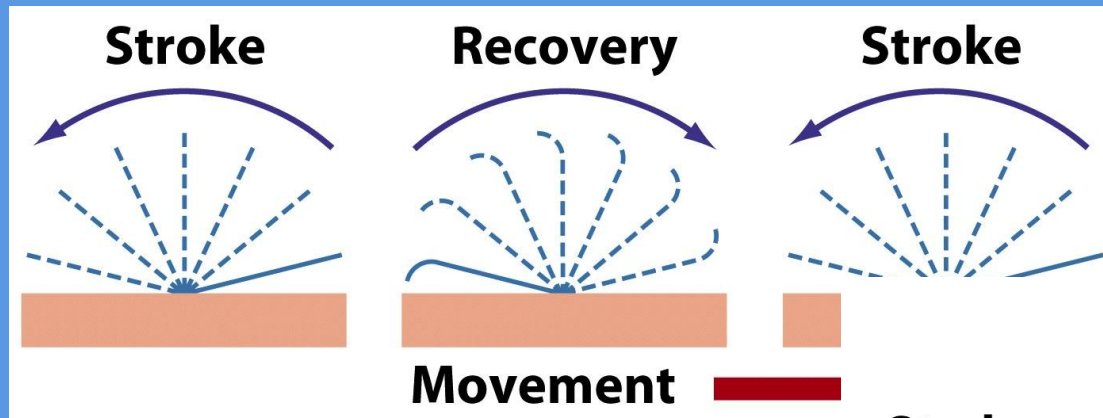
SEM

Motility — Cilia

■ Cilia

cilia and flagella

<http://programs.northlandcollege.edu/biology/Biology1111/animations/flagellum.html>



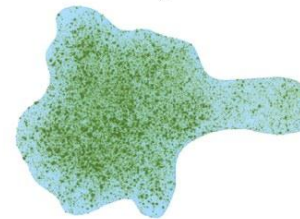
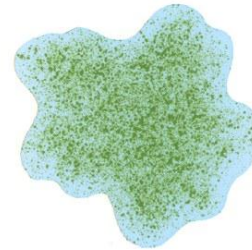
Motility — Pseudopods

■ Pseudopodia

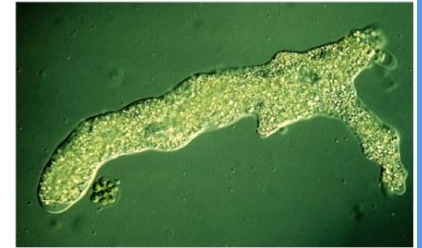
Amoeba in motion

http://www.youtube.com/watch?v=7pR7TNzJ_pA&feature=related

Resting amoeba with
cytoplasm distributed evenly.



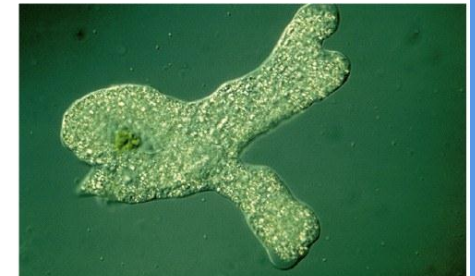
Newly formed pseudopodium
with less dense cytoplasm.



