

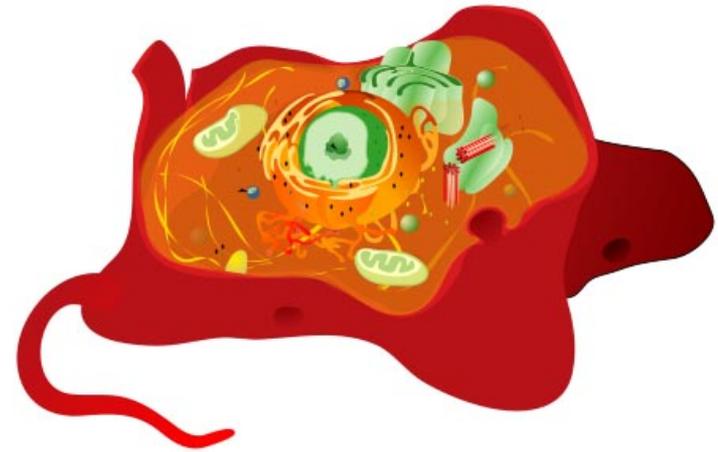
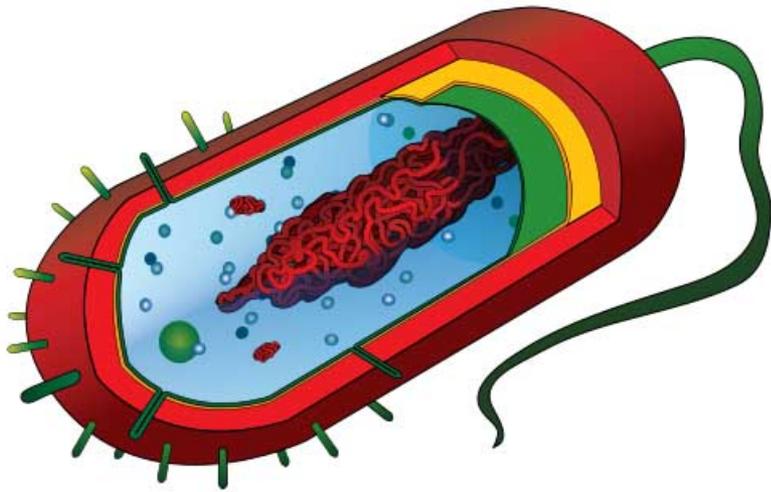


# About Science Prof Online PowerPoint Resources

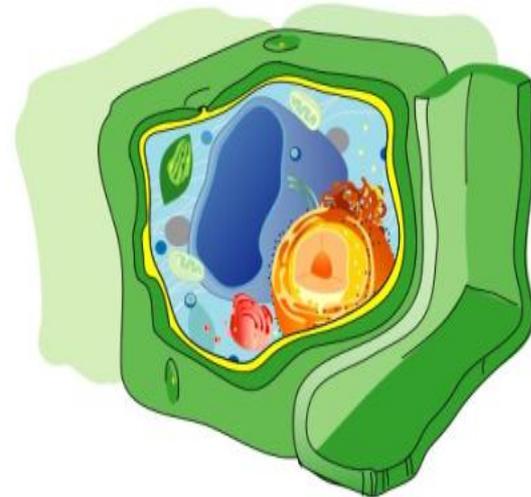
- Science Prof Online (SPO) is a free science education website that provides fully-developed Virtual Science Classrooms, science-related PowerPoints, articles and images. The site is designed to be a helpful resource for students, educators, and anyone interested in learning about science.
- The SPO Virtual Classrooms offer many educational resources, including practice test questions, review questions, lecture PowerPoints, video tutorials, sample assignments and course syllabi. New materials are continually being developed, so check back frequently, or follow us on Facebook (Science Prof Online) or Twitter (ScienceProfSPO) for updates.
- Many SPO PowerPoints are available in a variety of formats, such as fully editable PowerPoint files, as well as uneditable versions in smaller file sizes, such as PowerPoint Shows and Portable Document Format (.pdf), for ease of printing.
- Images used on this resource, and on the SPO website are, wherever possible, credited and linked to their source. Any words underlined and appearing in blue are links that can be clicked on for more information. PowerPoints must be viewed in *slide show mode* to use the hyperlinks directly.
- Several helpful links to fun and interactive learning tools are included throughout the PPT and on the Smart Links slide, near the end of each presentation. You must be in *slide show mode* to utilize hyperlinks and animations.
- This digital resource is licensed under Creative Commons Attribution-ShareAlike 3.0:  
<http://creativecommons.org/licenses/by-sa/3.0/>

Alicia Cepaitis, MS  
Chief Creative Nerd  
Science Prof Online  
Online Education Resources, LLC  
[alicia@scienceprofonline.com](mailto:alicia@scienceprofonline.com)

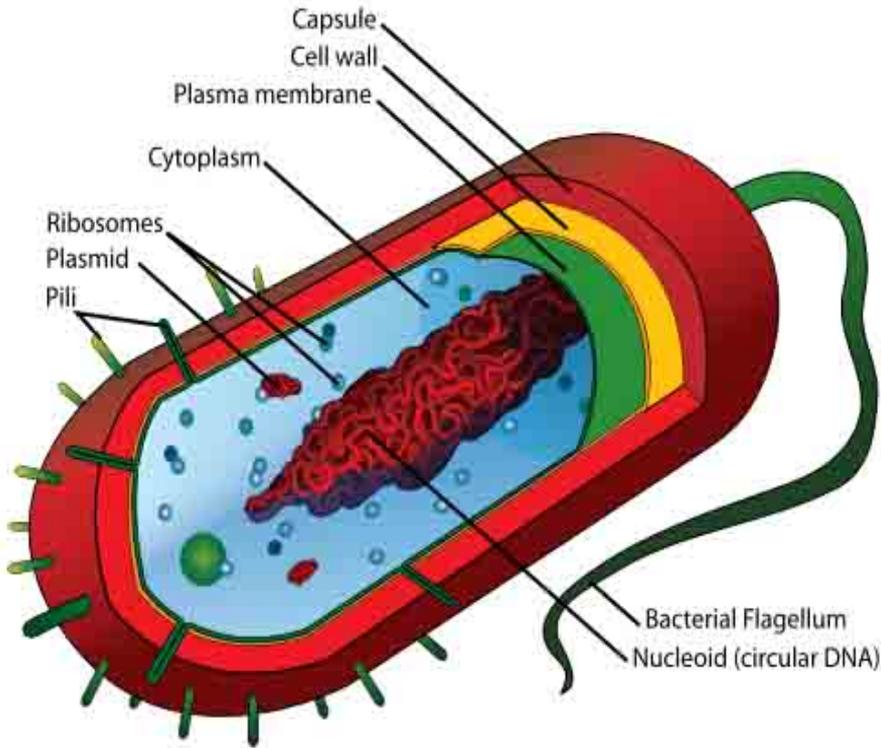
Tami Port, MS  
Creator of Science Prof Online  
Chief Executive Nerd  
Science Prof Online  
Online Education Resources, LLC  
[info@scienceprofonline.com](mailto:info@scienceprofonline.com)



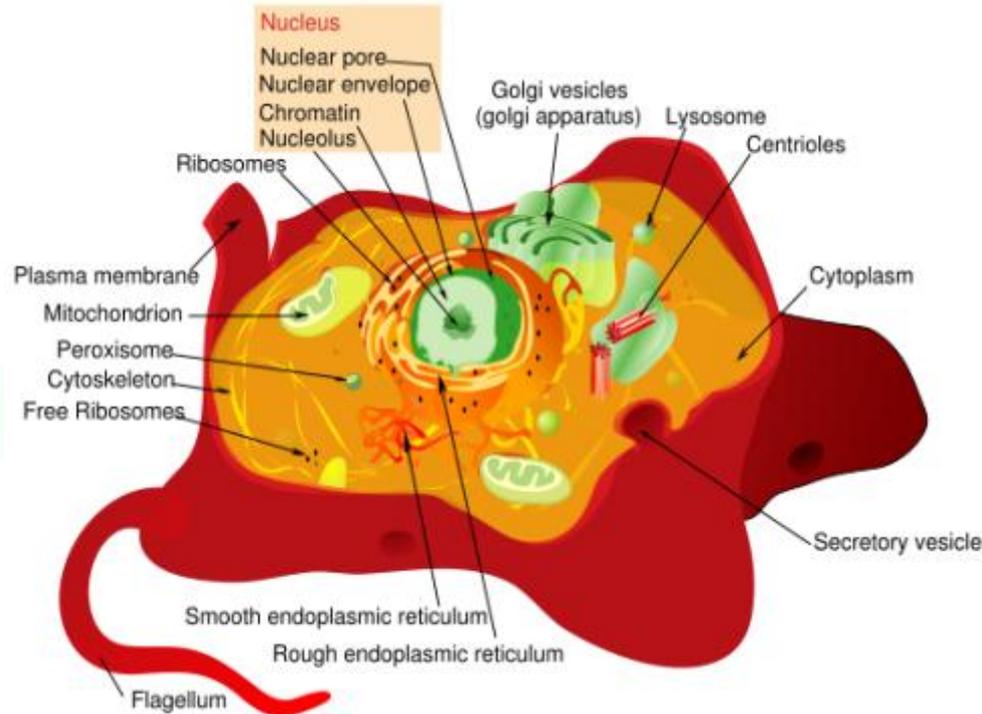
# Biological Cell Structure & Function



# Two Basic Types of Cells



Prokaryotic Cell

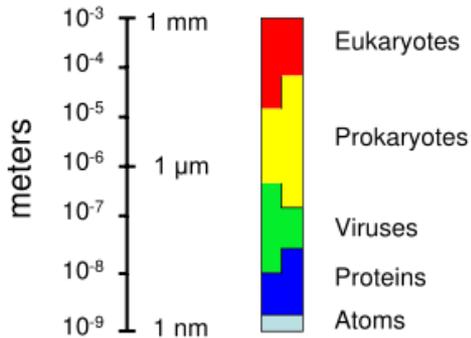
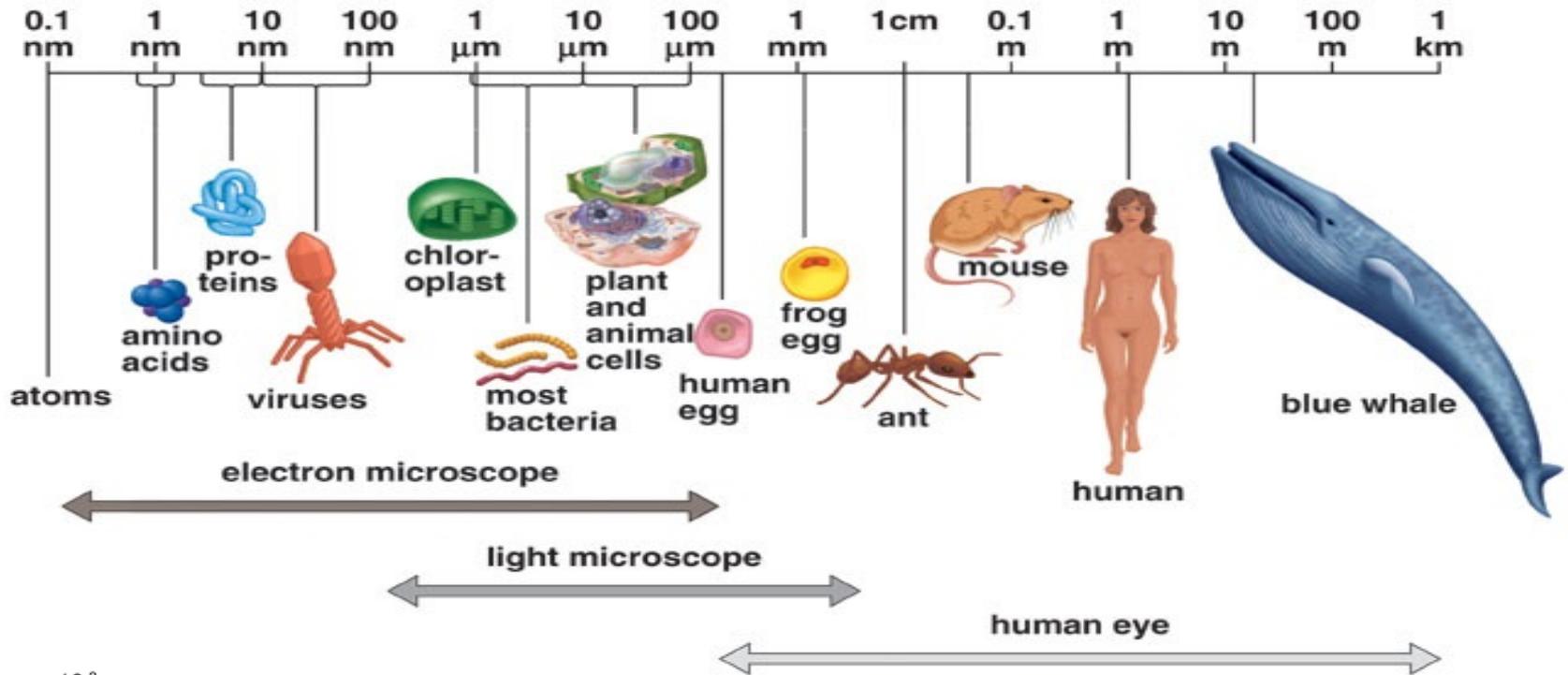


Eukaryotic Cell

**WATCH THIS!**

[Introduction to Cells Video](#)

# Size of Living Things



1 m = 100 cm = 1,000mm = 1,000,000 μm = 1,000,000,000nm

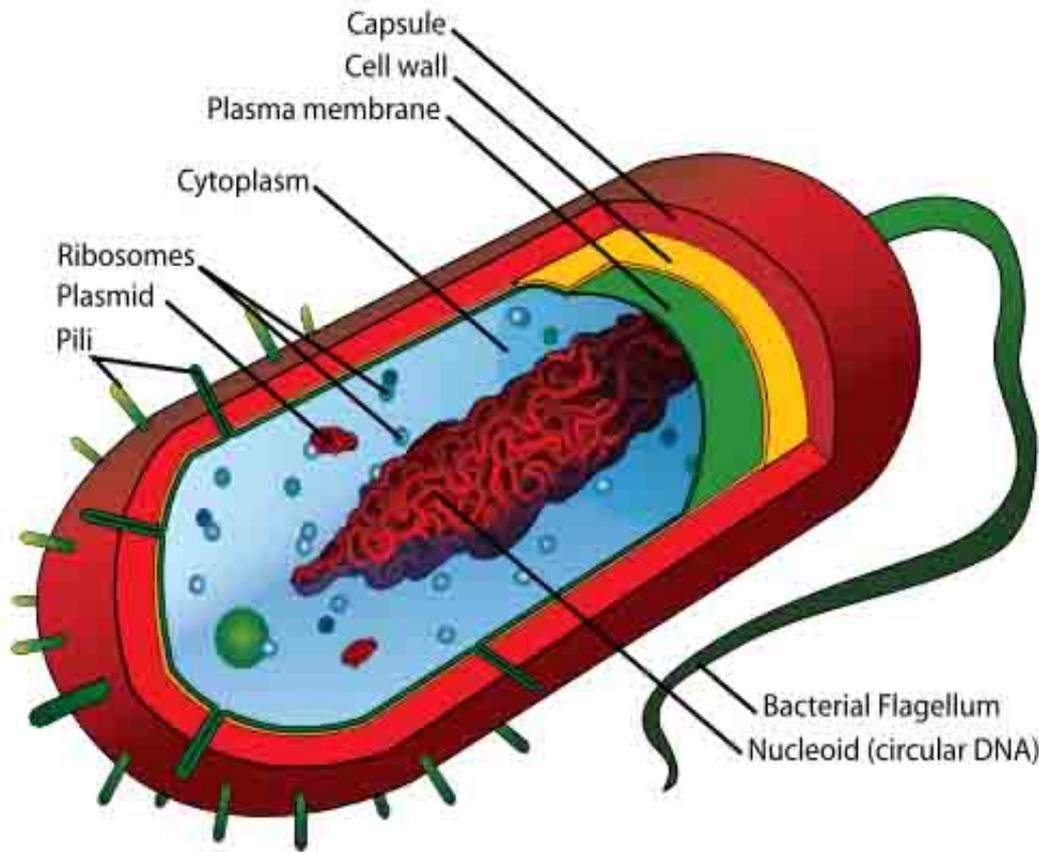
1mm = 1000 μm = 1000000nm

1 μm = 1000nm

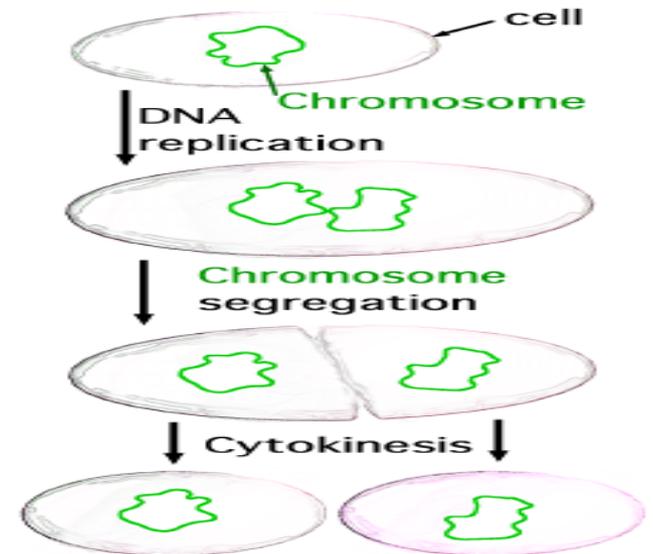
Click link for an interactive [Size of Microscopic Things](#) animation on Cells Alive.

