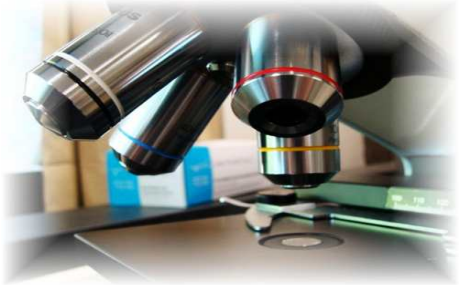

About Science Prof Online PowerPoint Resources

• 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 (.ppt), as well as uneditable versions in smaller file sizes, such as PowerPoint Shows (.pps) and Portable Document Format (.pdf), for ease of printing. The font "Jokerman" is used frequently in titles. It has a microbiology feel to it. If you do not have this font, some titles may appear odd, oversized and off-center. Find free downloads of Jokerman by Googling "download jokerman font microsoft".

• 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. PPT files 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.

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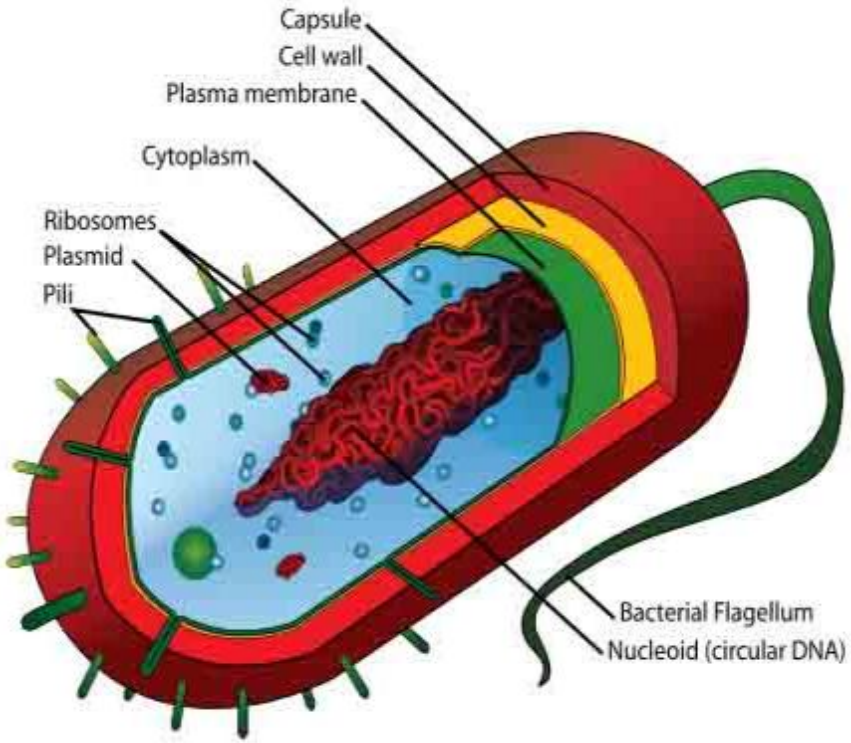
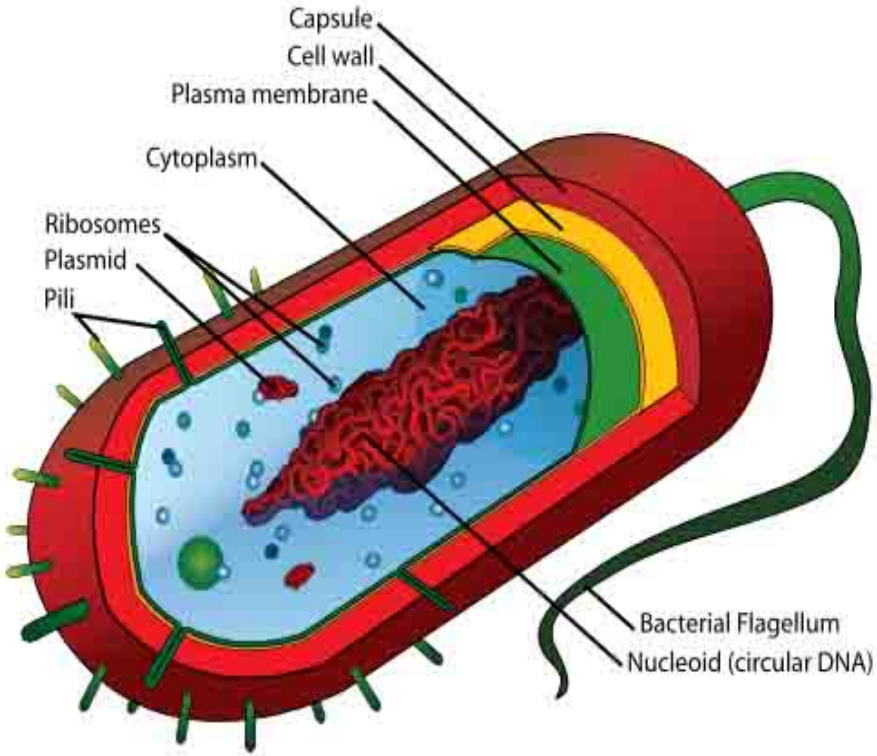
Image: Compound microscope objectives, T. Port