LM

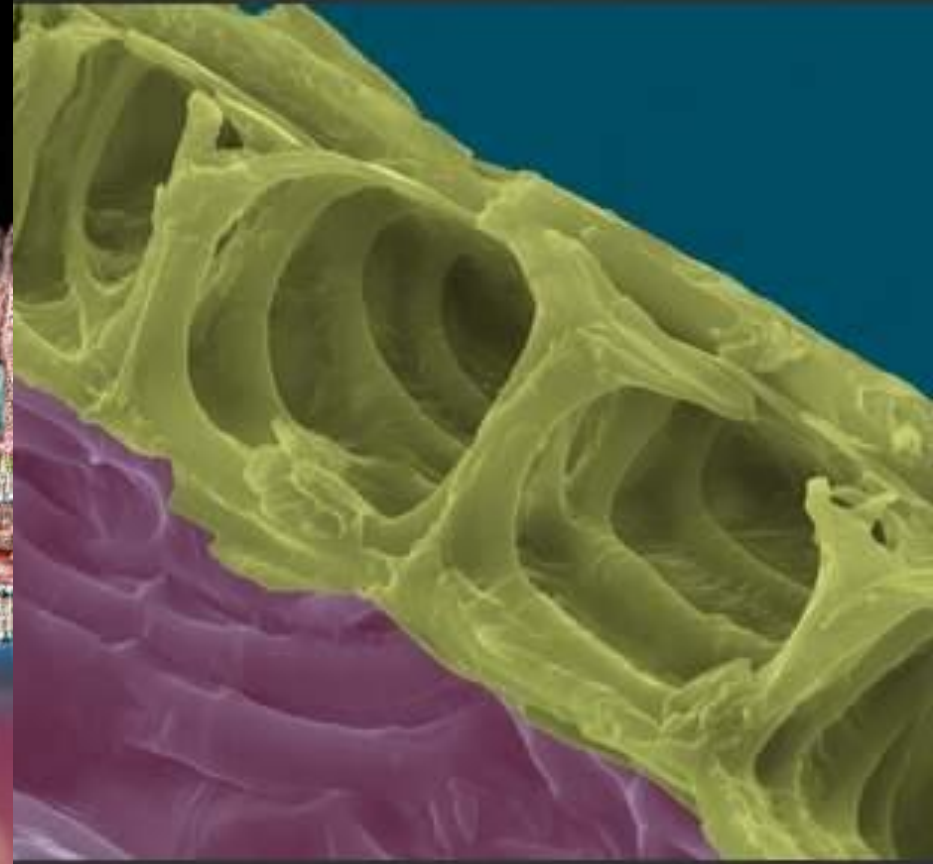
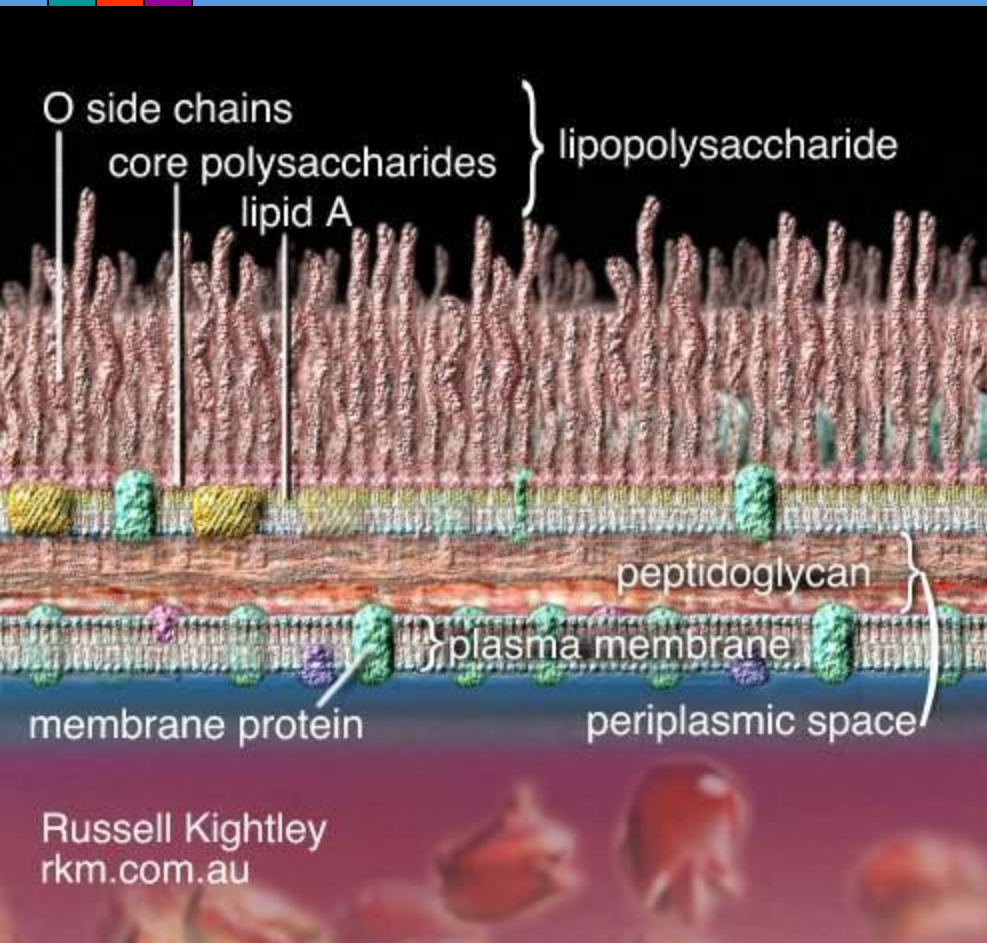


LM



LM

Cell Walls: support/signal/enzymatic



review: 1. The cell theory 2. Prokaryotic cells 3. Eukaryotic cells		
	bacteria	human cell
size	small	bigger
shape	varied	varied
cell wall	yes	no
nucleus	no	yes
organelles	no	yes
ribosome	70S	80S
PTG	yes	no
cell division form	binary fission	meiosis/mitosis
cell division rate	fast	slower
Genome size	small	large



Thank you.....