# Prokaryotes

Tell me about Prokaryotes...



## Binary Fission



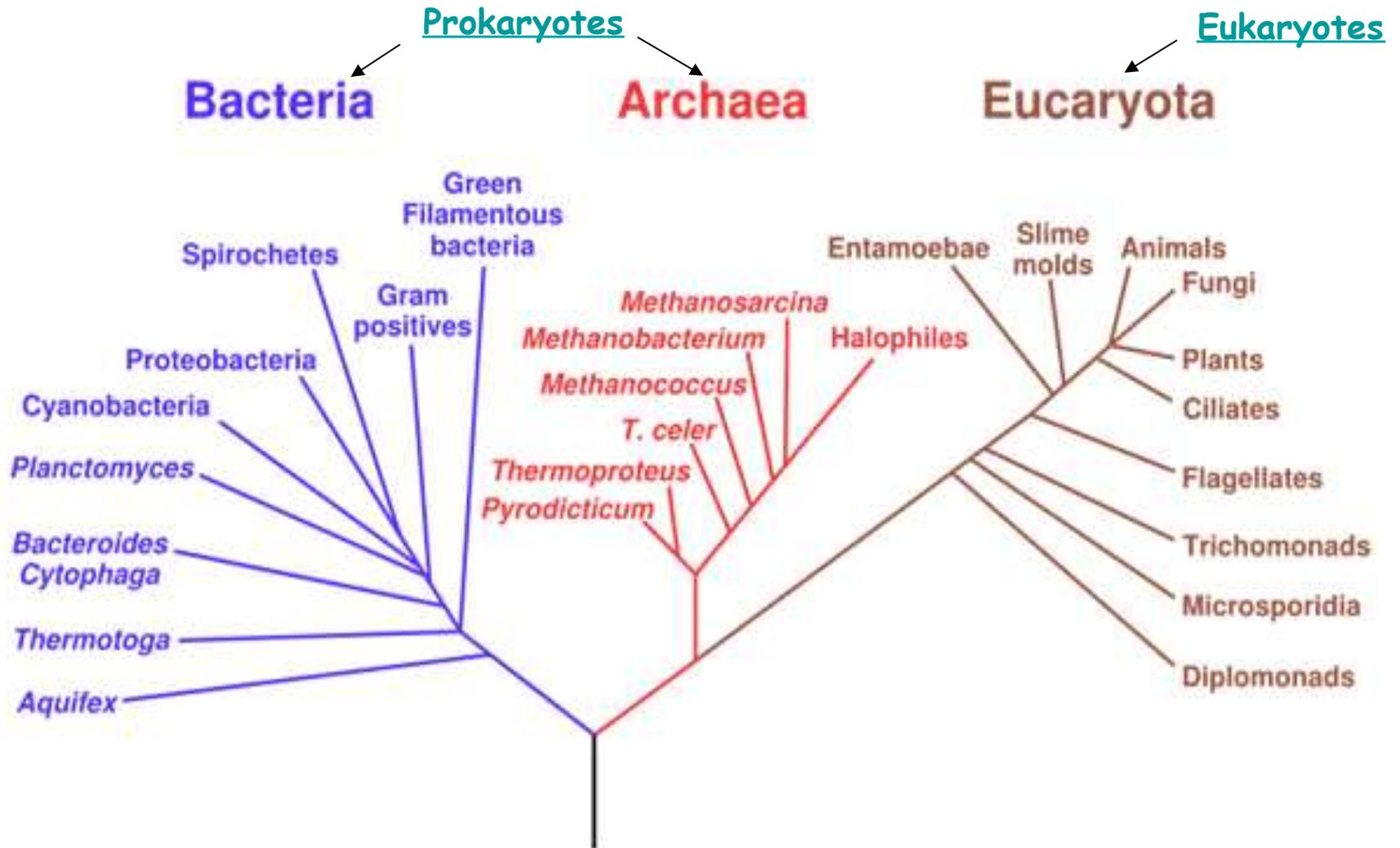
**Check out these quick animated lessons on binary fission:**

(Please watch both, as each provides different and useful information.)

[Binary Fission Animation](#)  
from ClassZone

[Binary Fission Animation](#)  
From McGraw-Hill

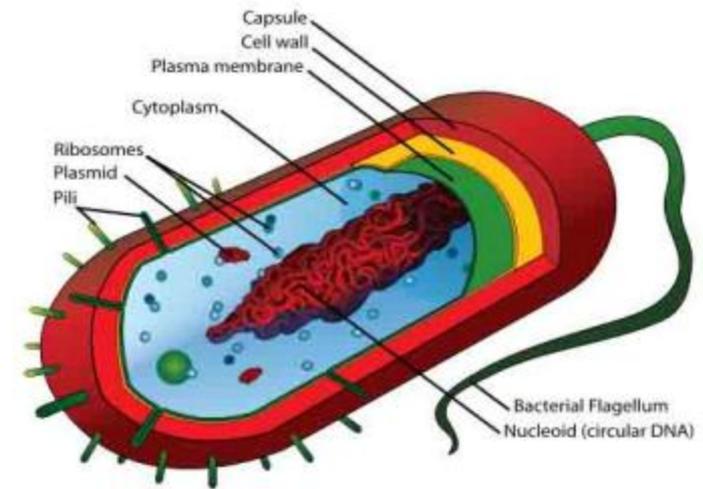
# Phylogenetic Tree of Life



# Prokaryote Genetics

## Nucleoid

- Region of cytoplasm where prokaryote's **genome** (DNA) is located.
- Usually a singular, circular chromosome.



## Plasmid

- Small extra piece of chromosome/genetic material.
- 5 - 100 genes
- Not critical to everyday functions.
- Can provide genetic information to promote:
  - Antibiotic resistance
  - Virulence factors  
*(molecules produced by pathogen that specifically influence host's function to allow the pathogen to thrive)*
  - Promote conjugation  
*(transfer of genetic material between bacteria through cell-to-cell contact)*

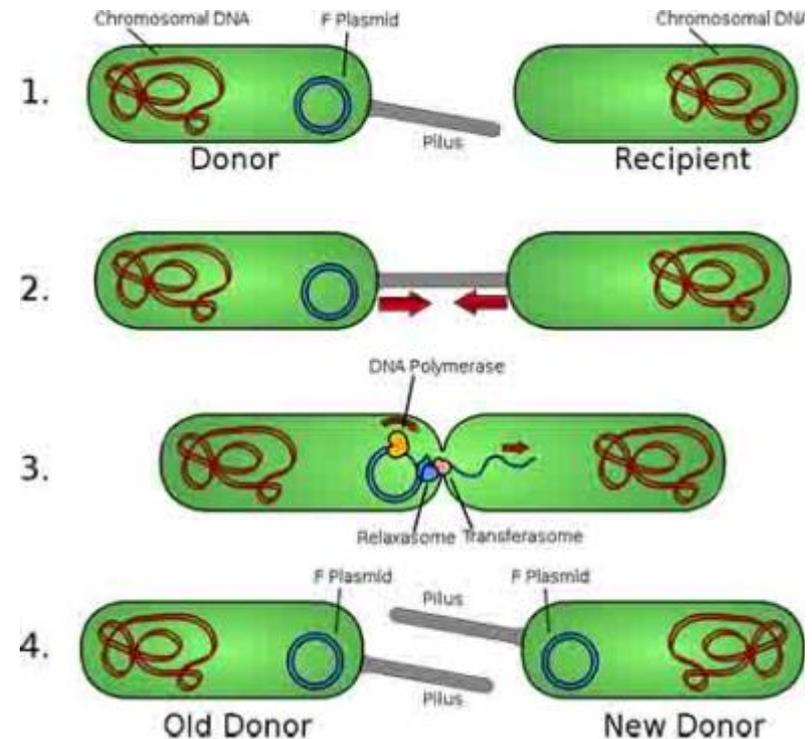
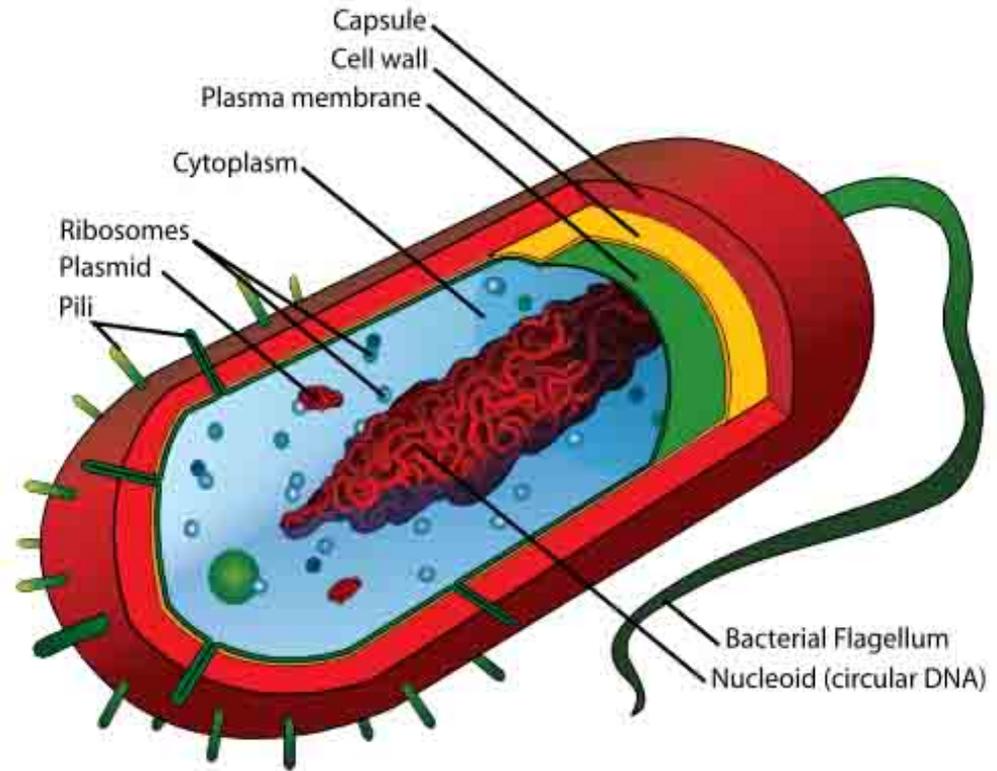


Image: [Prokaryotic Cell Diagram](#); M. Ruiz, [Bacterial conjugation](#), Adenosine

# Prokaryotes

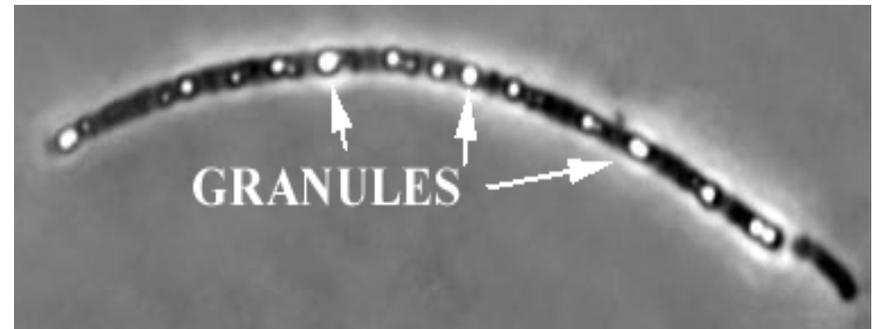
## Cytoplasm

- Also known as proto-plasm.
- Gel-like matrix of water, [enzymes](#), nutrients, wastes, and gases and contains cell structures.
- Location of growth, metabolism, and [replication](#).



## Granules

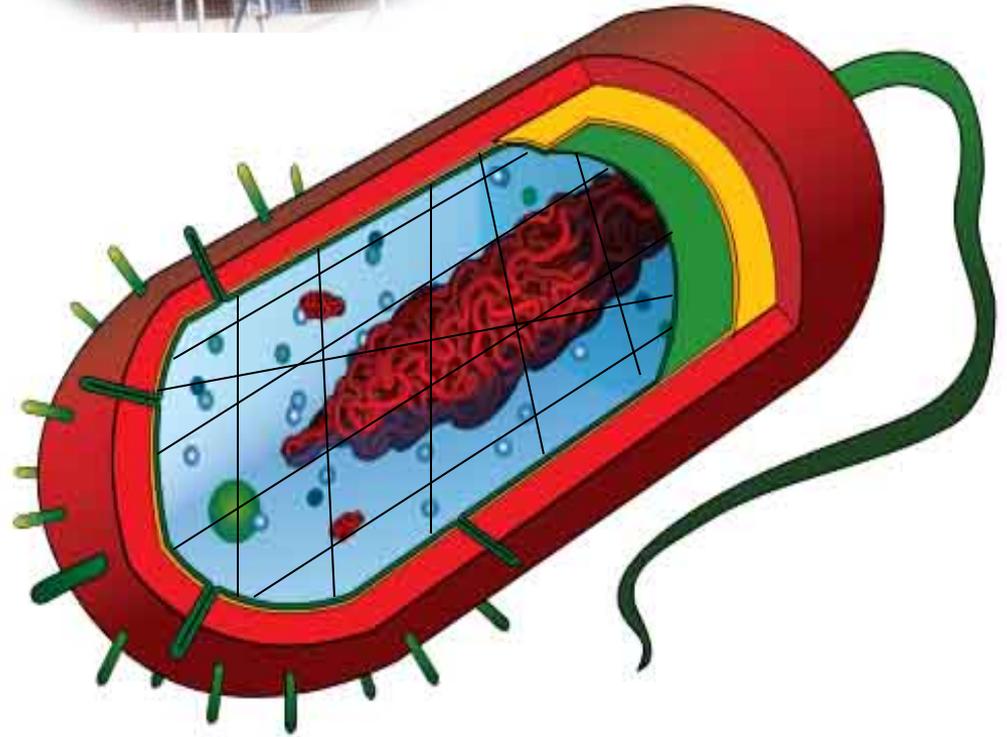
- Bacteria's way of storing nutrients.
- Staining of some granules aids in identification.



# Prokaryotes

## Cytoskeleton

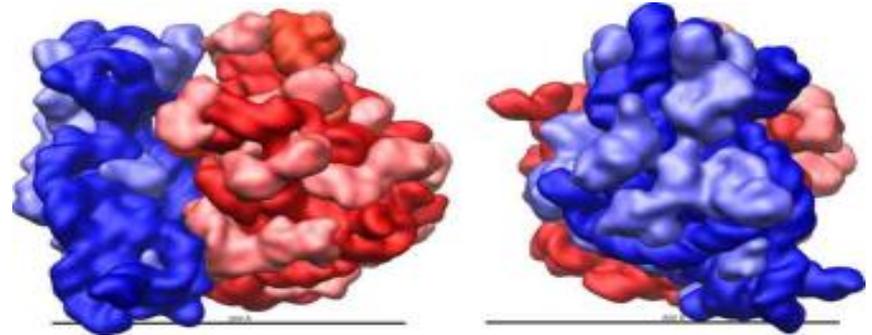
- Cellular "scaffolding" or "skeleton" within the cytoplasm.
- Major advance in prokaryotic [cell biology](#) in the last decade has been discovery of the [prokaryotic](#) cytoskeleton.
- Up until recently, thought to be a feature only of [eukaryotic](#) cells.