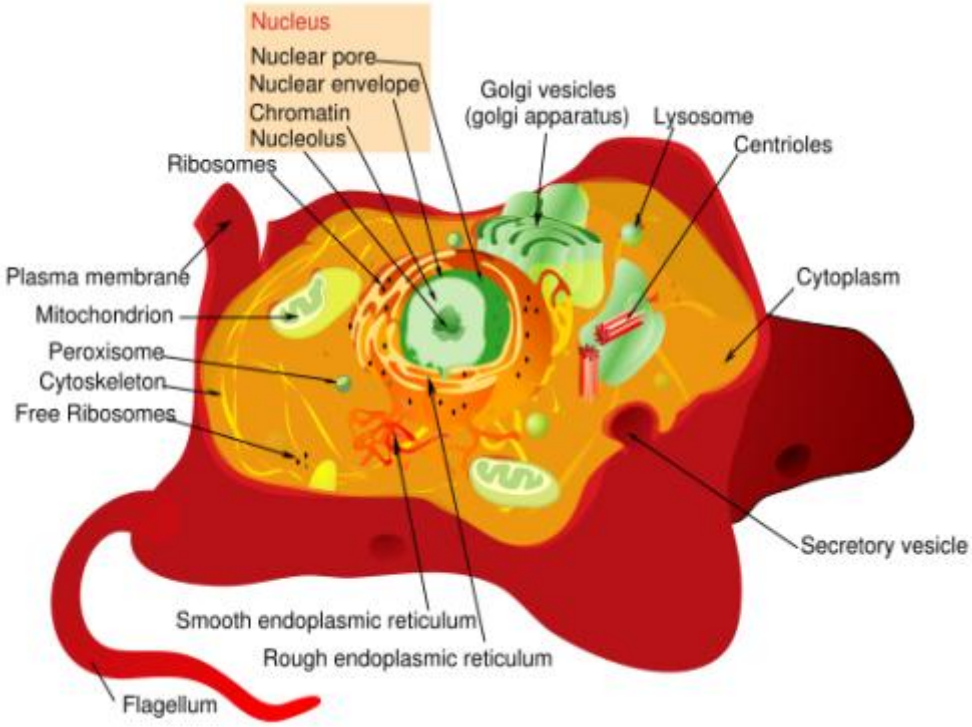


Prokaryotic Cell Structure & Function

Image: Prokaryotic cell diagram: M. Ruiz

Two Basic Types of Cells





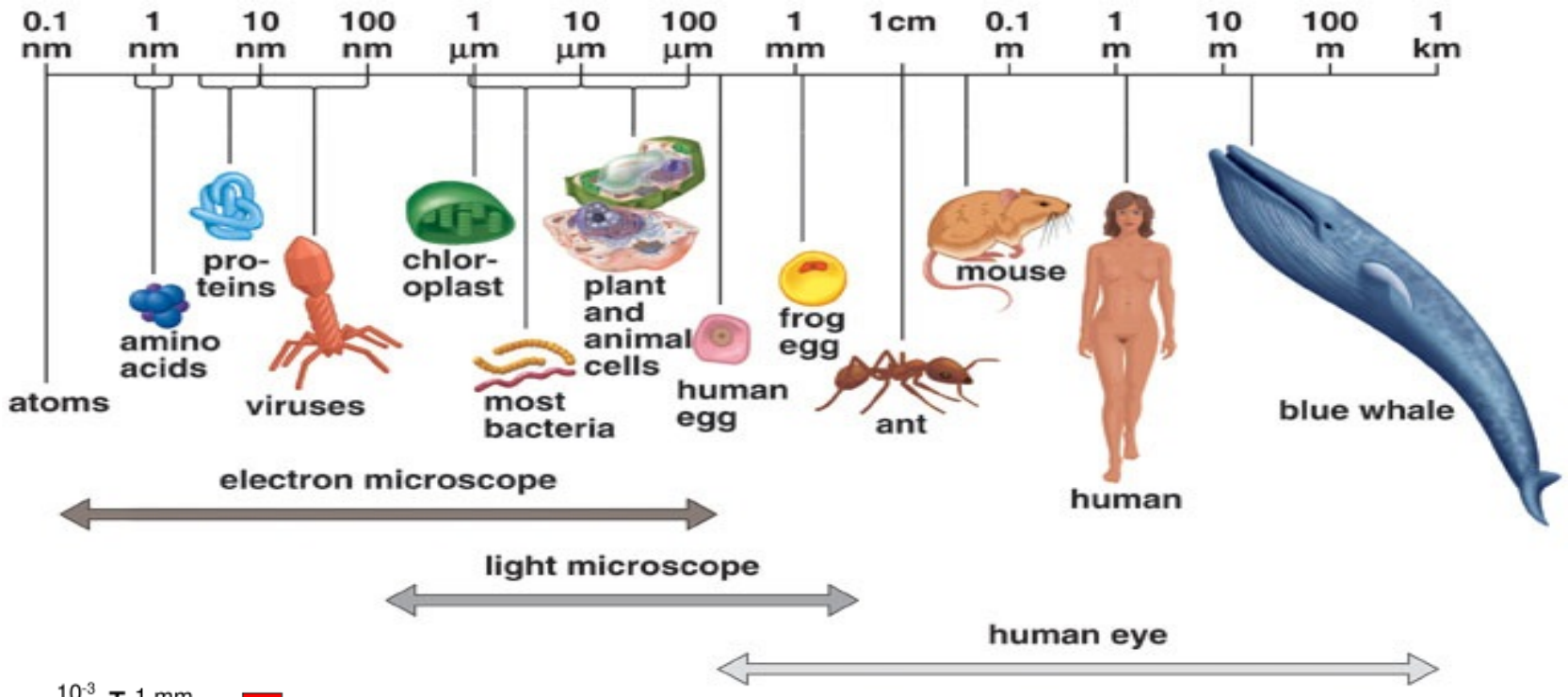
Prokaryotic Cell

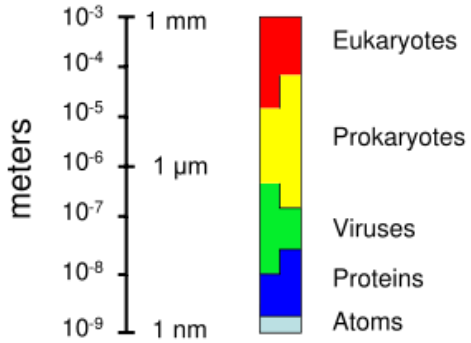
Eukaryotic Cell

From the Virtual Microbiology Classroom on ScienceProfOnline.com

Images: Prokaryotic cell diagram & Eukaryotic cell diagram, M. Ruiz

Size of Living Things





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

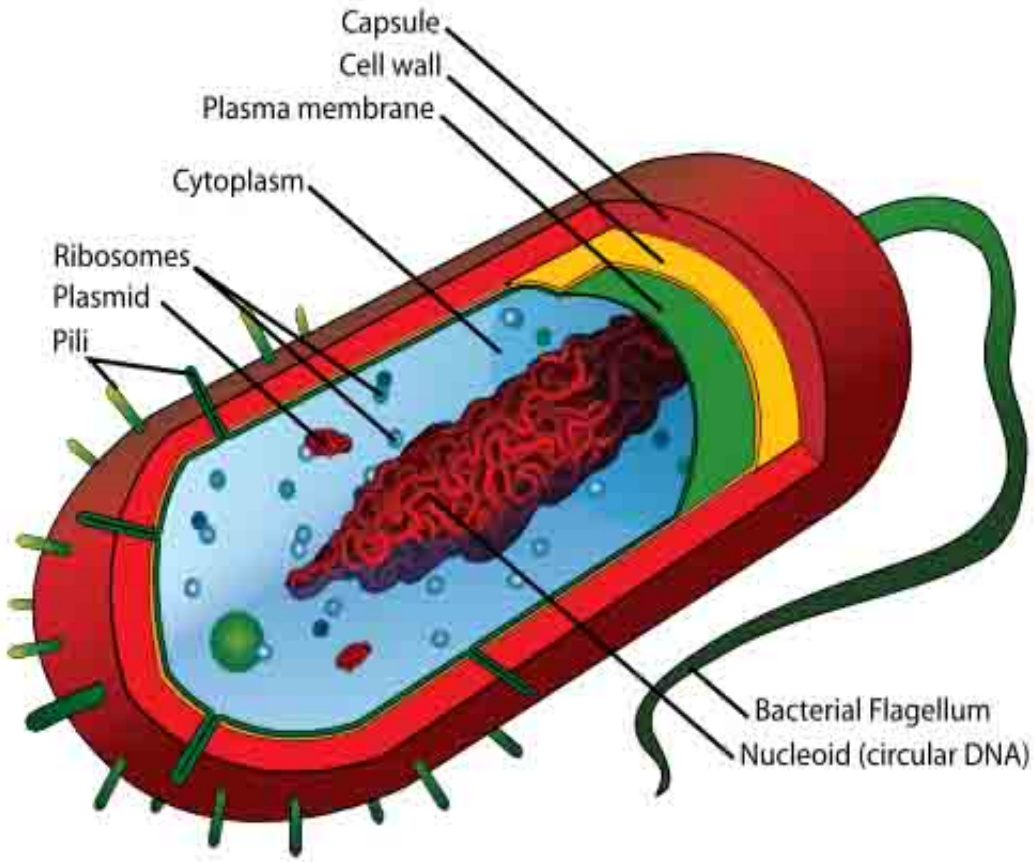
1mm = 1000 μm = 1000000nm

1 μm = 1000nm

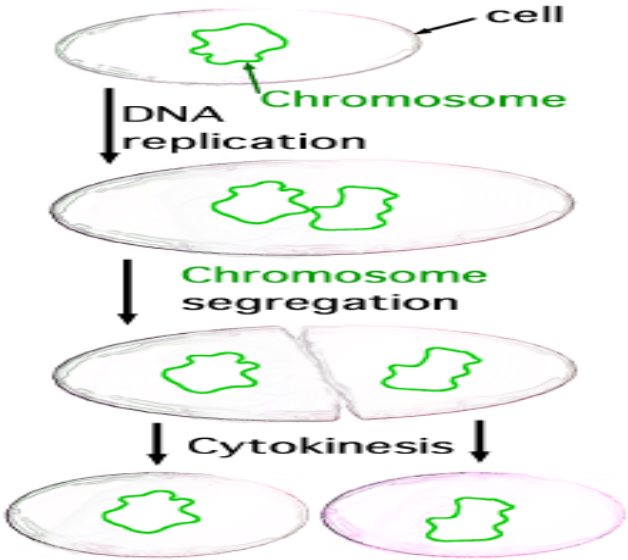
Click link for an interactive "Size of Microscopic Things" animation on Cells Alive.

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.)

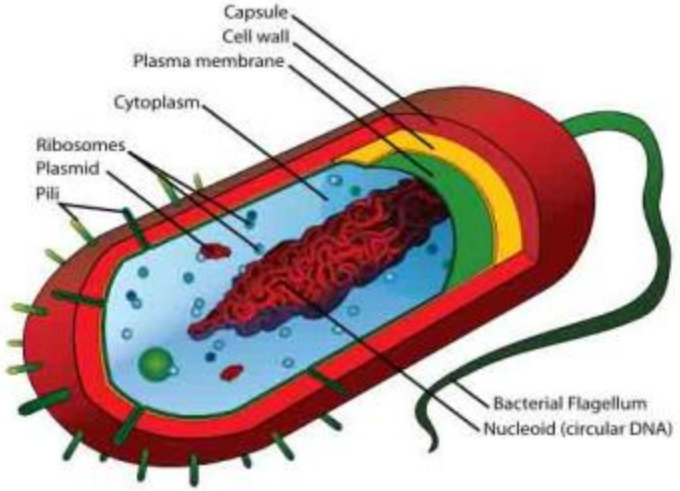
Binary Fission Animation
from ClassZone

Binary Fission Animation
From McGraw-Hill

From the Virtual Microbiology Classroom on ScienceProfOnline.com

Images: Prokaryotic cell diagram, M. Ruiz, Binary fission, JW Schmidt

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:

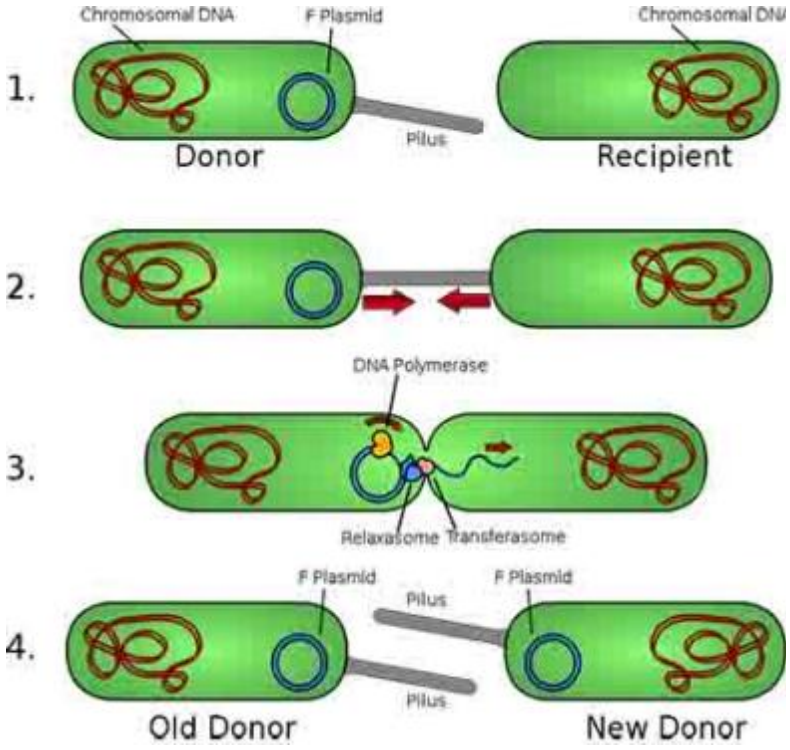
  - Antibiotic resistance

  - 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)