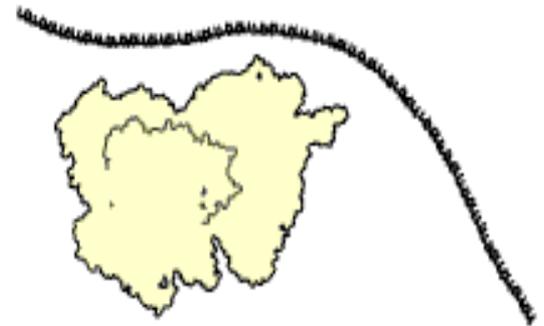
# Prokaryotes

## Ribosomes

- Found within cytoplasm or attached to plasma membrane.
- Made of protein & rRNA.
- Composed of two subunits.
- Cell may contain thousands .
- **Q: What do ribosomes do?**
- **Q: What's the relationship between the job that the ribosomes do and the genetic instructions (nucleic acids) of the cell?**



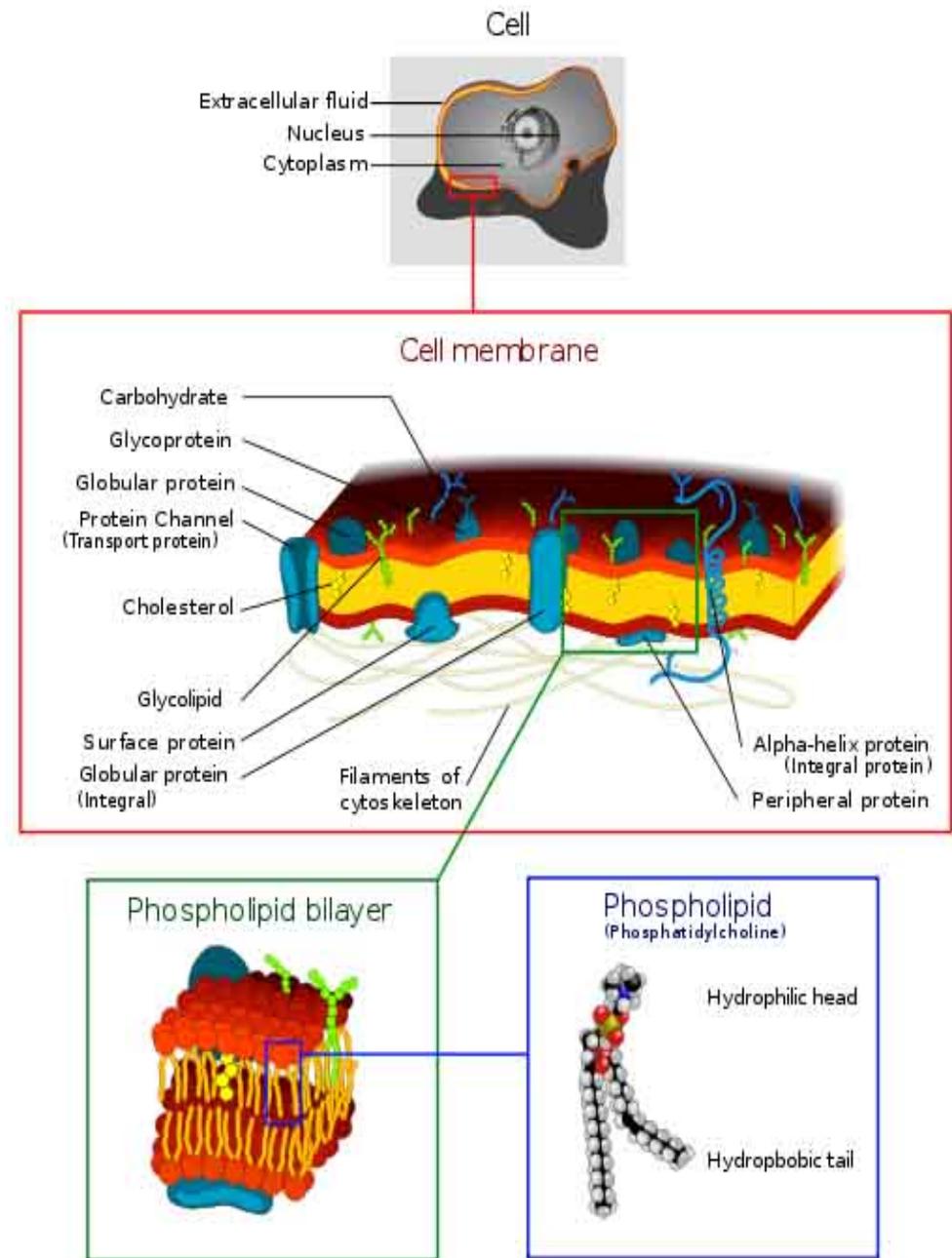
[Click here](#) for animation of ribosome building a protein.



# Prokaryotes

## Plasma Membrane

- Separates the cell from its environment.
- Phospholipid molecules oriented so that **hydrophilic water-loving** heads directed outward and **hydrophobic water-hating** tails directed inward.
- Proteins embedded in two layers of lipids (lipid bilayer).
- Membrane is **semi-permeable**.  
*Q: What does that mean?*



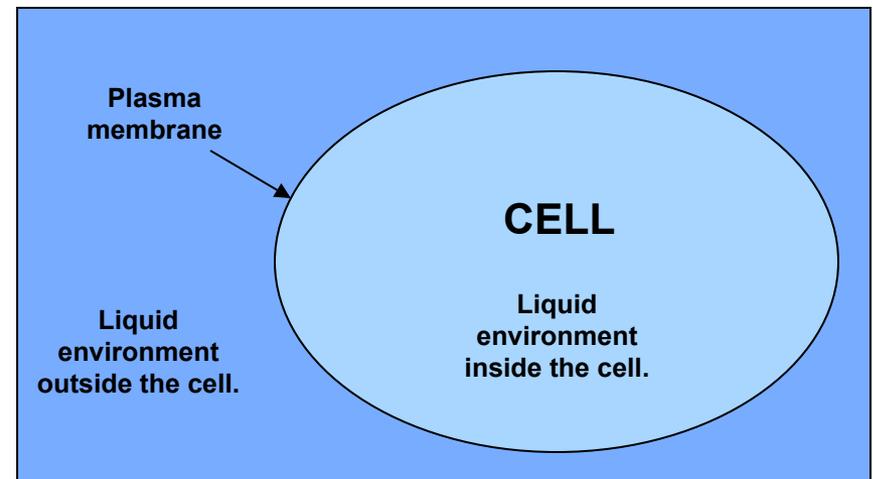
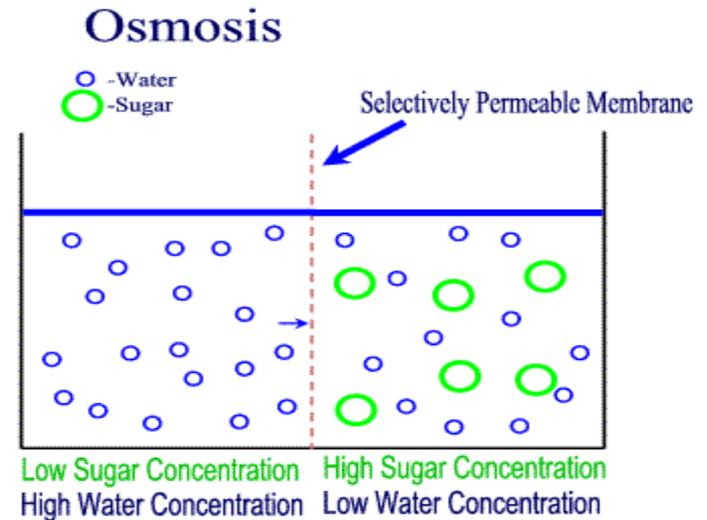
# Passive Transport - Osmosis

**Q:** Diffusion of **what** across the plasma membrane?

Environment surrounding cells may contain amounts of dissolved substances (solutes) that are...

- equal to
- less than
- greater than

...those found with in the cell.

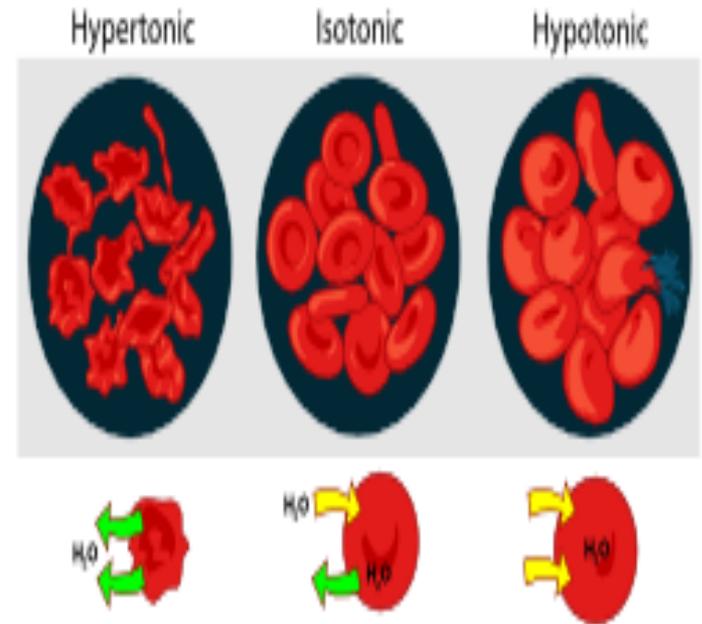


# Passive Transport - Osmosis

## Tonicity and Osmosis

- **isotonic:** equal concentration of a solute inside and outside of cell.
- **hypertonic:** a higher concentration of solute.
- **hypotonic:** a lower concentration of solute.

**Water will always move toward a hypertonic environment!!**



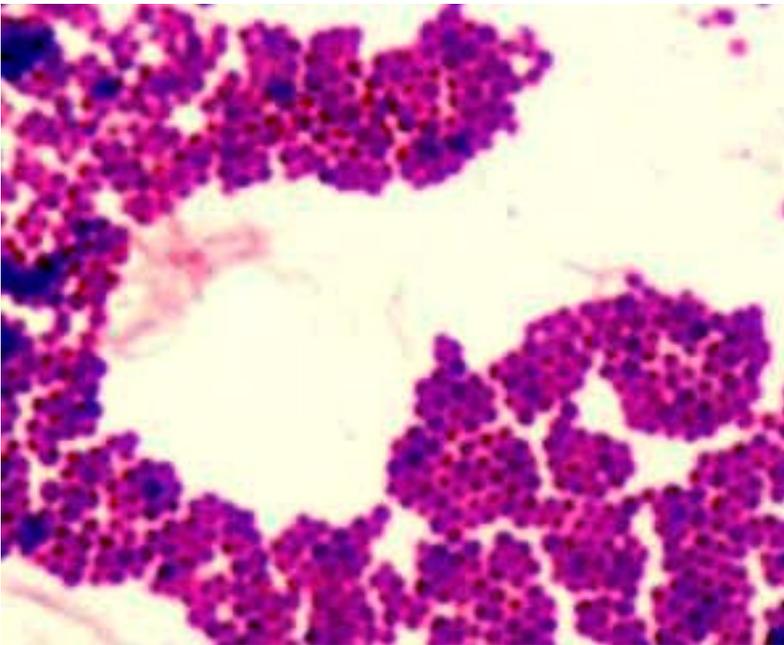
## REVIEW!

- [How Osmosis Works](#) animation
- [Diffusion, Osmosis & Active Transport](#) Lecture Main Page of the [Virtual Cell Biology Classroom](#) on the [Science Prof Online](#) website

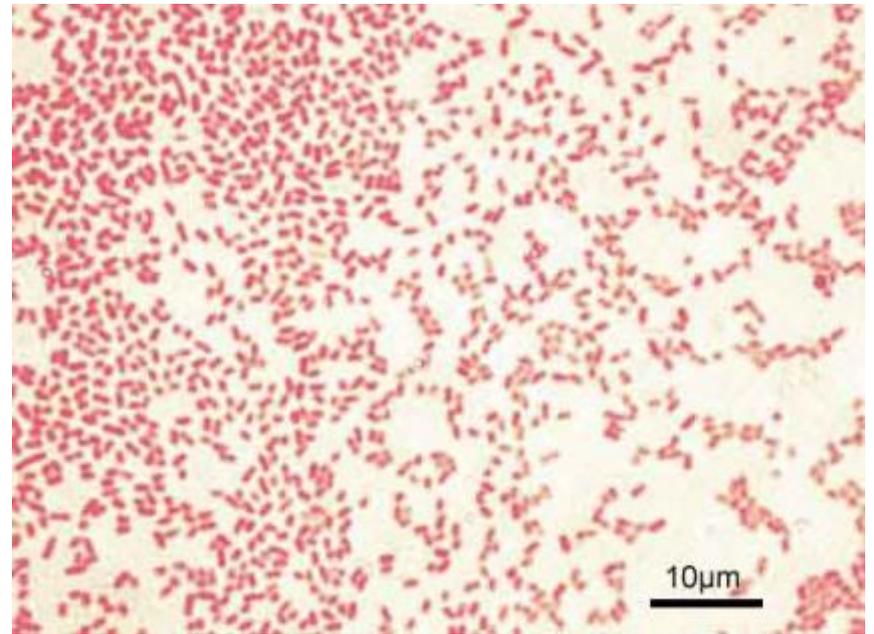
# Prokaryotes - Cell Wall

From the peptidoglycan inwards all bacteria are very similar. Going further out, the bacterial world divides into two major classes (plus a couple of odd types). These are:

## Gram-positive



## Gram-negative



# Bacterial Cell Wall

- **Peptidoglycan** is a huge polymer of interlocking chains of alternating monomers.
- Provides rigid support while freely permeable to solutes.
- Backbone of peptidoglycan molecule composed of two amino sugar derivatives of glucose. The "glycan" part of peptidoglycan:
  - N-acetylglucosamine (NAG)
  - N-acetylmuramic acid (NAM)
- NAG / NAM strands are connected by interlocking peptide bridges. The "peptid" part of peptidoglycan.

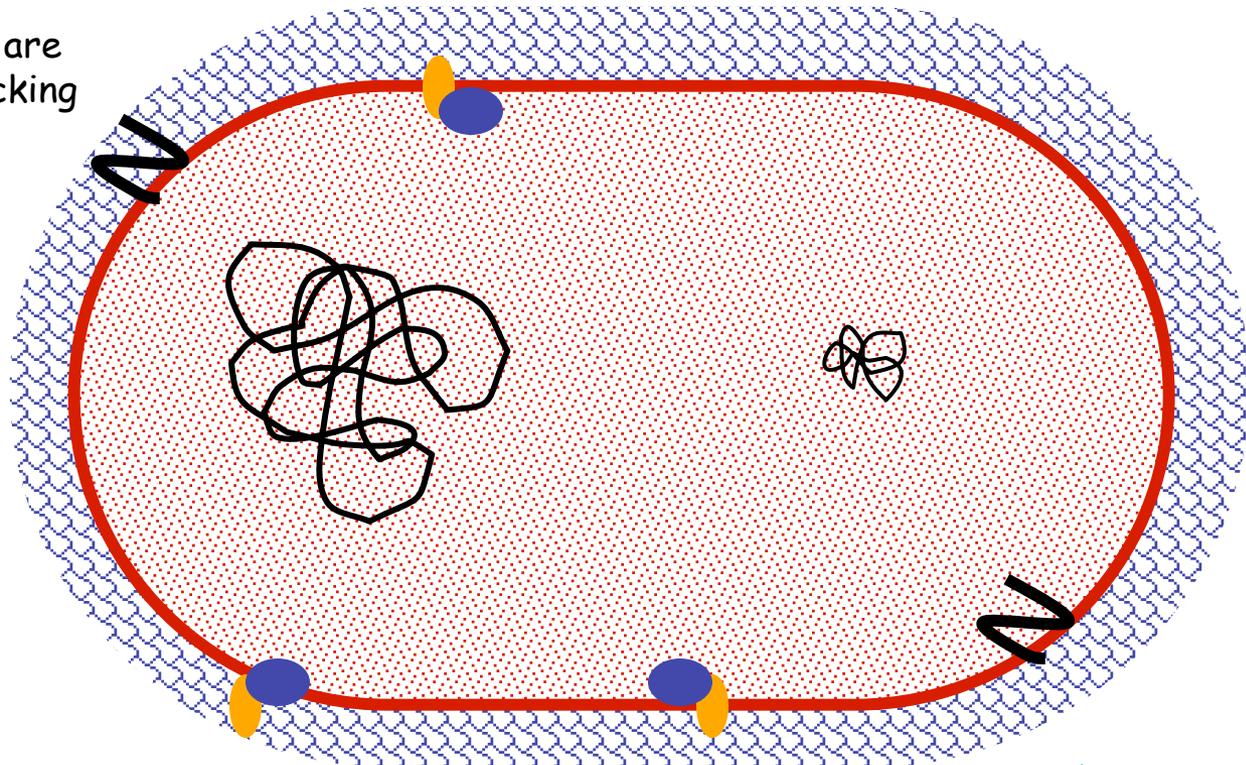
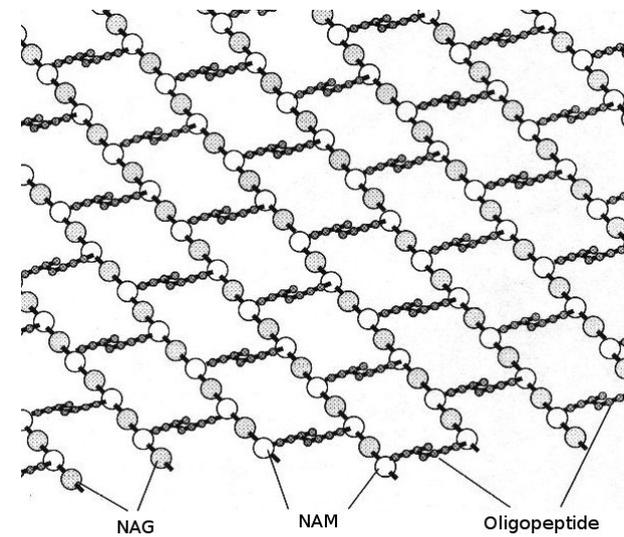
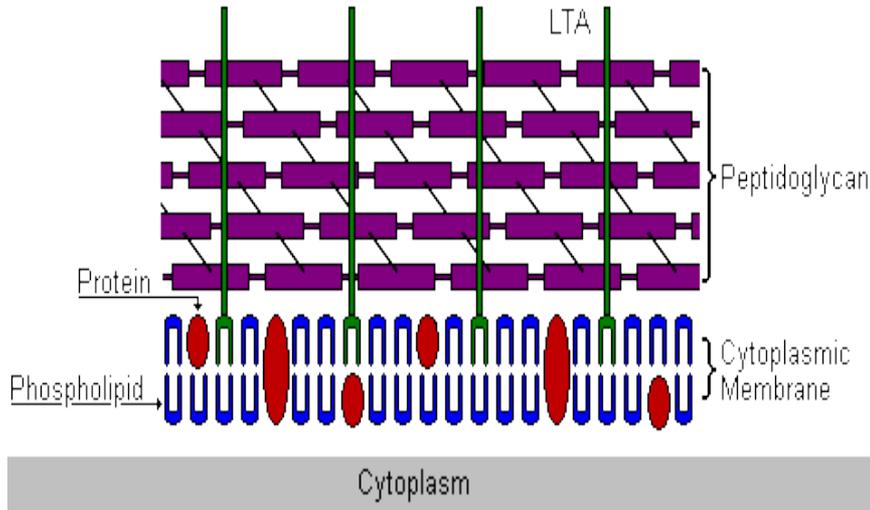