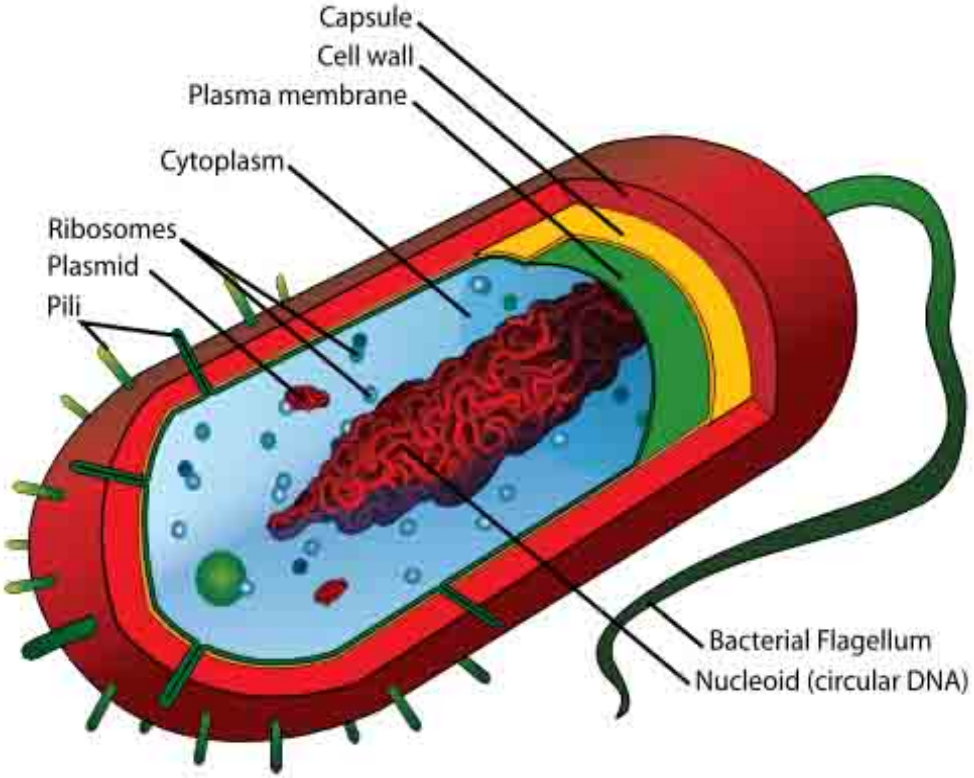
From the Virtual Microbiology Classroom on ScienceProfOnline.com

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.

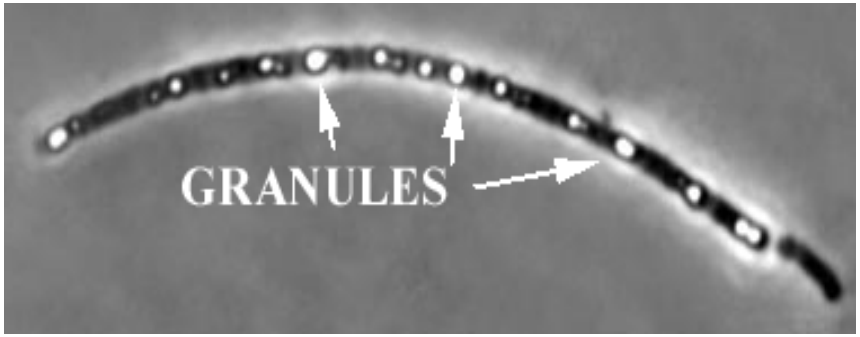


Image: Prokaryotic cell diagram: M. Ruiz, Granules, Source Unknown

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.

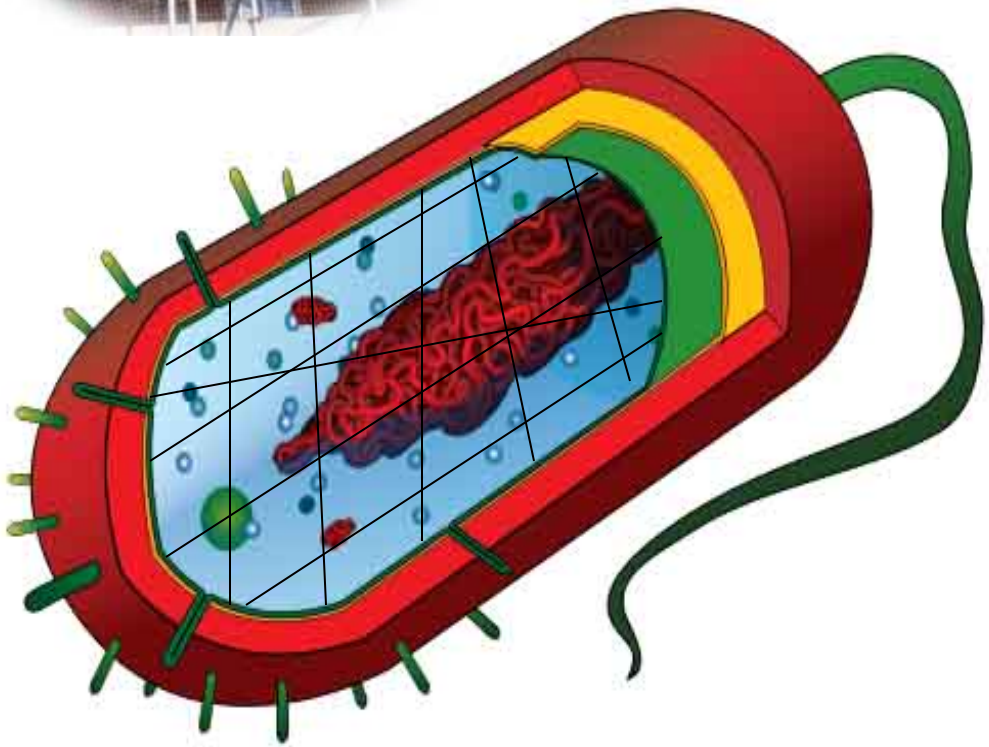
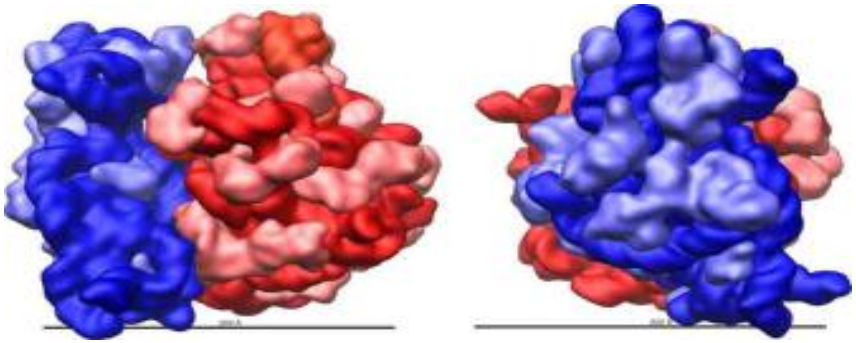


Image: Prokaryotic Cell: M. Ruiz

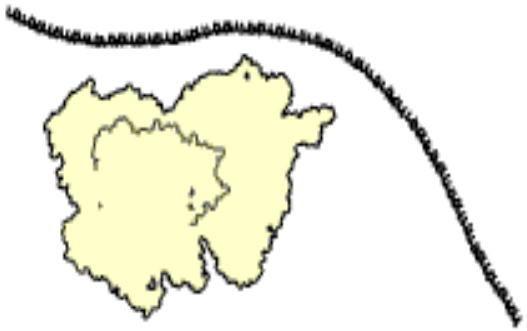
Prokaryotes

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.



Animation: Ribosome translating protein,Xvazquez; Ribosome Structure, Vegaman

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?