Image: [Bonding structure peptidoglycan](#),  
Mouagip; Other Image Source Unknown

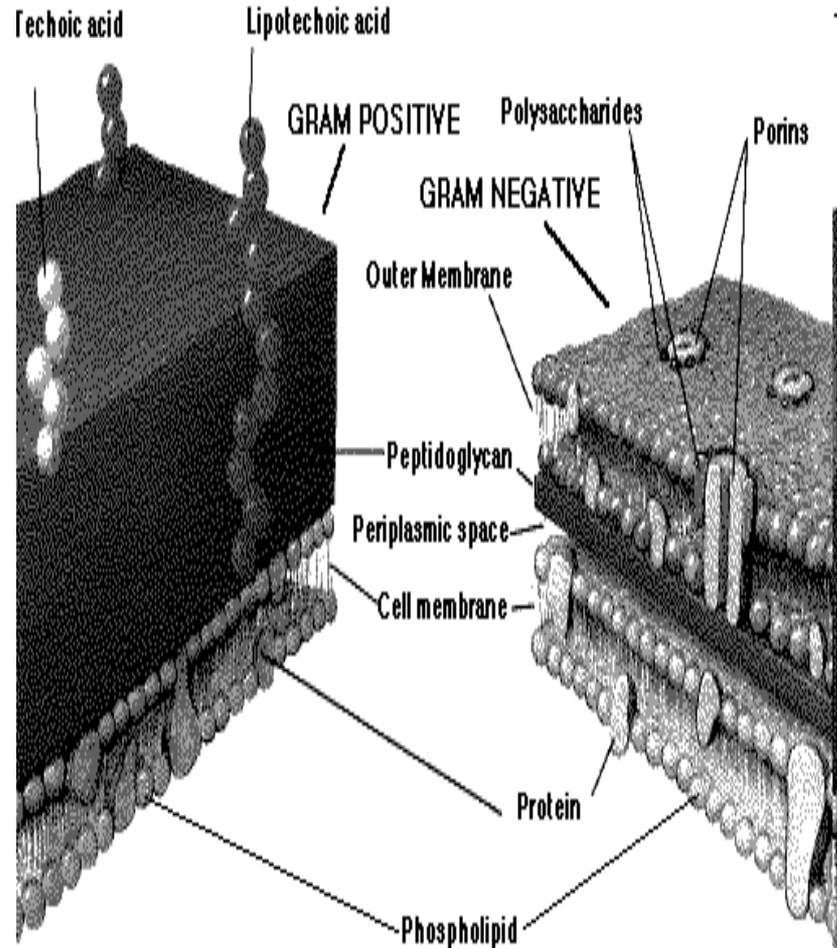
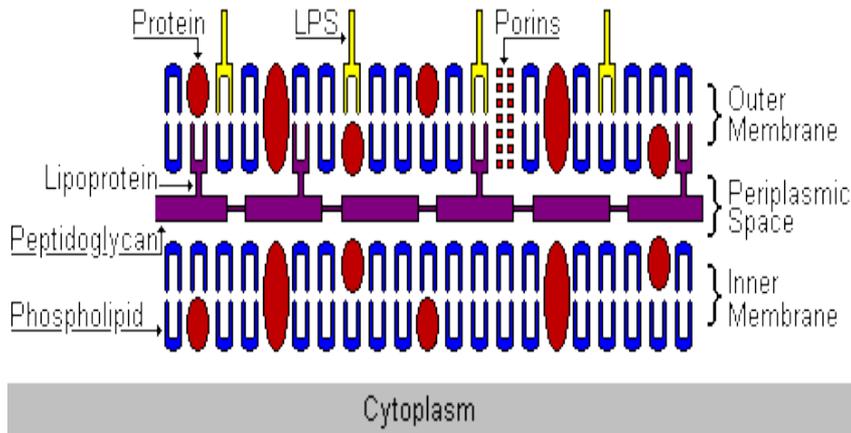
# Prokaryotes - Cell Wall

## Gram-Positive & Gram-Negative

*Gram-positive Cell Wall*



*Gram-negative Cell Wall*





**Q:** Why are these differences in bacterial cell wall structure so important?

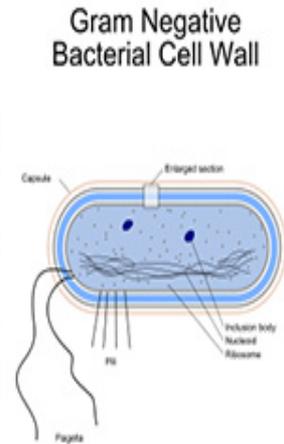
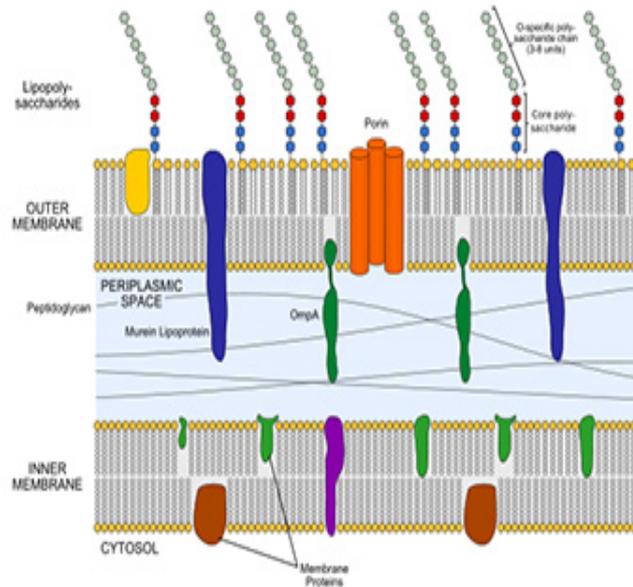
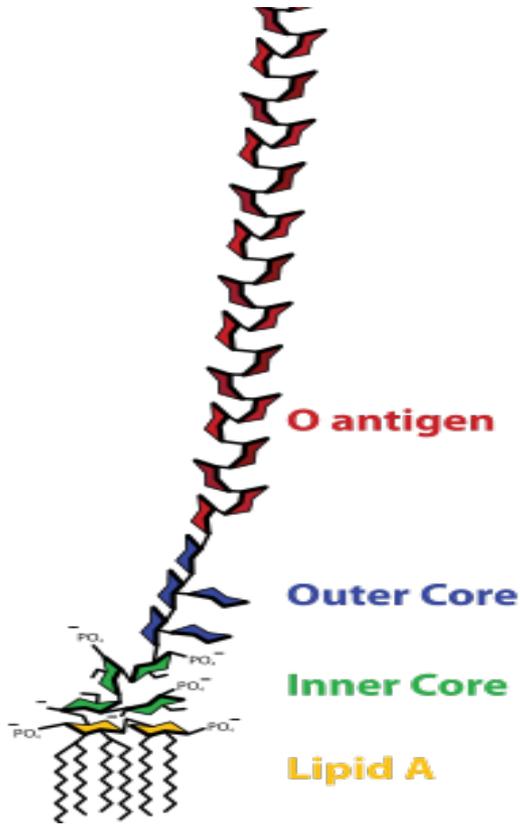
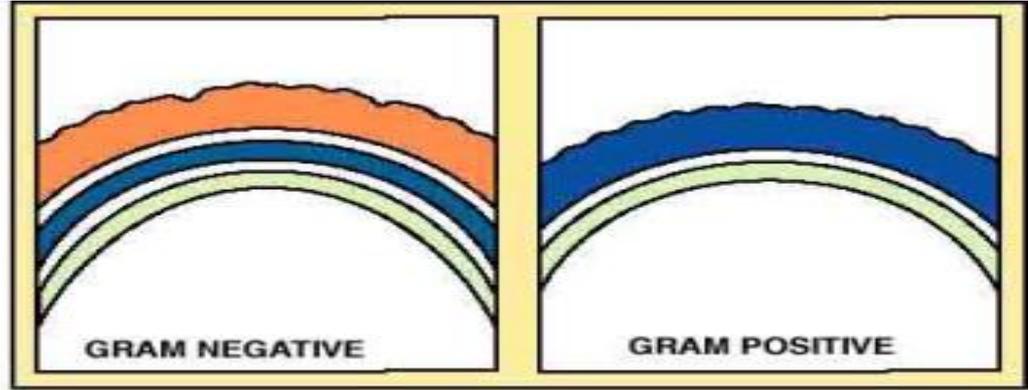


Image: [Lipopolysaccharide](#), Wiki; Gram+ and Gram- cell wall diagram, source unknown; ; [Gram-negative cell wall schematic](#), Jeff Dahl



# Prokaryotes - Glycocalyx

Some bacteria have an additional layer outside of the cell wall called the **glycocalyx**.

This additional layer can come in one of two forms:

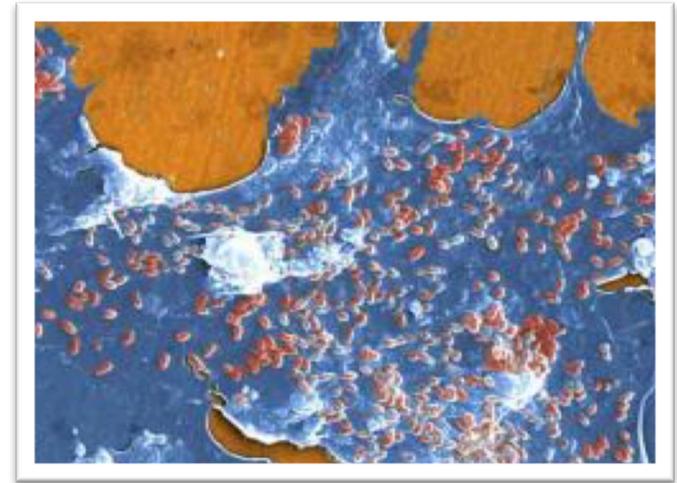
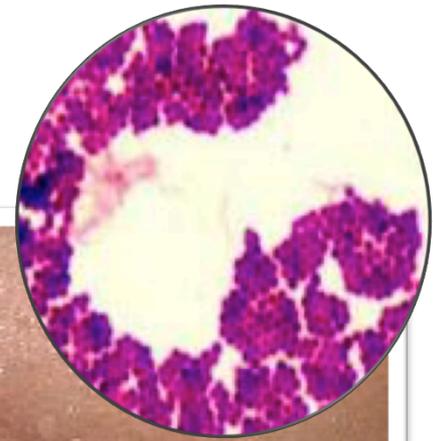
## 1. Slime Layer

- Glycoproteins loosely associated with the cell wall.
- Slime layer causes bacteria to adhere to solid surfaces and helps prevent the cell from drying out.

### - *Streptococcus*

The slime layer of **Gram+** *Streptococcus mutans* allows it to accumulate on tooth enamel (yuck mouth and one of the causes of cavities).

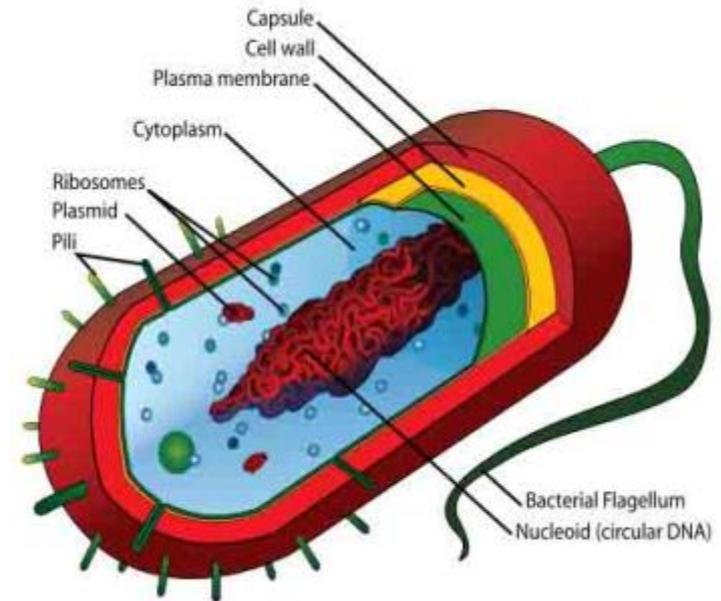
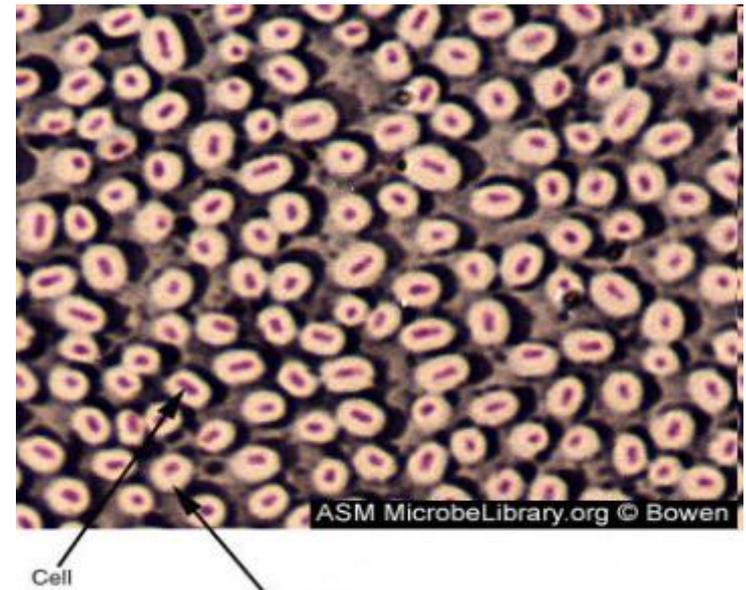
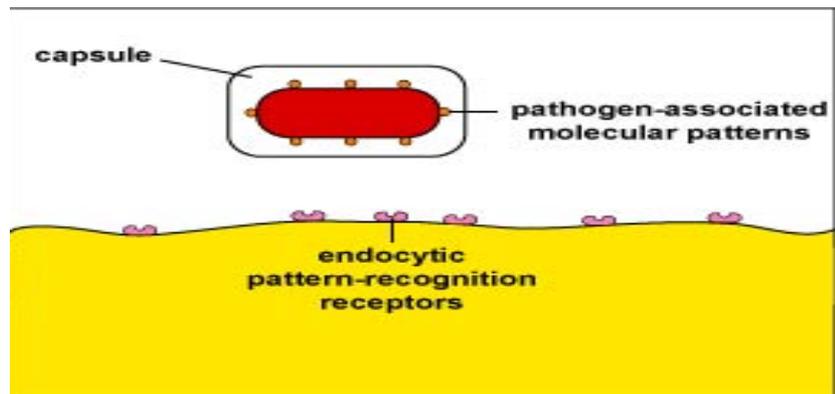
Other bacteria in the mouth become trapped in the slime and form a biofilm & eventually a buildup of plaque.