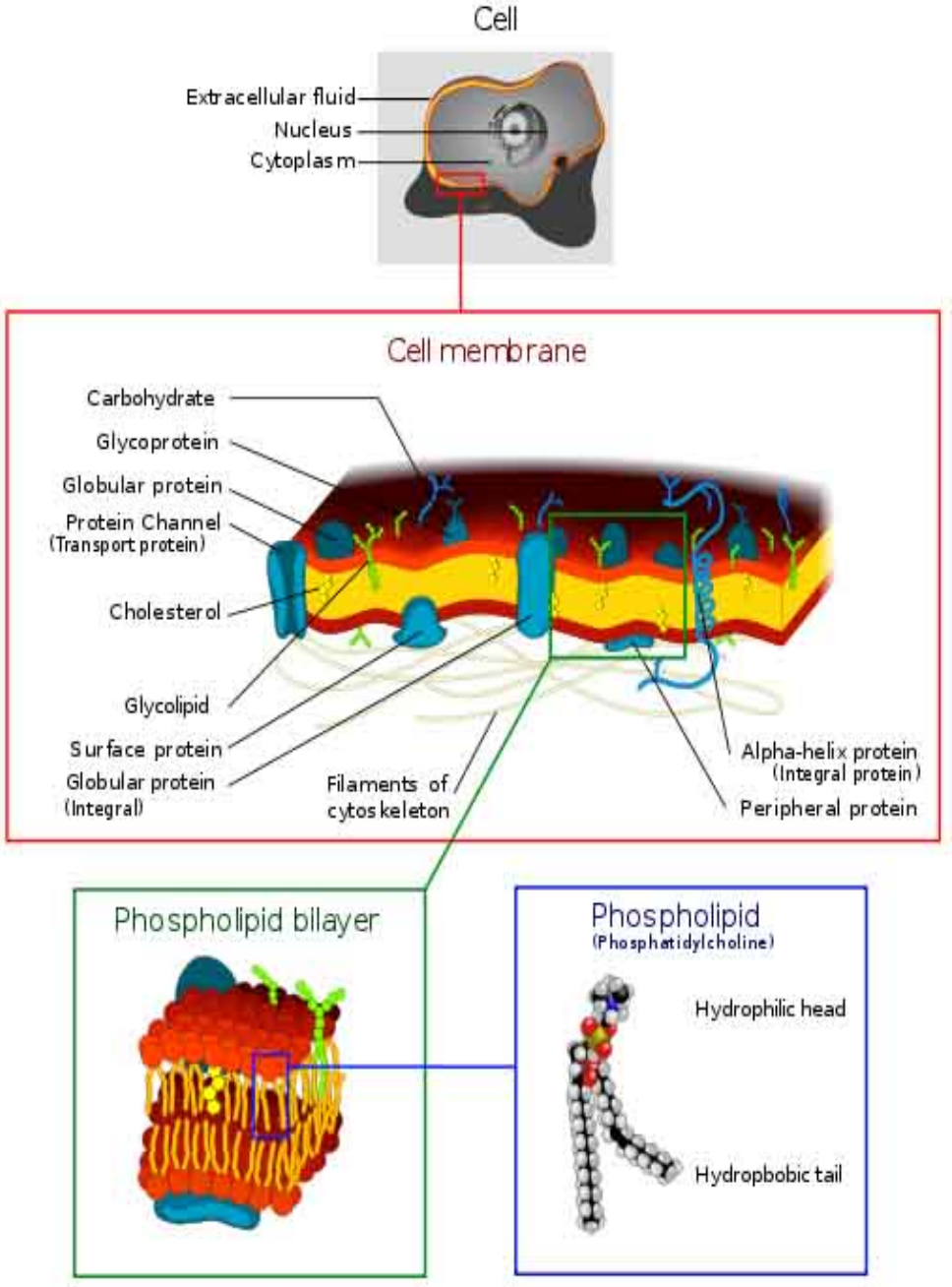


Image: Cell Membrane diagram, Dhatfield

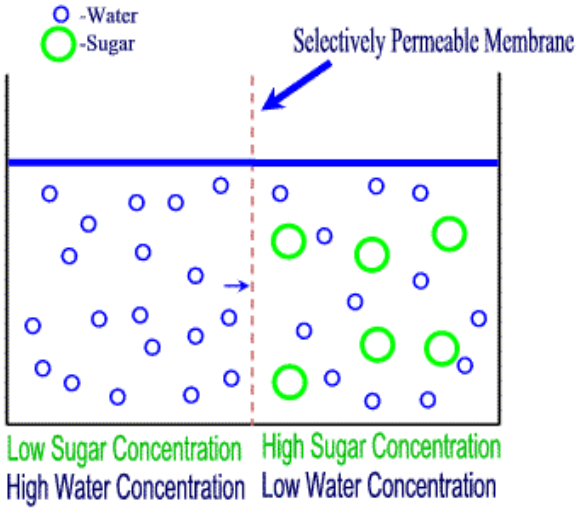
Prokaryotes – Plasma Membrane as a Barrier

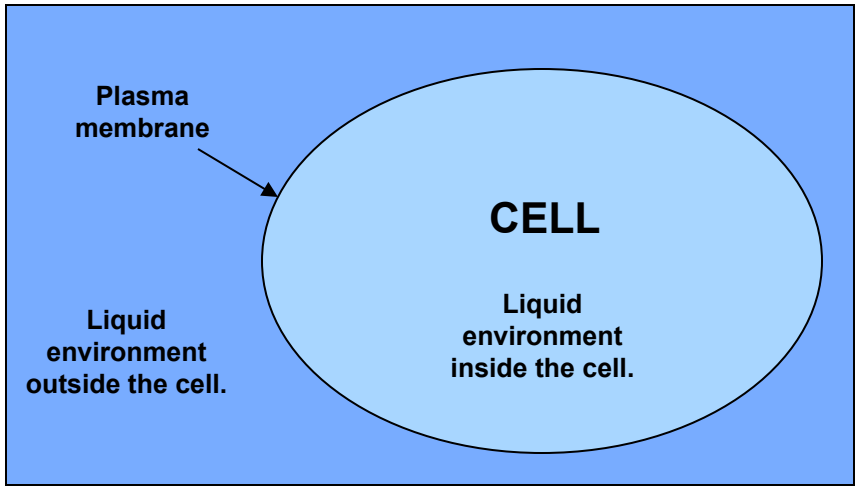
Osmosis

- Is the **diffusion** of **water** across a semi-permeable membrane.
- Environment surrounding cells may contain amounts of dissolved substances (solutes) that are…

- equal to
- less than
- greater than

…those found within the cell.





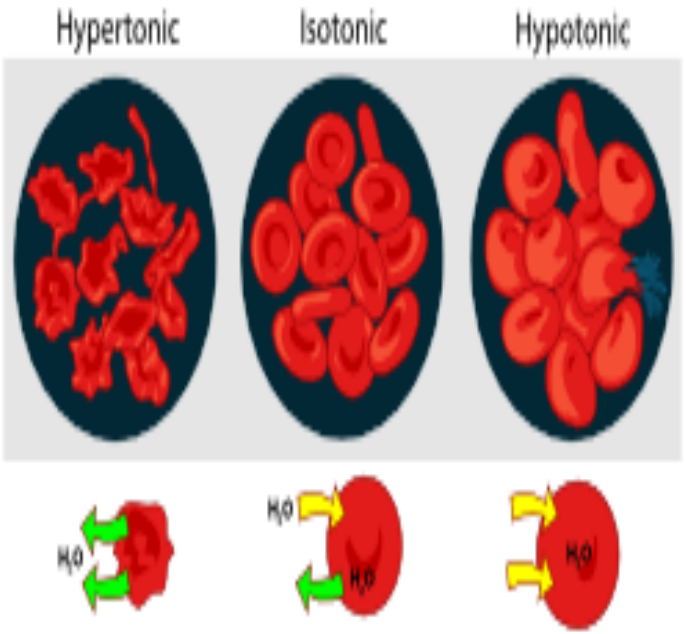
Images: Osmosis animation; Osmosis with RBCs, M. Ruiz

Prokaryotes – Plasma Membrane as a Barrier

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!!



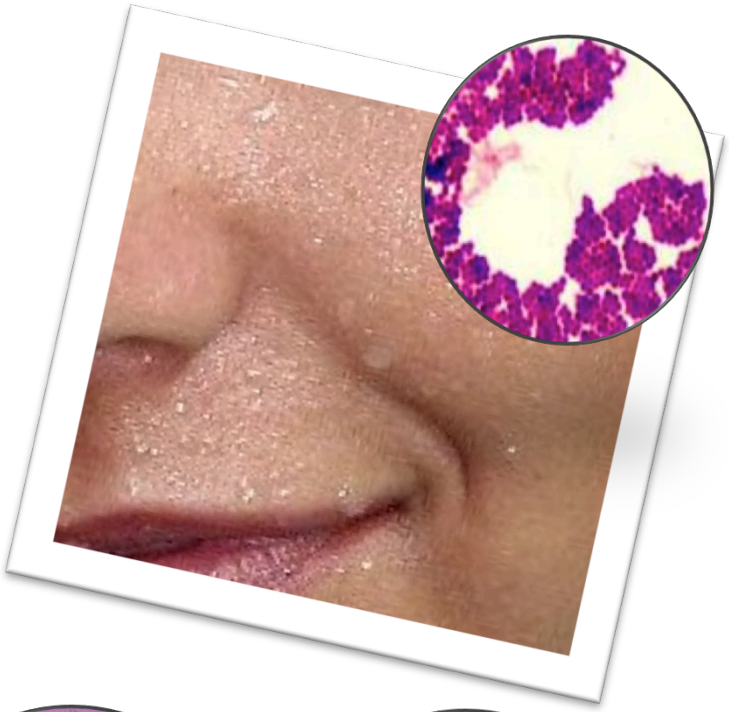
REVIEW!