# Prokaryotes - Glycocalyx

## 2. Capsule

- Polysaccharides firmly attached to the cell wall.
- Capsules adhere to solid surfaces and to nutrients in the environment.
- Adhesive power of capsules is a major factor in the initiation of some bacterial diseases.
- Capsule also protect bacteria from being phagocytized by cells of the hosts immune system.





# Prokaryotes - Endospores

- Dormant, tough, non-reproductive structure produced by small number of bacteria.
- Resistant to radiation, desiccation, lysozyme, temperature, starvation, and chemical disinfectants.
- Endospores are commonly found in soil and water, where they may survive for very long periods of time.
- **Q:** How and why do endospores form? Watch the animated lesson "Bacterial Spore Formation" to find out. Link also provides quiz questions to test your understanding of the material.

An endospore stained bacterial smear of *Bacillus subtilis* showing **endospores** as green and **vegetative cells** as red.

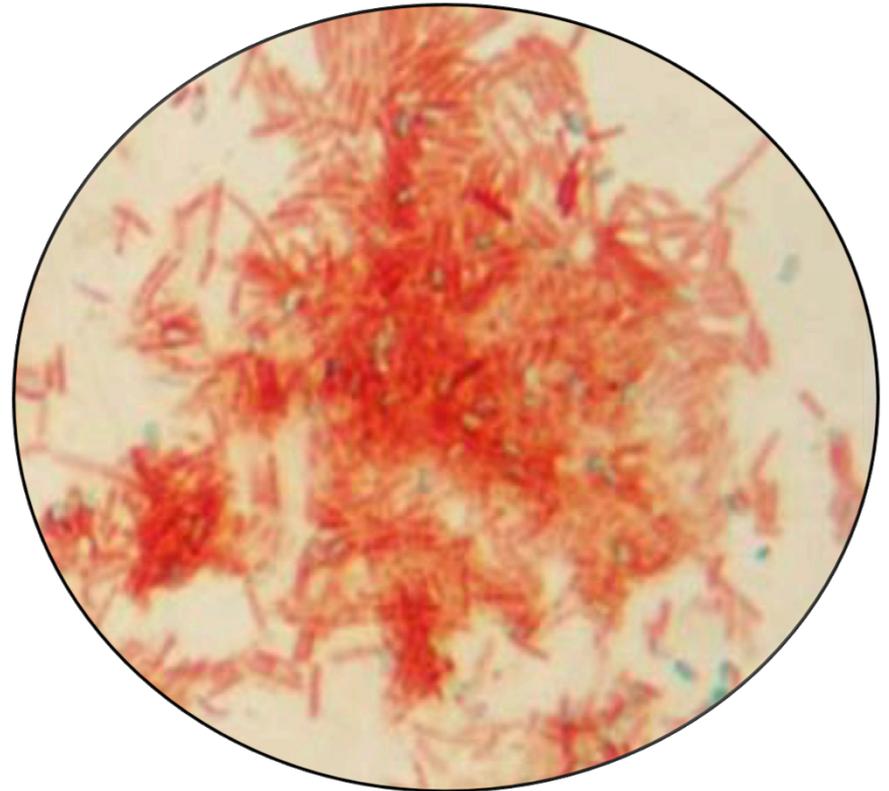


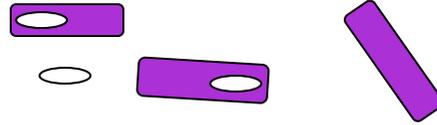
Image: *Bacillus subtilis*, SPO Science Image Library; , *Clostridium botulinum*, [PHIL](#) #2107

# Bacterial Genus : Clostridium

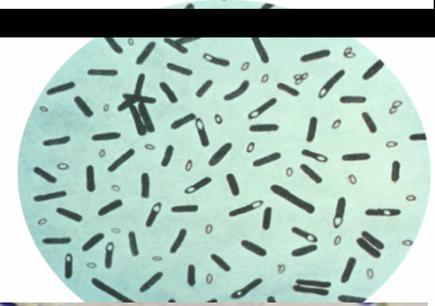
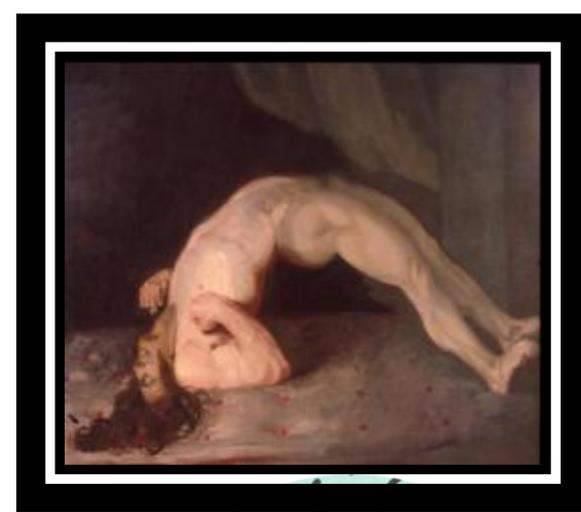
## GRAM-POSITIVE

### Obligate anaerobes

bacillus-shaped  
endospore producer



- The members of this genus have a couple of bacterial "superpowers" that make them particularly tough pathogens.
- All have a strictly **fermentative** mode of metabolism (Don't use oxygen).
- Vegetative cells are **obligate anaerobes** killed by exposure to O<sub>2</sub>, but their **endospores** are able to survive long periods of exposure to air.
- Known to produce a variety of toxins, some of which are fatal.
  - *Clostridium tetani* = agent of tetanus
  - *C. botulinum* = agent of botulism
  - *C. perfringens* = one of the agents of gas gangrene
  - *C. difficile* = part of natural intestinal flora, but resistant strains can proliferate and cause pseudomembranous colitis.



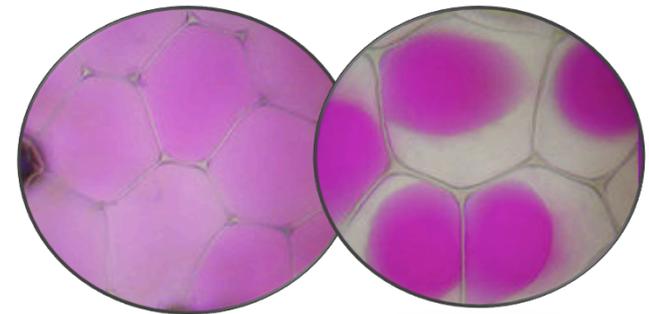


# More About Cells & Water... Osmotic Pressure

**Q:** What is the impact of osmotic pressure on cells?

- $H_2O$  important reactant in many metabolic reactions.
- Most cells die in absence of water.
- Cell walls of bacteria and plants prevent them from exploding in a **hypotonic** environment, but most bacteria are vulnerable in **hypertonic** environments.
- Many bacteria can be plasmolyzed by high concentrations of solutes.
- Your salty perspiration protects you from bacteria that cannot handle the high sodium chloride concentration.
- Water moves out of the bacterium and it dies of 'hyperosmotic shock' (desiccation).

**Q:** What protects cells in a *hypertonic* environment?

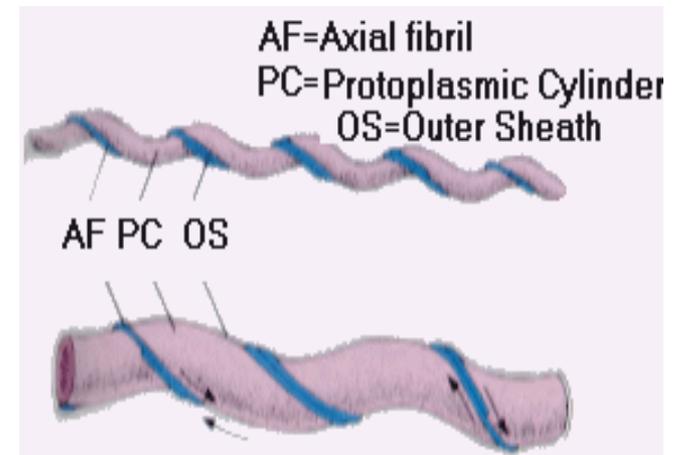
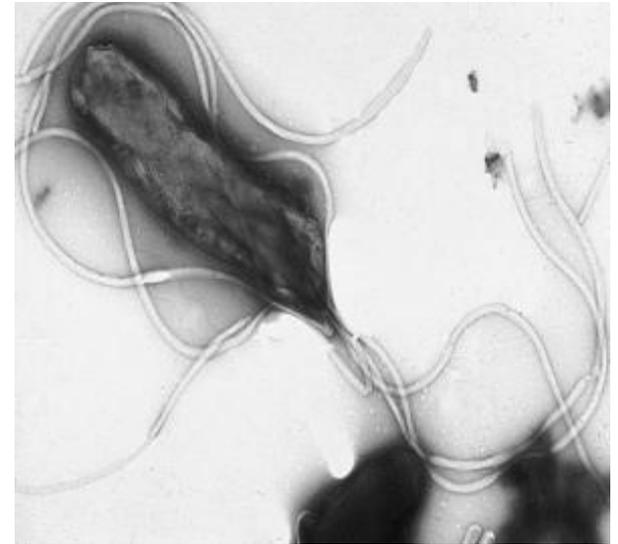


**Q:** Why can you keep honey on the cupboard for months, even years, without it spoiling?

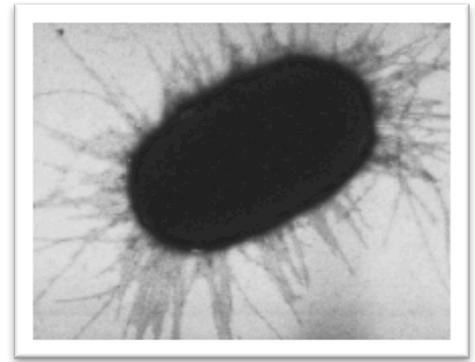


# Prokaryotes - Surface Appendages

- Some prokaryotes have distinct appendages that allow them to move about or adhere to solid surfaces.
- Consist of delicate stands of proteins.
- **flagella**: Long, thin extensions that allow some bacteria to move about freely in aqueous environments.  
(singular: flagellum)
- **axial filament (endoflagella)**: Wind around bacteria, causing movement in waves.



# Prokaryotes - Surface Appendages

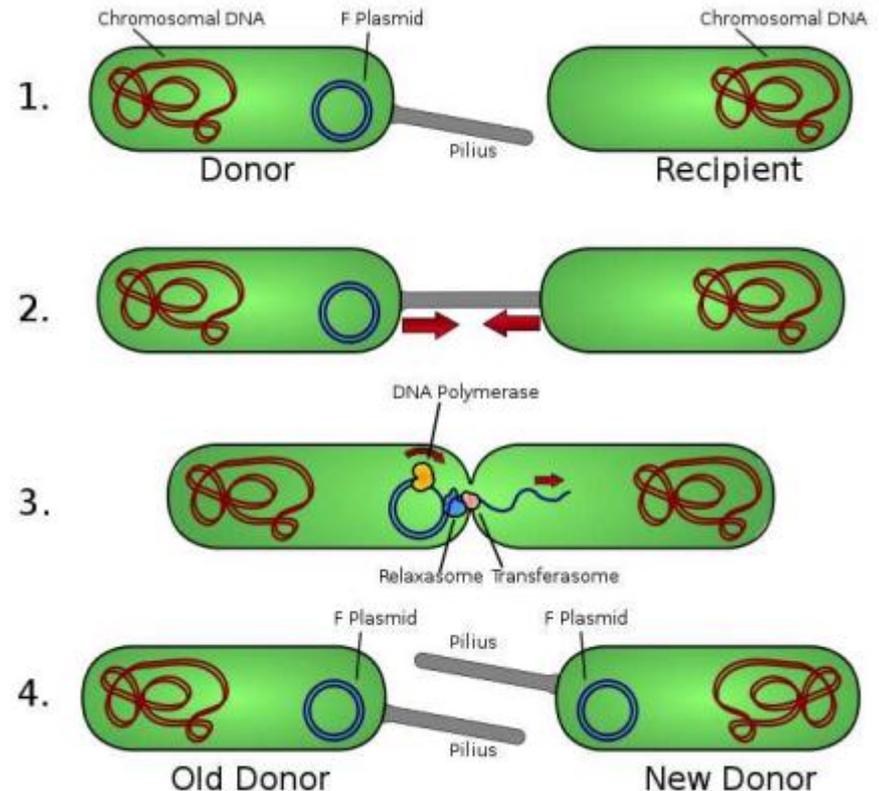


- **fimbriae:** Most Gram-negative bacteria have these short, fine appendages surrounding the cell. Gram+ bacteria don't have.

No role in motility. Help bacteria adhere to solid surfaces. Major factor in virulence.  
(singular: fimbria)

- **pili:** Tubes that are longer than fimbriae, usually shorter than flagella.

Use for movement, like grappling hooks, and also use conjugation pili to transfer plasmids. (singular = pilus)



# Meet the Microbe! *Neisseria* and its Fimbriae

- **Gram-** diplococci, resemble coffee beans when viewed microscopically.
- *Neisseria gonorrhoeae* causes sexually transmitted disease gonorrhoeae.
- Antibiotics applied to the eyes of neonates as a preventive measure against gonorrhoea.
- One of the most communicable disease in the U.S.
- 125 cases per 100,000. Teens 15-19 yo 634 cases per 100,000. Young adults 20-25 460 per 100,000.
- *N. meningitidis* most common causes of bacterial meningitis in young adults.

## Q: What makes Neisseria so tough?

- Lipopolysaccharide (LPS) of the cell wall of *Neisseria* acts as an endotoxin.
- Polysaccharide **capsule** prevents host phagocytosis and aids in evasion of the host immune response.
- Use **fimbriae** to attach onto host cells; avirulent without. **Fimbriae** have adhesion proteins (adhesins) on their tips that match, lock and key, with **proteins** on host epithelial cell surface.

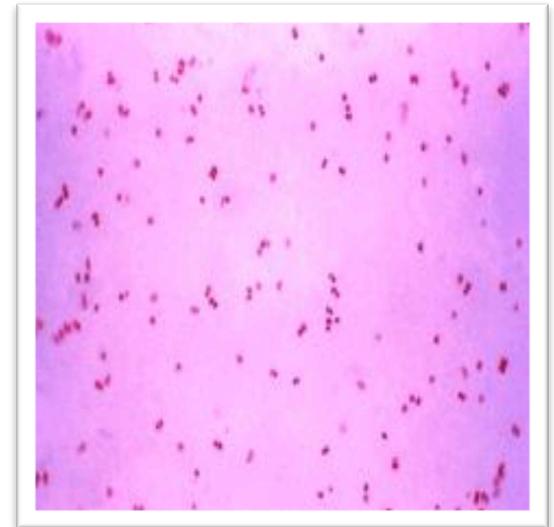
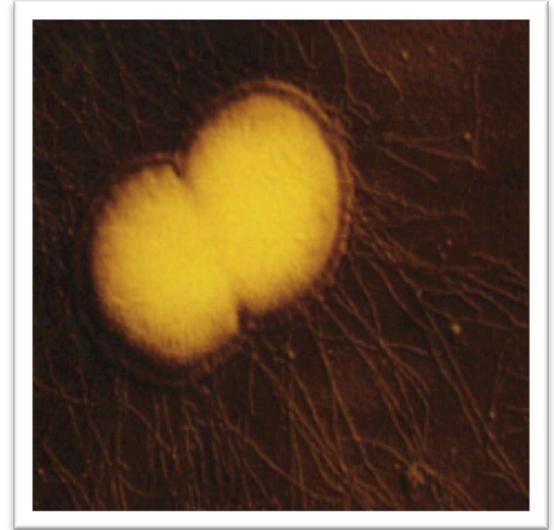


Image: [Neisseria](#) photo, Textbook of Bacteriology, Gram stain of *Neisseria gonorrhoeae*, Souce [PHIL #3798](#)

# Prokaryotes - Cell Shapes

Most bacteria are classified according to shape:

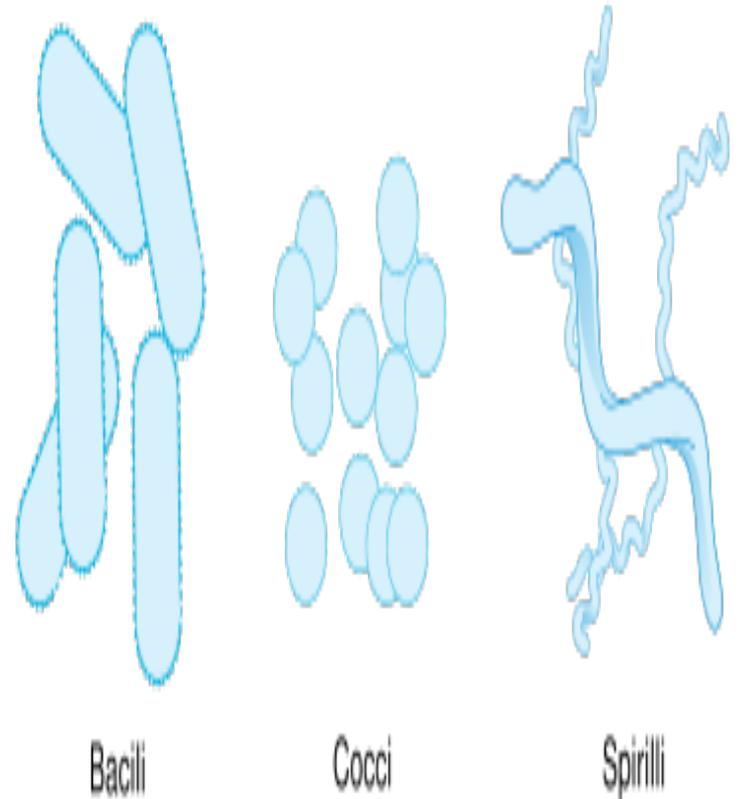
1. **bacillus** (*pl. bacilli*) = rod-shaped

2. **COCCUS** (*pl. cocci ... sounds like cox-eye*) = spherical

3. spiral shaped

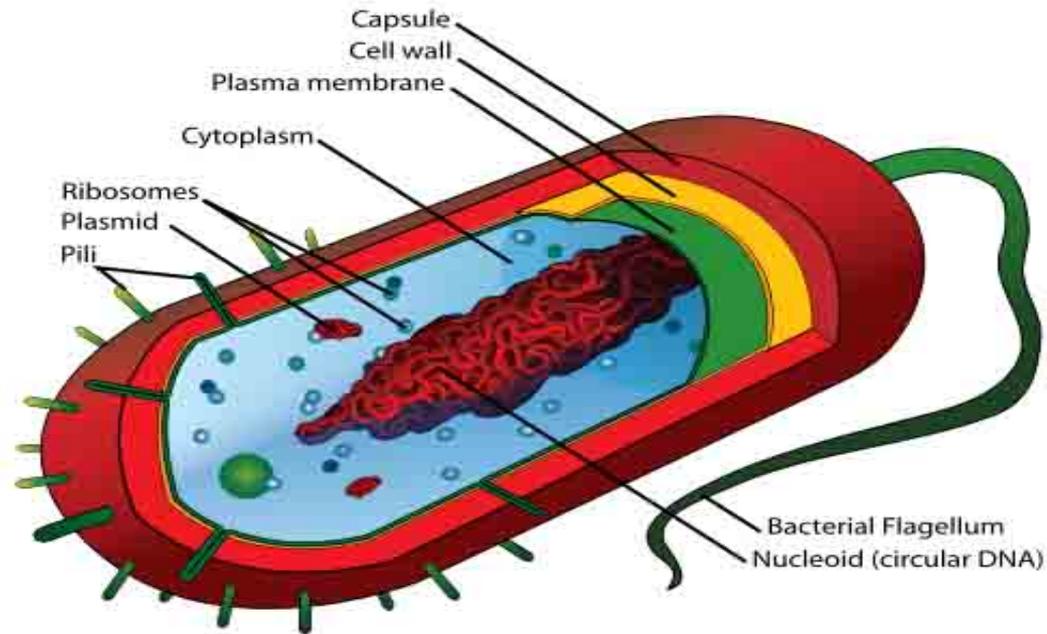
a. **spirillum** (*pl. spirilla*) = spiral with rigid cell wall, flagella

b. **spirochete** (*pl. spirochetes*) = spiral with flexible cell wall, axial filament

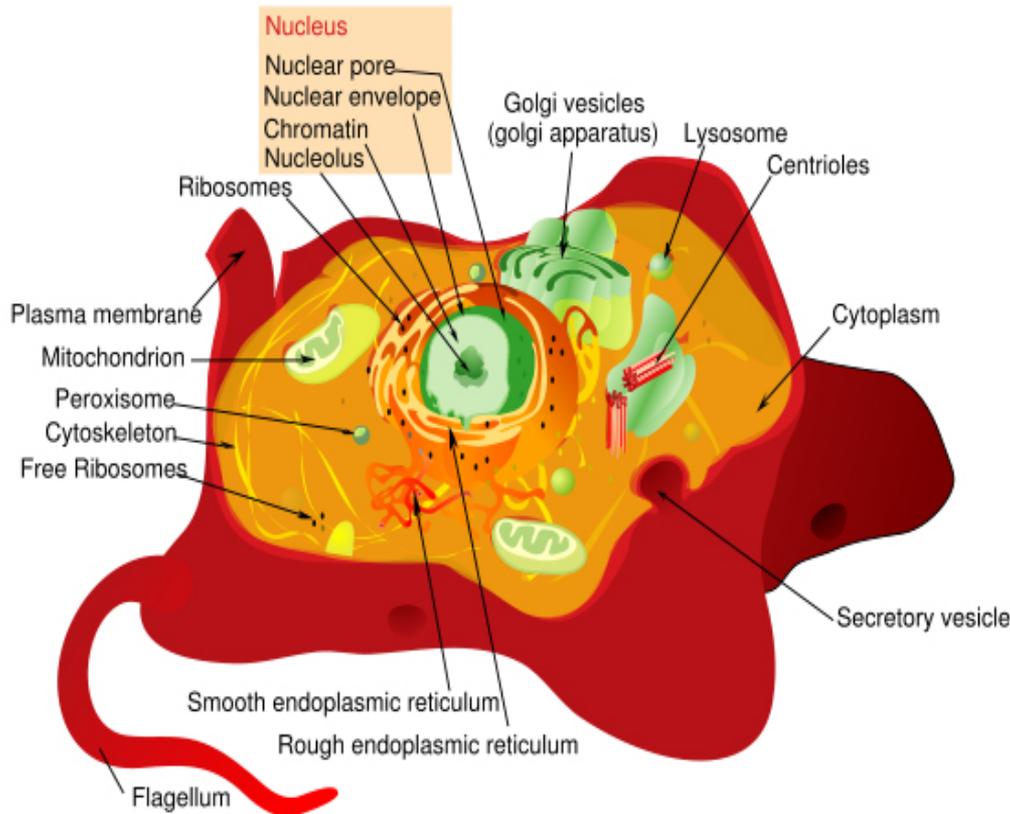


# REVIEW!

Here's an excellent interactive lesson on [Prokaryote Cell Structure](#)

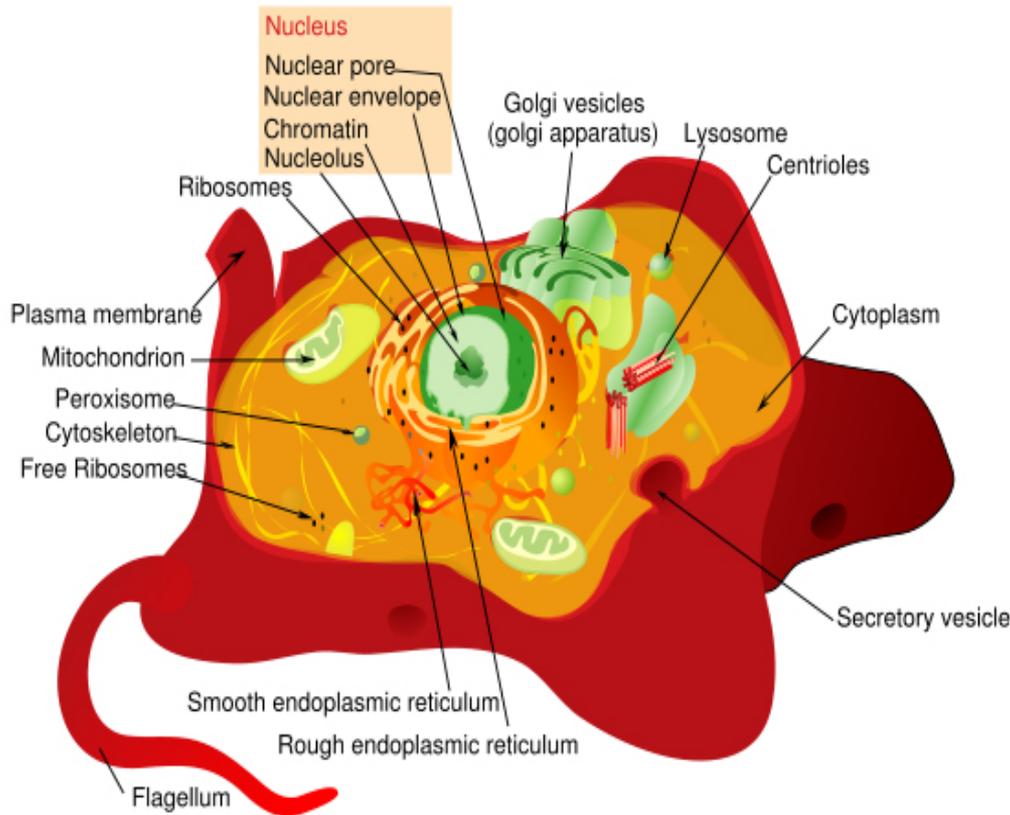


# Eukaryotic Cells



- Eu = "true", karyon = "nucleus"
- Genetic material contained in a nuclear membrane.
- Membrane bound organelles.
- Include animal, plant, fungi, algae cells as well as other microscopic eukaryotes.
- Evolved from prokaryotic cells.

# Eukaryotic Cells



- Eu = "true", karyon = "nucleus"
- Genetic material contained in a nuclear membrane.
- Membrane bound organelles.
- Include animal, plant, fungi, algae cells as well as other microscopic eukaryotes.
- Evolved from prokaryotic cells.

# Eukaryotic Genomes

- Like prokaryotes, and all living things, their genome is made of DNA.
- May include several to many linear chromosomes within a membrane-bound nucleus.
- **Q: How many chromosomes do humans have?**
- Replication (duplication of DNA prior to cell division) occurs in all living things.
- Two locations of eukaryotic DNA
  - Nuclear DNA
  - Extranuclear DNA

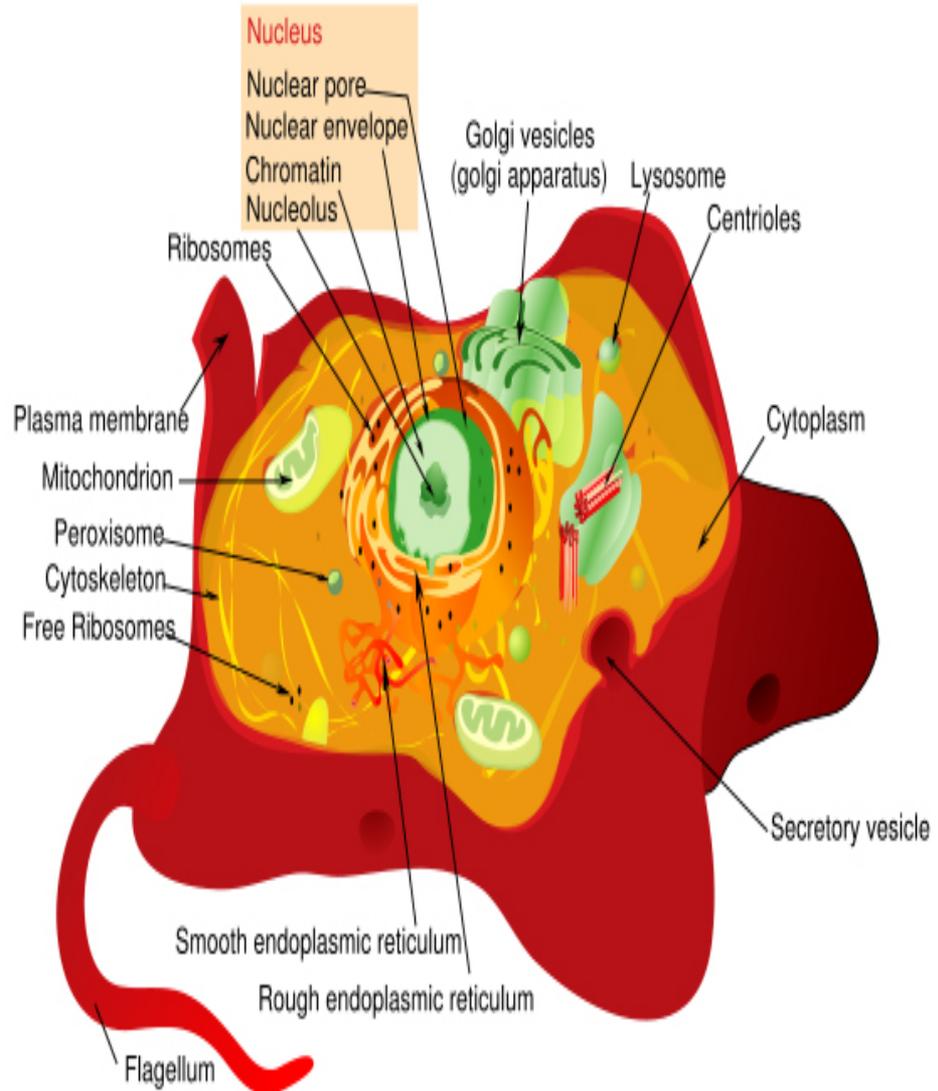


# Cytoplasm

**Nicknames:** The Matrix,  
Molecular Chowder

- Fills the space between the plasma membrane and the nuclear membrane
- A water-like substance that fills cells.
- 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.