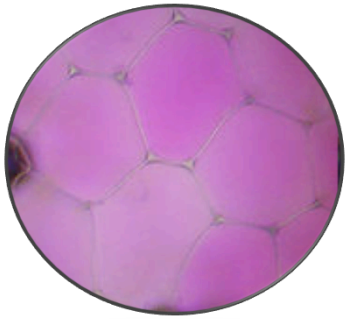
- How Osmosis Works animation
- Diffusion, Osmosis & Active Transport Lecture Main Page of the Virtual Cell Biology Classroom on the Science Prof Online website

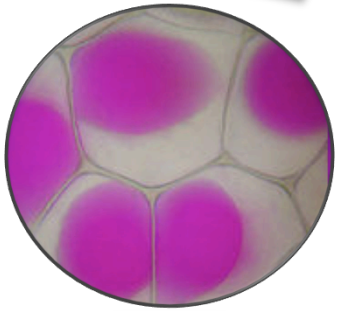
Images: Osmosis animation; Osmosis with RBCs, M. Ruiz

Cells & Water: Osmotic Pressure

- 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.
- You salty perspiration protects you from bacteria that cannot handle the high sodium chloride concentration.
- The water moves out of the bacterium and it dies of 'hyperosmostic shock' (desiccation).







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

Images: Water drop; Sweat on face of runner; *Staphylococcus*, T. Port; Cells, full of water versus plasmolyzed, Mnolf, Wiki

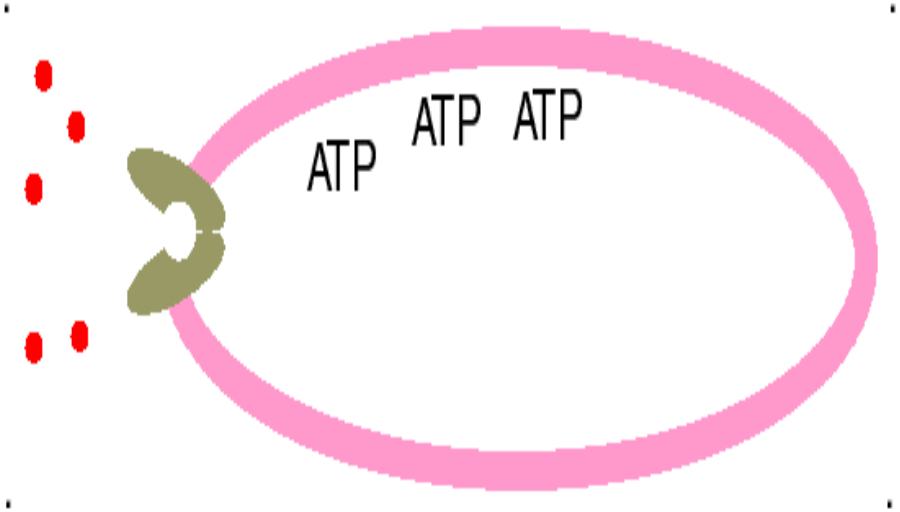
From the Virtual Microbiology Classroom on ScienceProfOnline.com

Plasma Membrane as a Barrier

ACTIVE TRANSPORT

- How most molecules move across the plasma membrane.
- Analogous to a pump moving water uphill.
- Types of active transport are classified by type of energy used to drive molecules across membranes.
- **ATP Driven Active Transport**

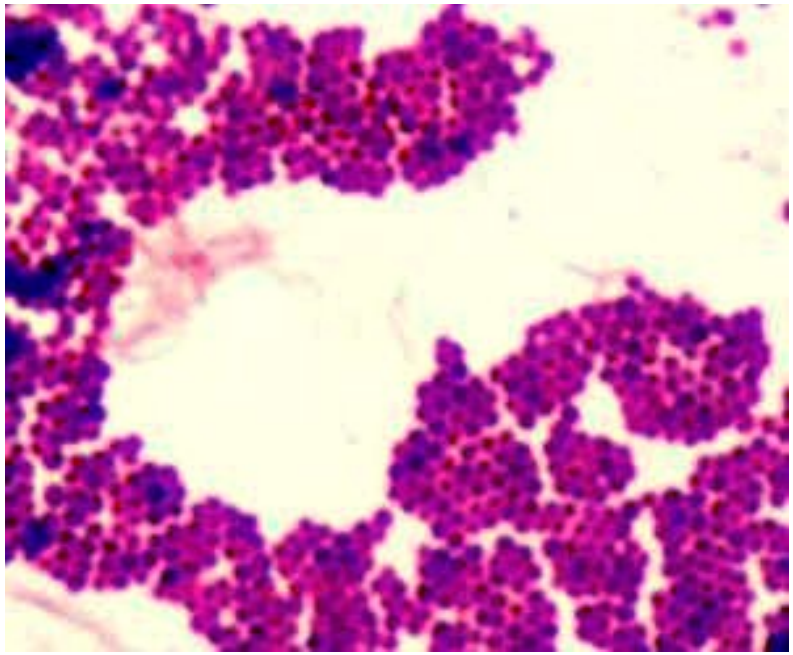
  Energy from adenosine triphosphate (ATP) drives substances across the plasma membrane with the aid of carrier molecules.



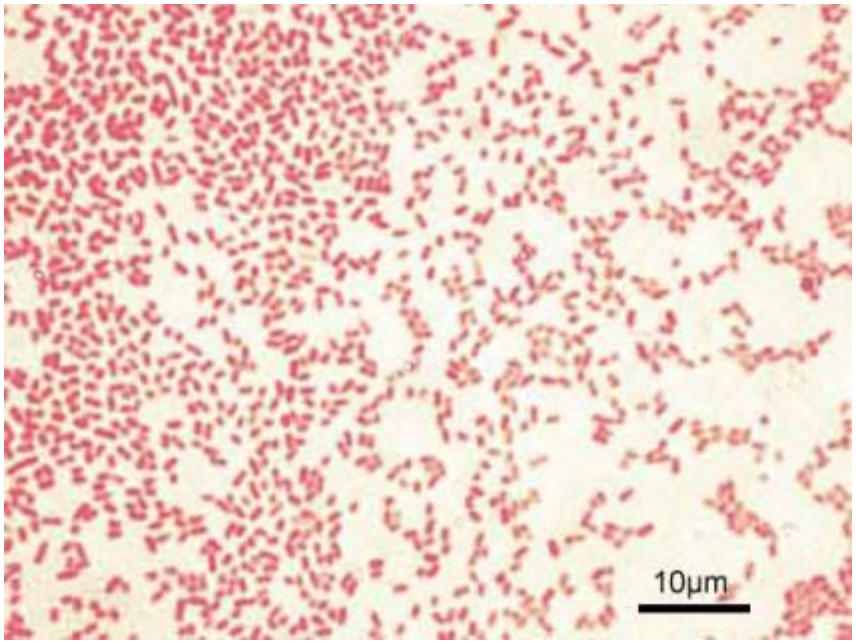
Prokaryotes - Cell Wall

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

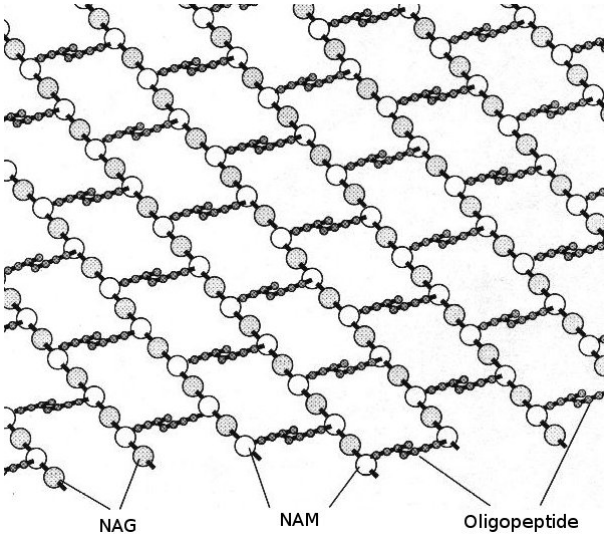


Gram-negative



Images: Staph, Gram Stain, SPO Microbiology Images, T. Port; E coli, Y tambe

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-acetlymuramic acid (NAM)
- NAG / NAM strands are connected by interlocking peptide bridges. The "peptid" part of peptidoglycan.

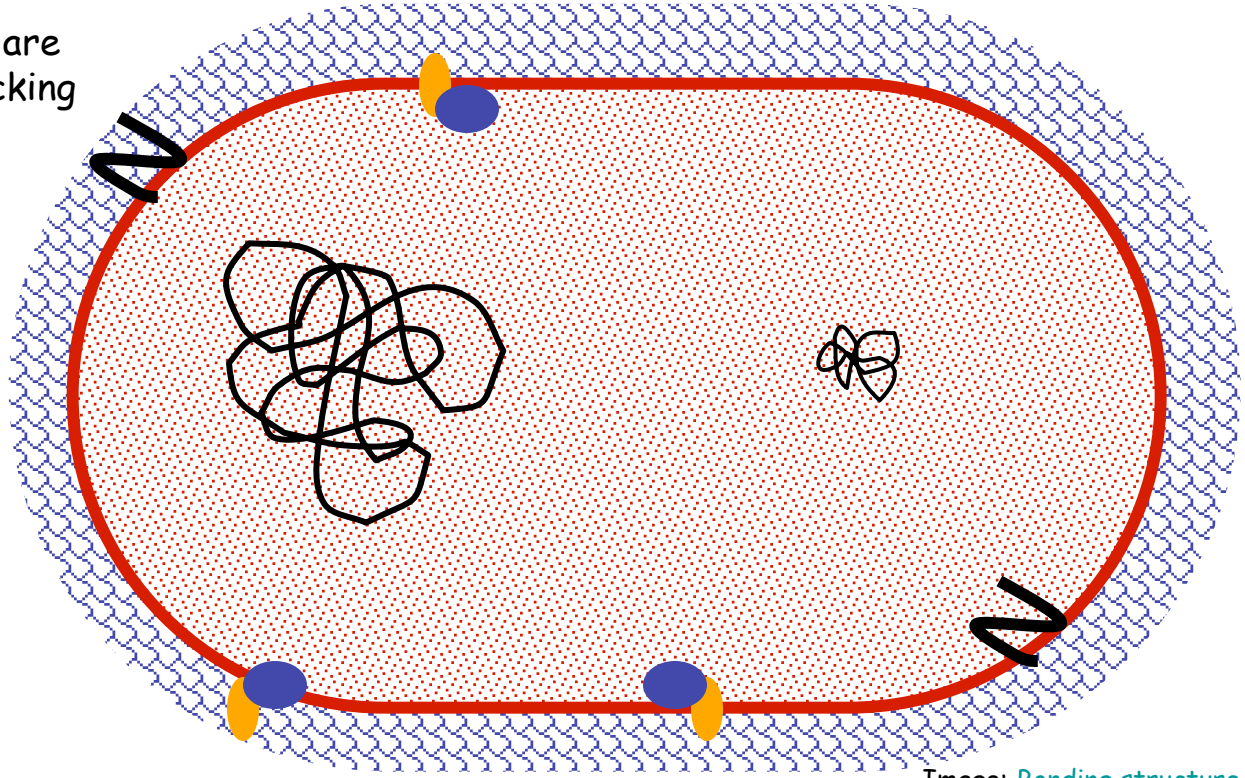
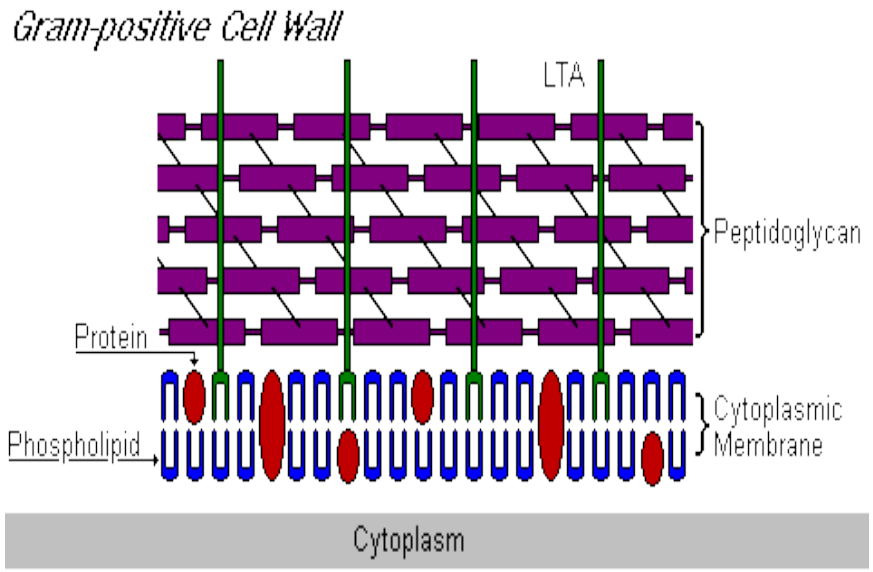
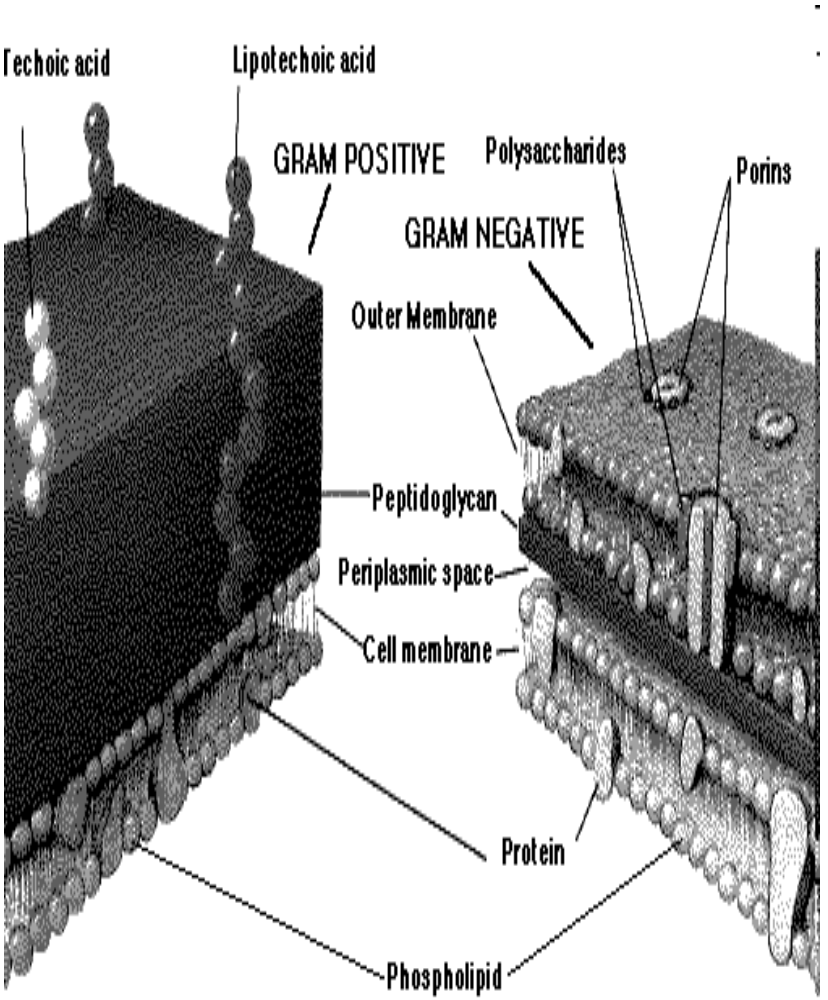


Image: Bonding structure peptidoglycan, Mouagip; Other Image Source Unknown

Prokaryotes - **Cell Wall**

Gram-Positive & Gram-Negative



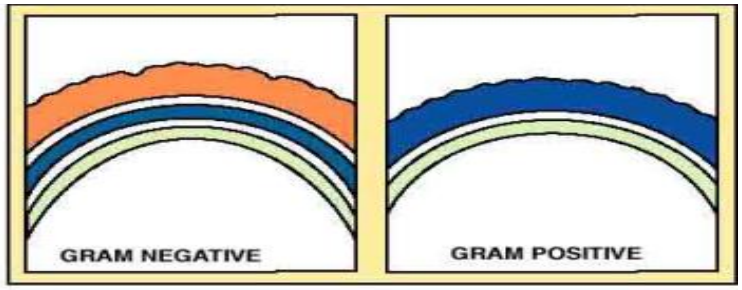


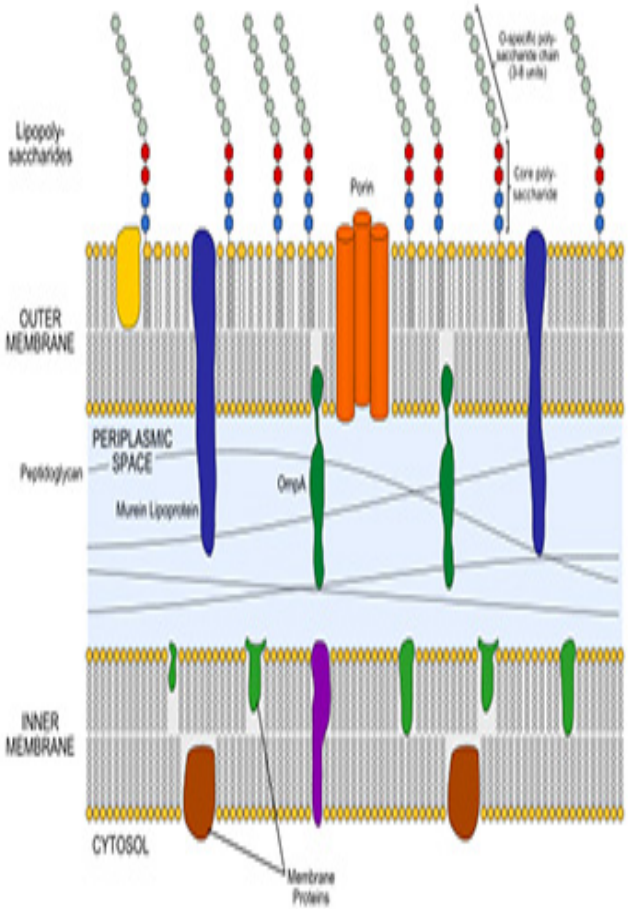
From the Virtual Microbiology Classroom on ScienceProfOnline.com