**Q: Eukaryotes? Prokaryotes? Both?**

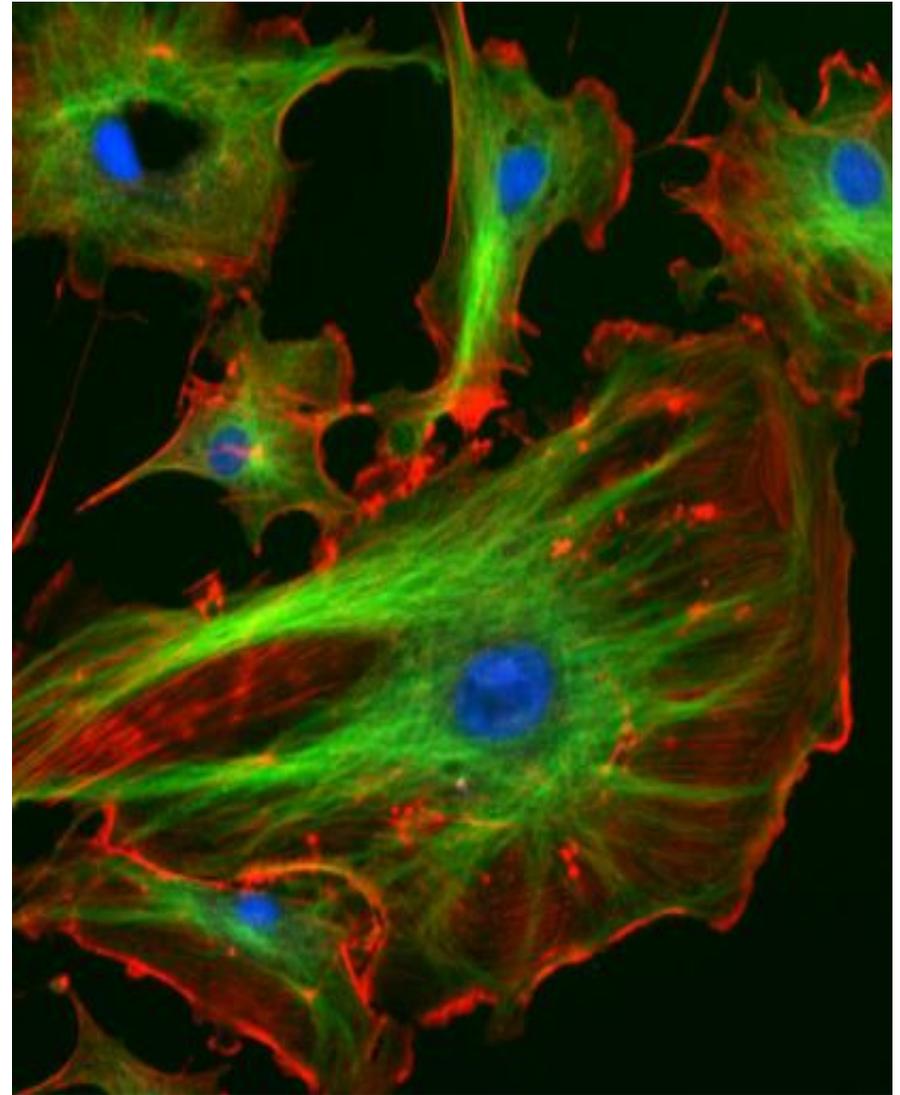


# Cytoskeleton

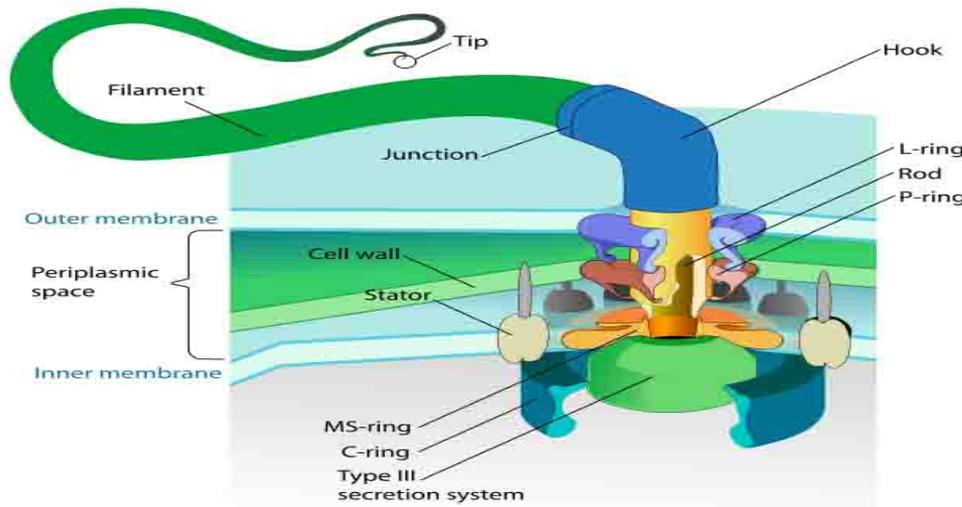
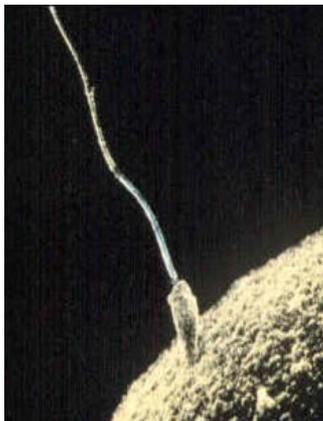
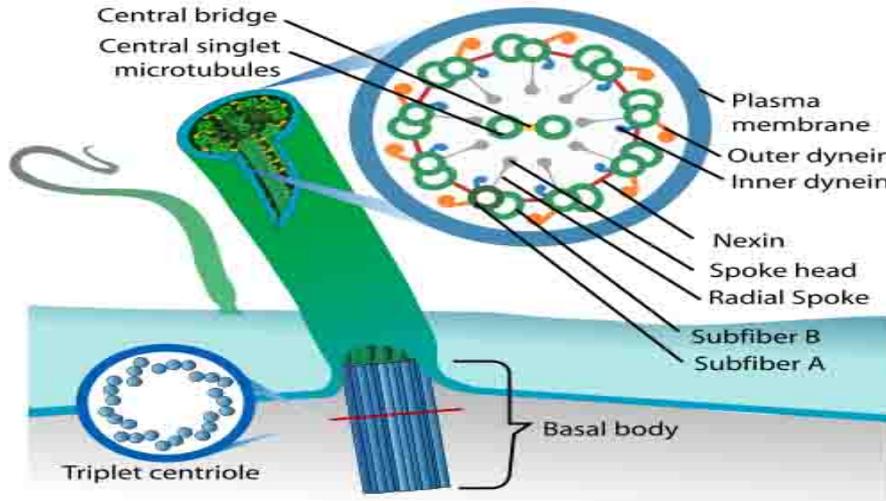
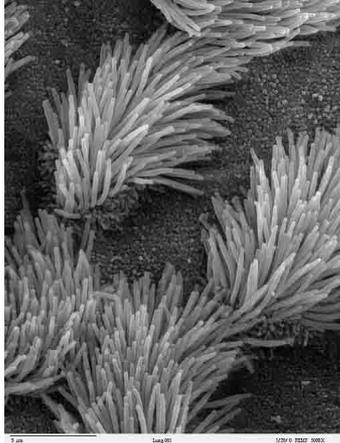
Nicknames: Scaffolding,  
Highways

- Maintains cell shape.
- Protects the cell.
- Enables some cell movement (using structures such as flagella and cilia).
- Plays important roles in intracellular transport (the movement of vesicles and organelles).
- Plays important role in [cell division](#).

**Q:** Eukaryotes? Prokaryotes? Both?



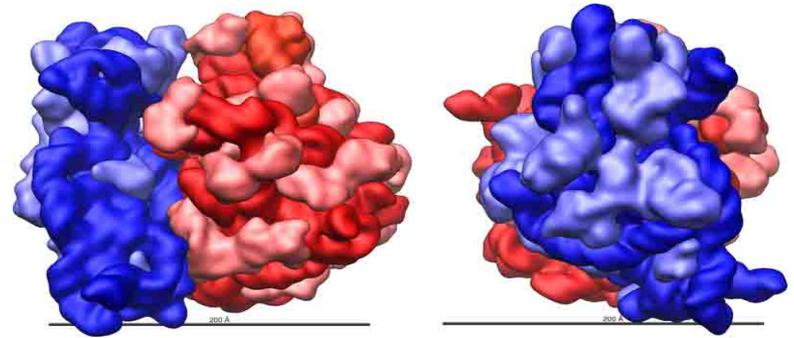
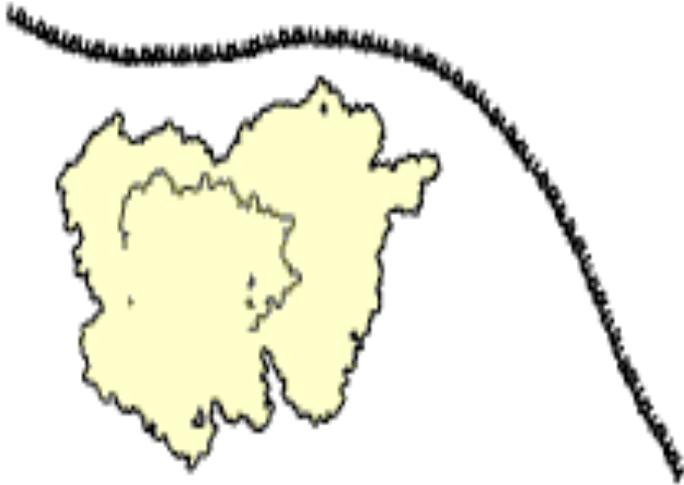
# Cilia & Flagella



- External appendages from cell membrane.
- Aid in locomotion of the cell or movement of materials near cell.
- Motility > coordinated sliding movements of microtubules.
- Both Prokaryotes & Eukaryotes can have external appendages, but are constructed differently.
- **Eukaryotes** may have flagella or cilia (components of cytoskeleton covered with plasma membrane).
- **Prokaryotes** may have flagella, endoflagella, **fimbriae** or pili (composed of proteinaceous molecules and not covered with plasma membrane).

# Ribosomes

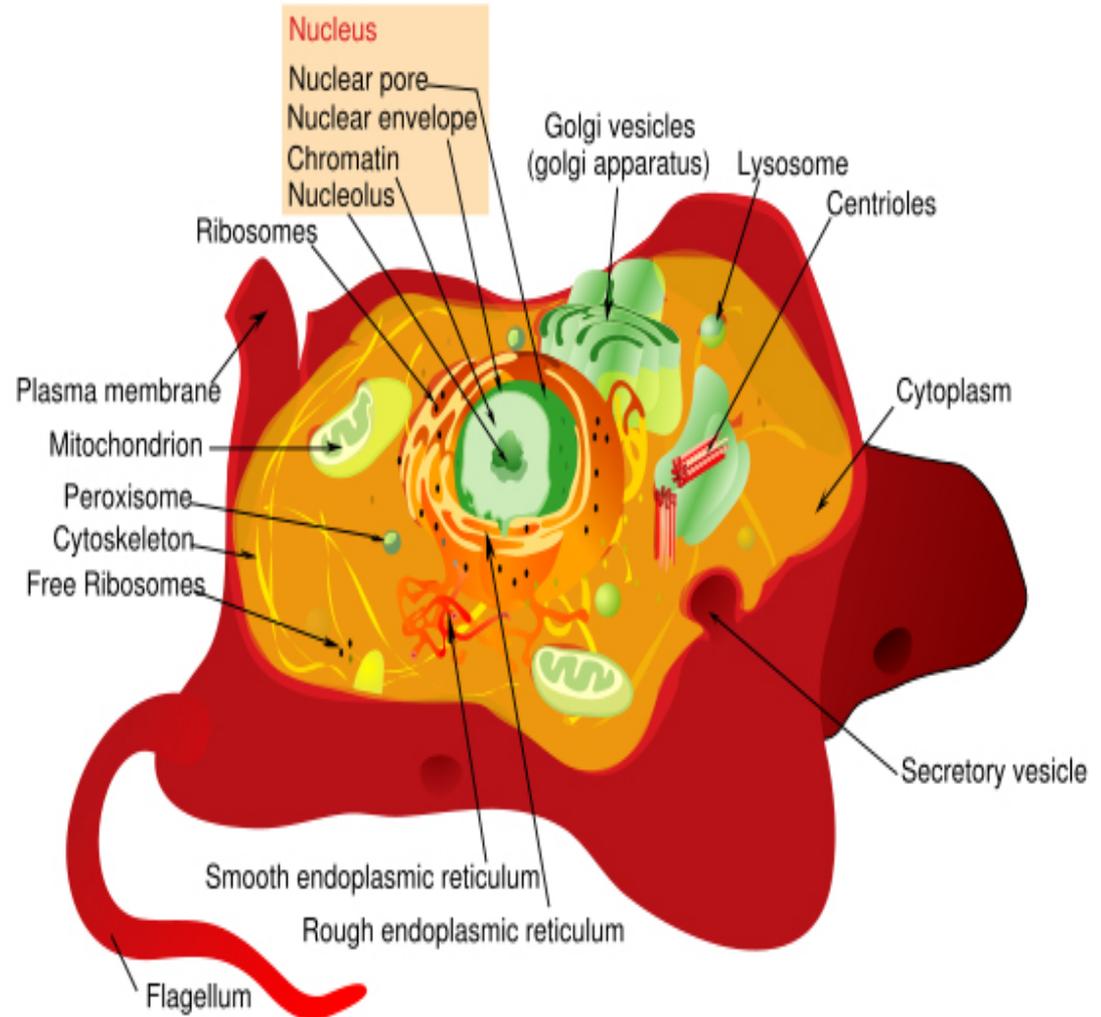
[Click here](#) for animation of ribosome building a protein.



- **Q:** What do ribosomes do?
- **Q:** What are they made of?
- Can be found alone in the cytoplasm, in groups called **polyribosomes**, or attached to the endoplasmic reticulum.
- **Q:** Eukaryotes? Prokaryotes? Both?

# Membrane-bound Organelles

- Eukaryotic cells have many organelles.
- Prokaryotes only have ribosomes, which are not bound by a membrane.
- Membrane-bound eukaryotic organelles organize functions within the cell.



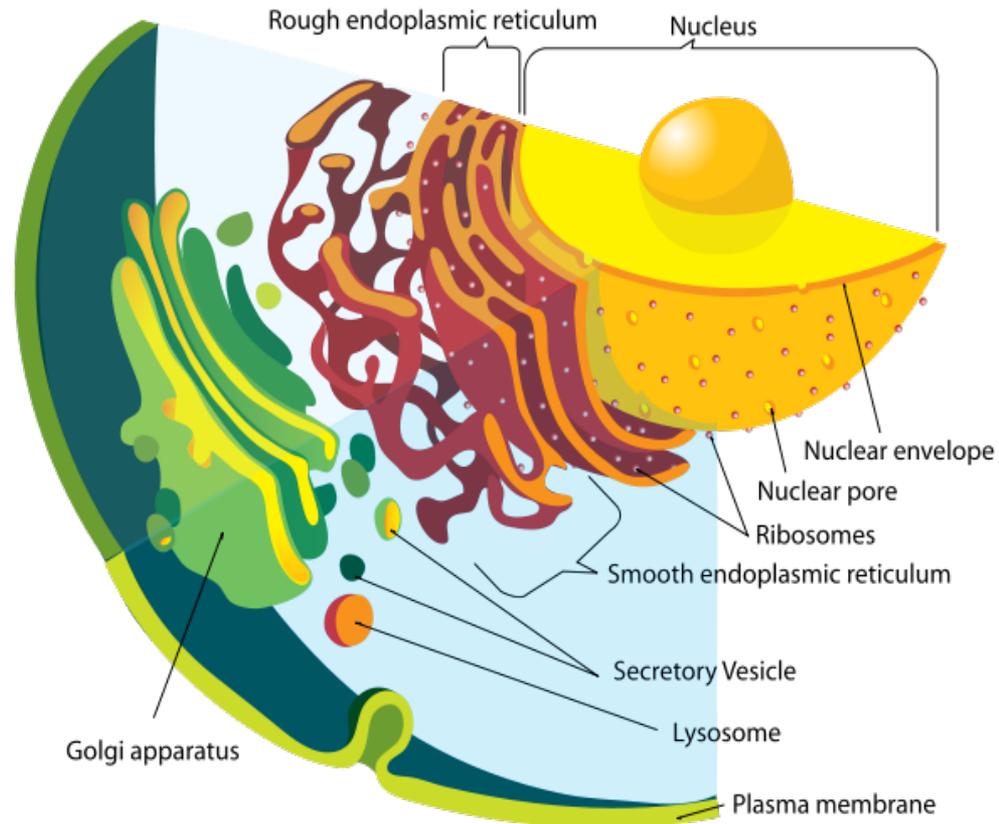
System of internal membranes within eukaryotic cells that divide the cell into compartments, or organelles.

Transport system, for moving molecules, into, out of, and through interior of cell, as well as interactive surfaces for lipid and protein synthesis.

Membranes of the endomembrane system are made of a lipid bilayer, with proteins.

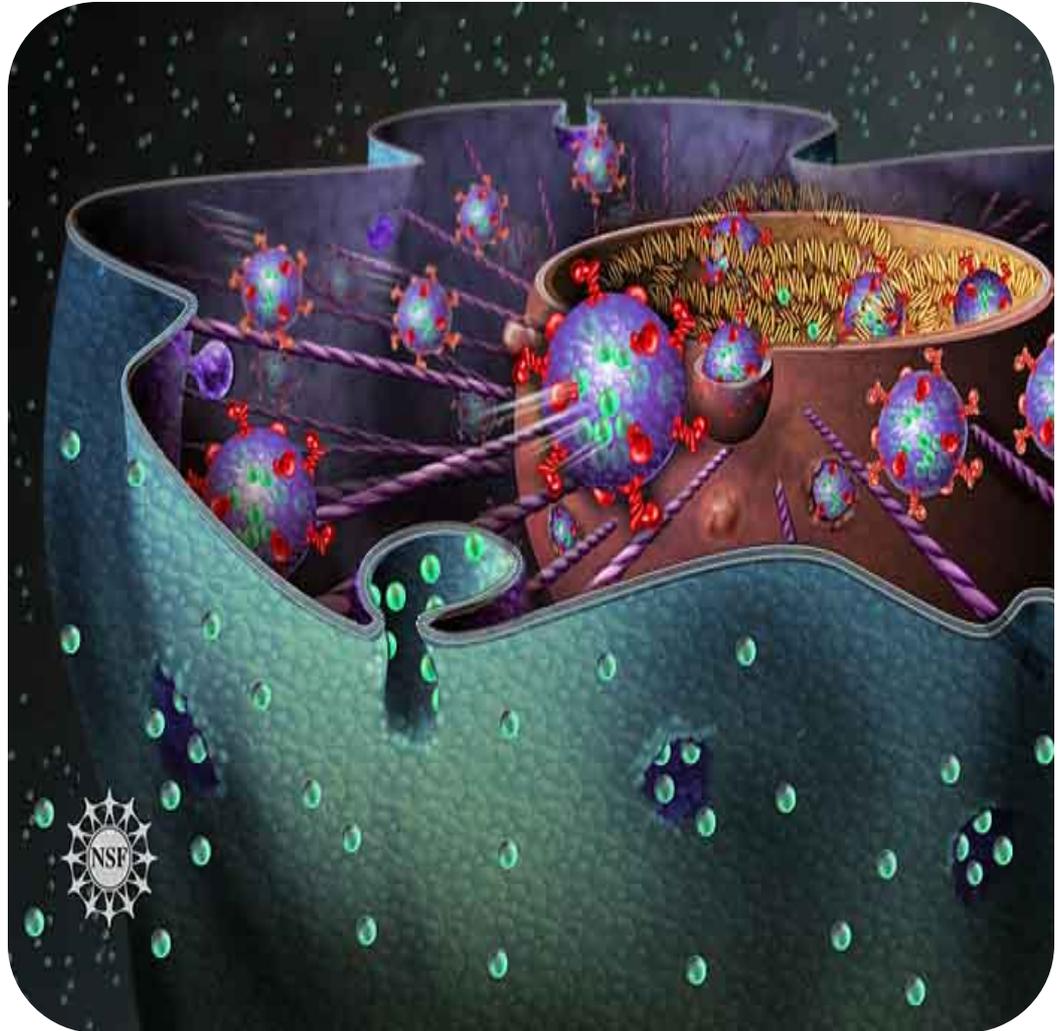
The **Endomembrane System** consists of:

1. nucleus
2. endoplasmic reticulum
3. Golgi apparatus
4. vesicles
5. lysosomes
- 6... **Q**: What other membranous part of the cell should also be included in this list?