Images: Sources Unknown

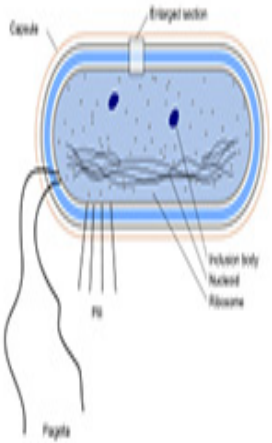
Prokaryotes - **Cell Wall**

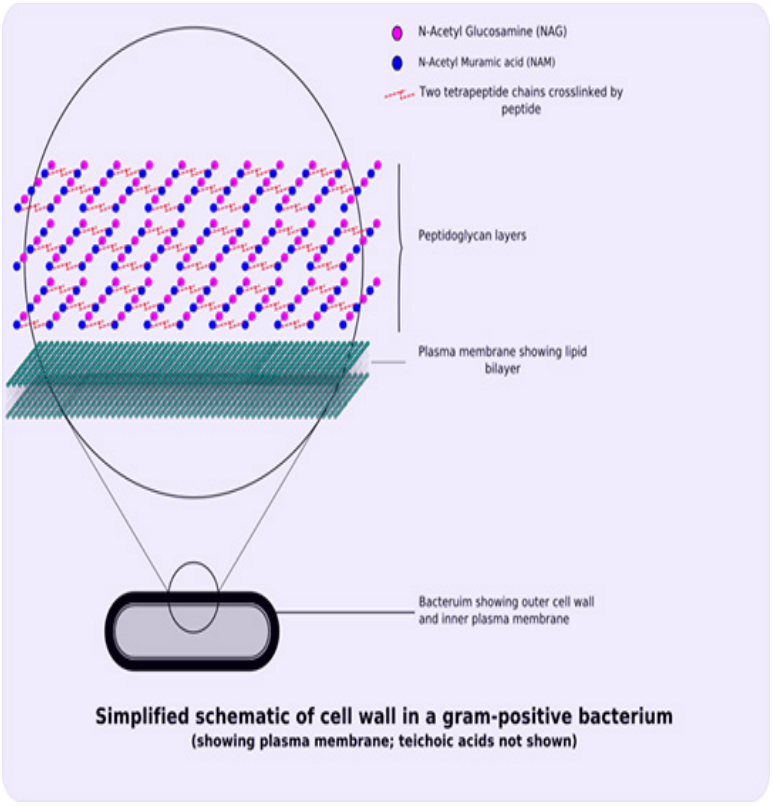
Gram-Positive & Gram-Negative





Gram Negative Bacterial Cell Wall

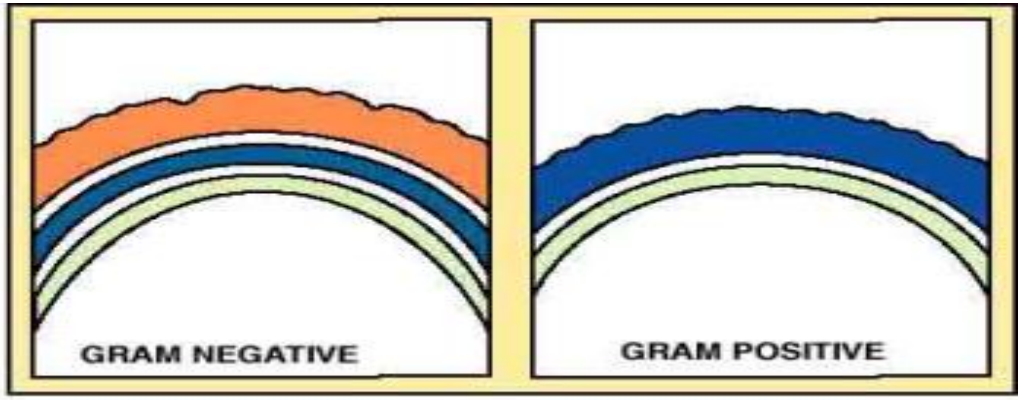


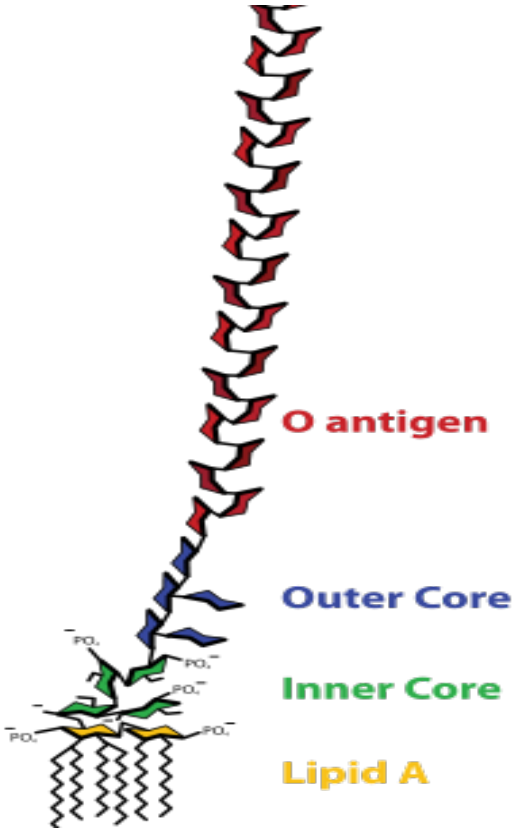


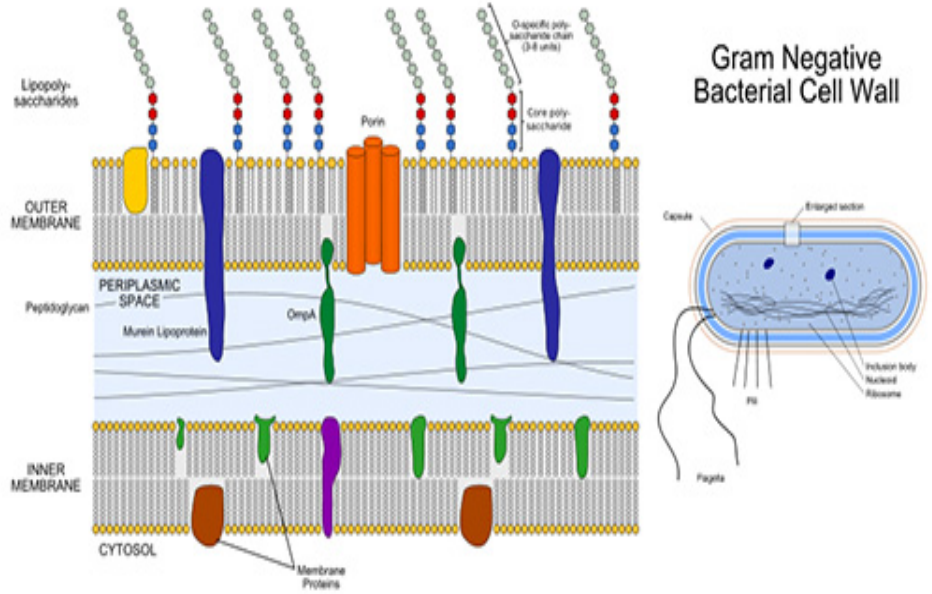
FYI: **The bacterial** plasma membrane **and** cell wall **together are called the cell envelope.**

Image: Gram-positive cell wall schematic, Wiki; Gram-negative cell wall schematic, Jeff Dahl

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







From the Virtual Microbiology Classroom on ScienceProfOnline.com

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

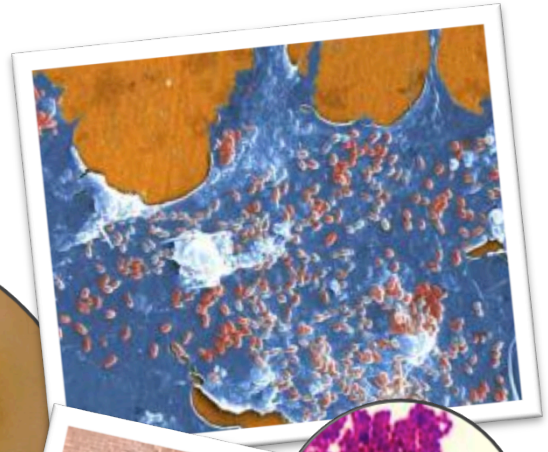
- Glycoproteins loosely associated with the cell wall.

- 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.