# Endomembrane System

Let's watch an  
animation  
on the  
eukaryotic  
Endomembrane  
System.

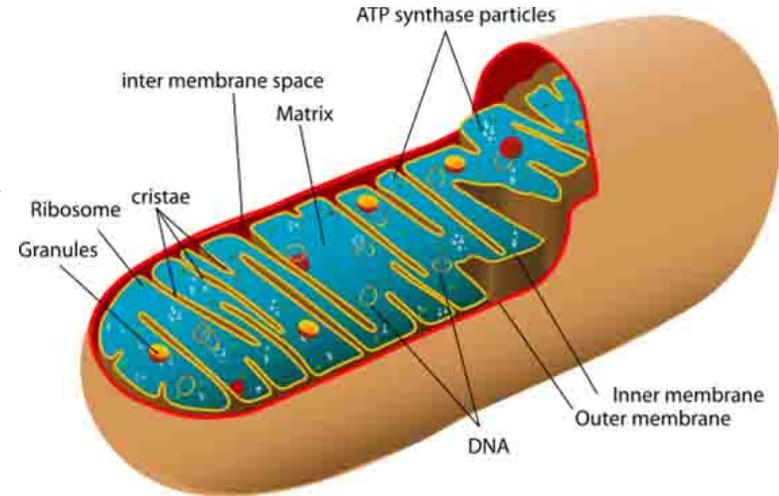


# Organelles: Energy-Related

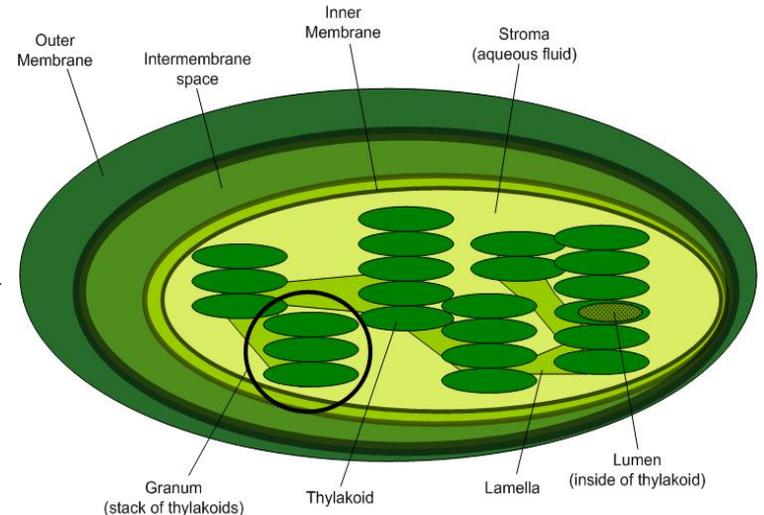
## Mitochondria & Chloroplast

- Both organelles house energy in the form of **ATP**.
- Both ancestrally were independent cells that formed a symbiotic relationship with other cells.
- **Q: Eukaryotes? Prokaryotes? Both?**

*Found in nearly all eukaryotes*



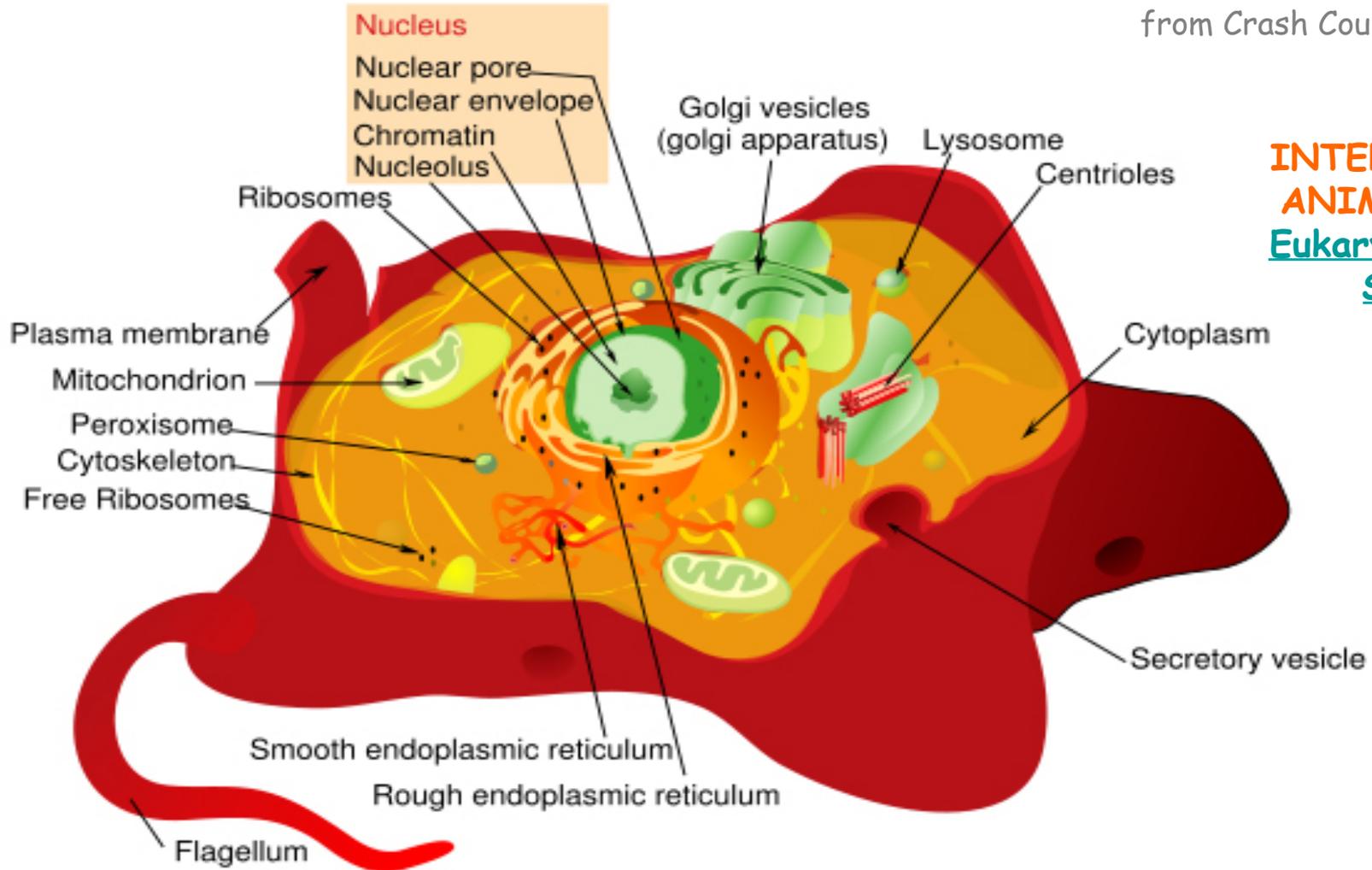
*Found in plants & algae & some microbes*



# Animal Cell (Eukaryote)

**VIDEO:**  
[Eukaryopolis: The City of Animal Cells](#)  
from Crash Course Biology

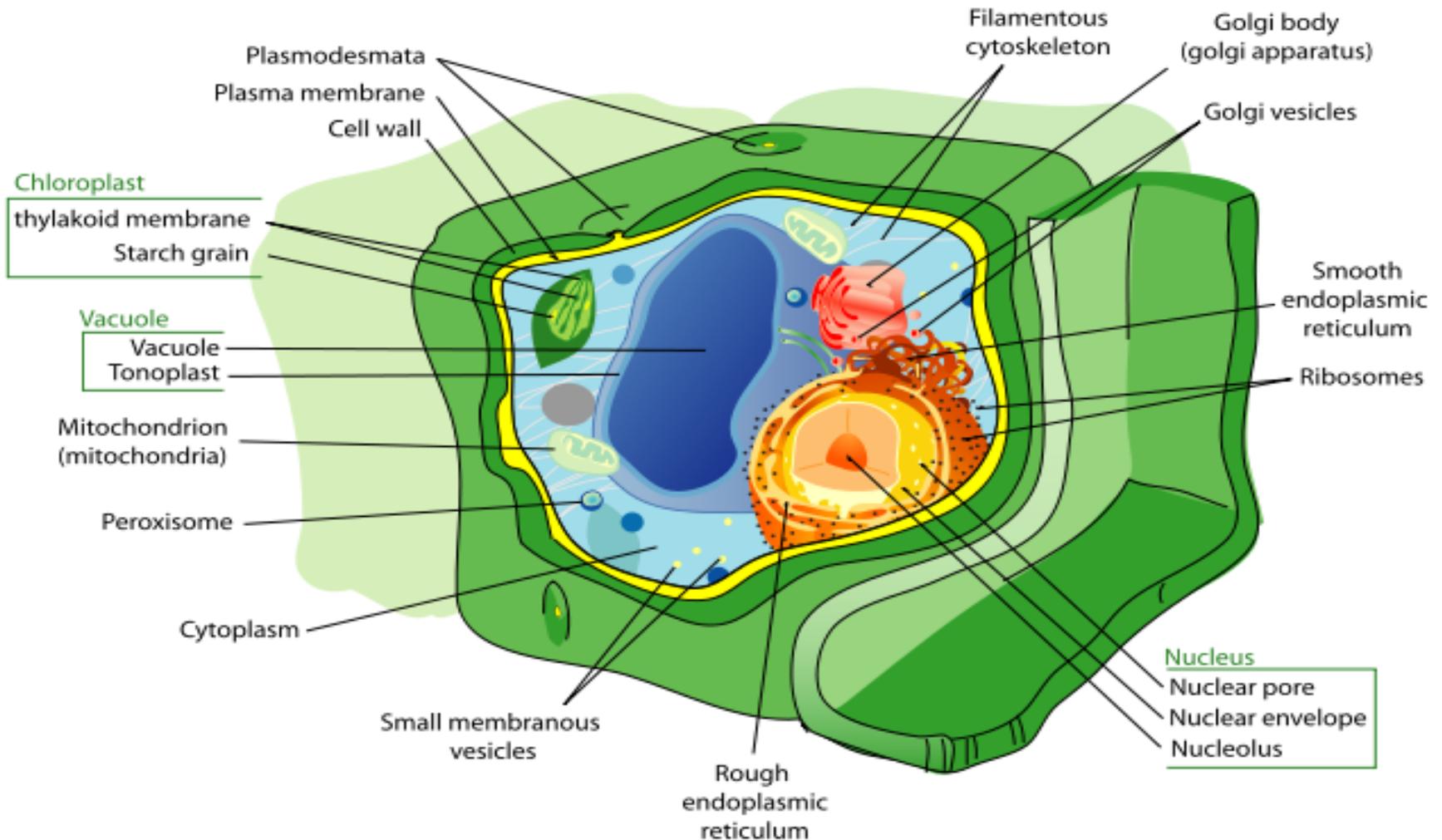
**INTERACTIVE ANIMATION:**  
[Eukaryotic Cell Structure](#)



# Plant Cell (Eukaryote)

**VIDEO:**  
Plant Cells

from Crash Course Biology



# Confused?

Here are some links to fun resources that further explain **Prokaryotic Cell Biology**:

Smart Links

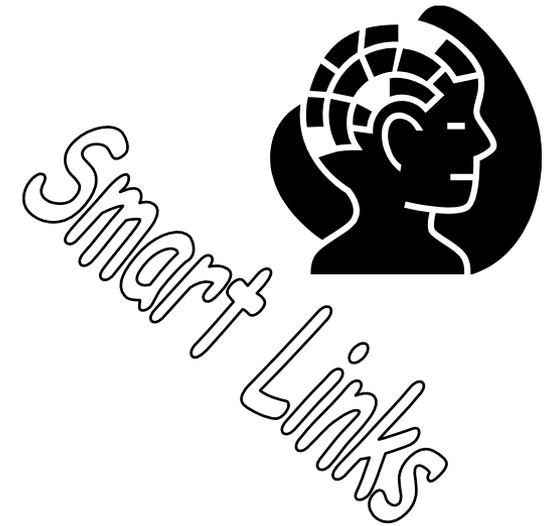


- [Prokaryotic Cells Main Page](#) on the Virtual Cell Biology Classroom of [Science Prof Online](#) website.
- [Prokaryotic Cell](#): Structures, Functions & Diagrams, an article from SPO.
- [Prokaryotic & Eukaryotic](#): Two Types of Biological Cells, an article from SPO.
- [Prokaryotic Cell](#) interactive diagram from [Cells Alive](#) website.
- ["How big is a..."](#) interactive diagram from [Cells Alive](#) website.
- [Cell Structure](#) tutorials and quizzes from Interactive Concepts in Biochemistry.
- ["Germs"](#). Music by Weird Al Yankovic. Video by RevLucio.
- [Evolution of the Three Domains](#) Animated Science Tutorial.
- Biology4Kids - [Cell Biology Main Page](#) by Raders.
- ["She Blinded Me With Science"](#) music video Thomas Dolby.

(You must be in PPT slideshow view to click on links.)

# Confused?

Here are some links to fun resources that further explain **Eukaryotic Cell Biology**:



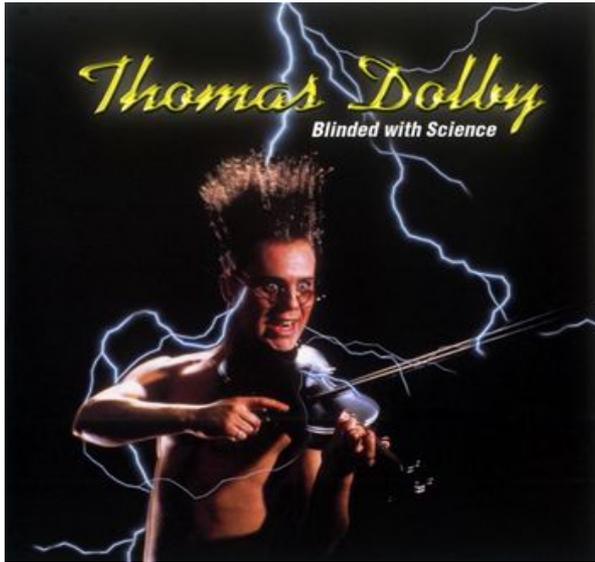
- [Cell Structure: Eukaryotes Main Page](#) on the Virtual Cell Biology Classroom of [Science Prof Online](#).
- ["Cells"](#) music video by They Might Be Giants.
- [Prokaryotic & Eukaryotic: Two Types of Biological Cells](#), an article from SPO.
- [Eukaryotic Cell: Structures, Functions & Diagrams](#) article from SPO.
- [Cell Structure](#) tutorials and quizzes from Interactive Concepts in Biochemistry.
- [Cells Alive](#) interactive website.
- [Eukaryotic Cell Tour](#) an Animated Science Tutorial.
- [Endoplasmic Reticulum & Golgi Apparatus](#) animation and quiz.
- [Endomembrane System](#) animation and quiz.
- ["The Cell Song"](#) lyrics by The Cell Squad, Freedom Middle School, Nashville, TN.
- [Endocytosis / Exocytosis](#) animation from McGraw Hill.
- [Evolution of the Three Domains](#) Animated Science Tutorial.
- Biology4Kids - [Cell Biology Main Page](#) by Raders.

(You must be in PPT slideshow view to click on links.)

Are you feeling blinded by science?

*Do yourself a favor. Use the...*

# Virtual Biology Classroom (VCBC)!



The VBC is full of resources to help you succeed,  
including:



- practice test questions
- review questions
- study guides and learning objectives
- PowerPoints on other topics

You can access the VCBC by going to the Science Prof Online website  
[www.ScienceProfOnline.com](http://www.ScienceProfOnline.com)