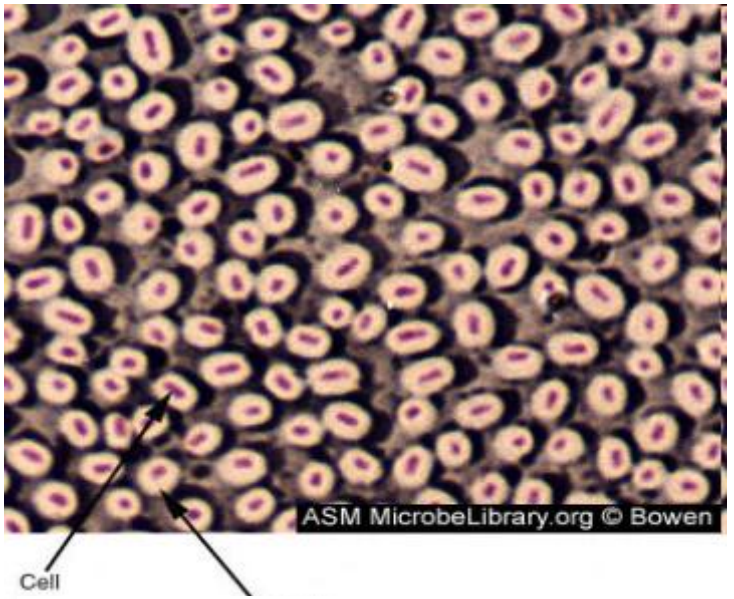


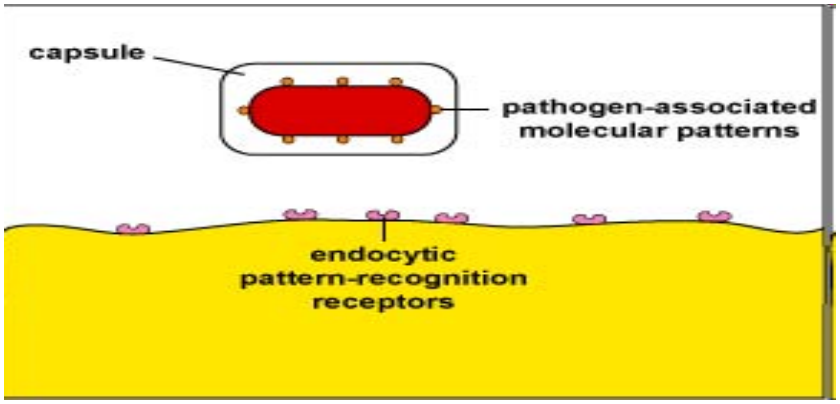
Images: Slime layer, Encyclopedia Britannica; Biofilm, PHIL # 11706; Dirty toilet, T. Port Sweat on face; *Staphylococcus* & Mannitol Salt agar, T. Port

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.





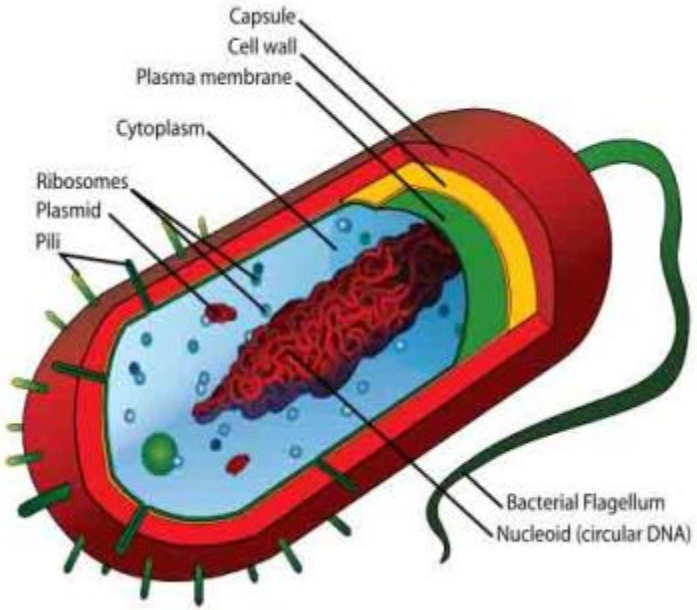
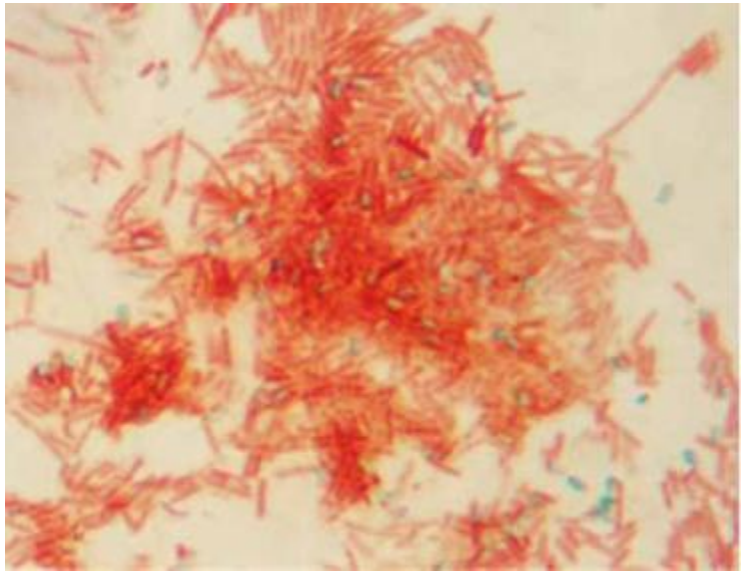


Image: Prokaryotic Cell Diagram: M. Ruiz, Other Images Unknown Source

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.
- **Q: What are the two endospore producing bacterial genera that were introduced in our History of Microbiology lecture?**



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

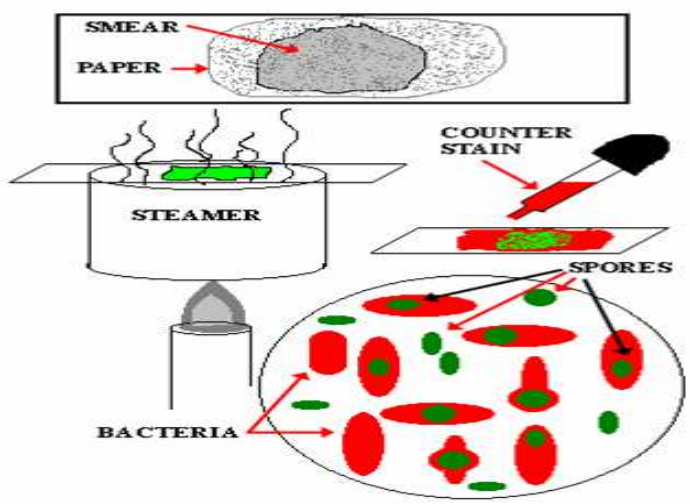
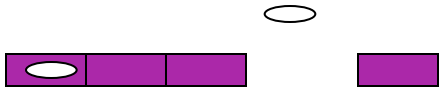
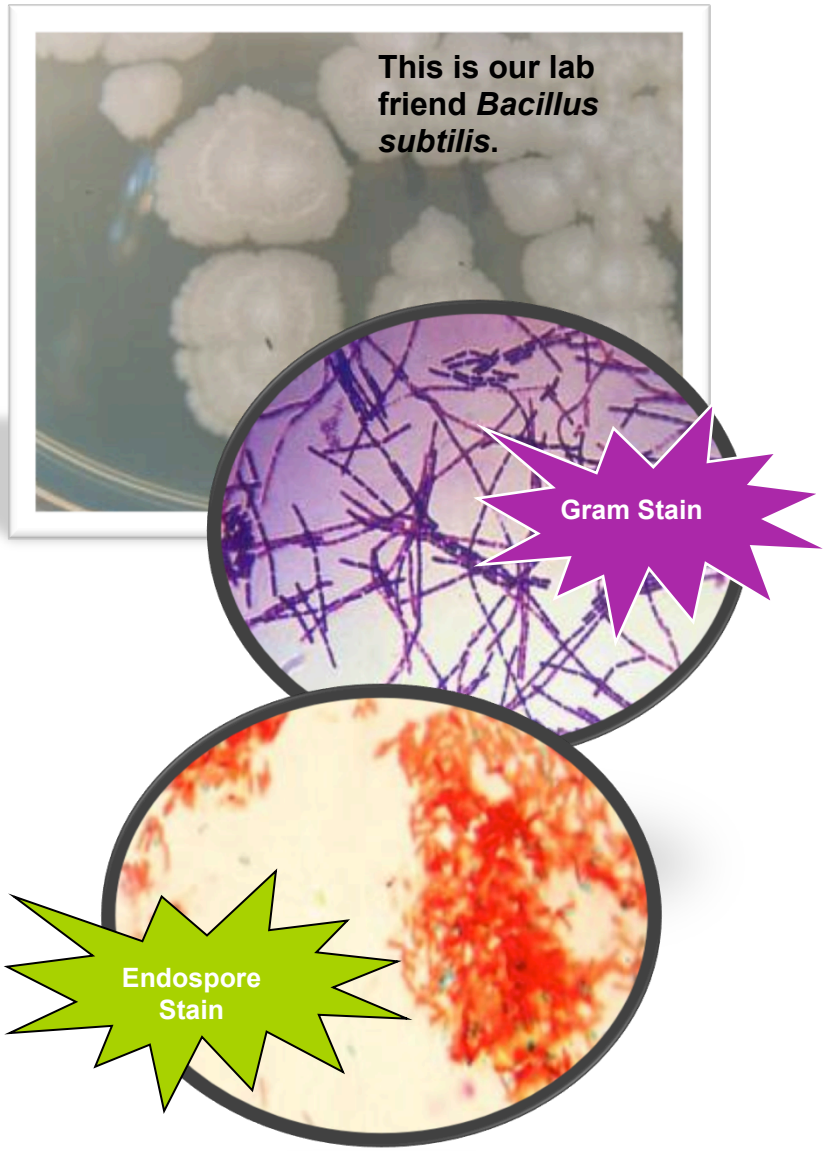


Image: *Bacillus subtilis*, SPO Science Image Library, Endospore stain from Dr. Ronald E. Hurlbert, Microbiology 101 lab manual

Bacterial Genus: _____

GRAM-POSITIVE
Obligate or facultative anaerobes,
endospore producers
bacillus-shaped





Q: Which two groups of bacteria produce endospores?

Common in soil. Only a few species cause disease in humans.

Extremely diverse group of bacteria, includes:

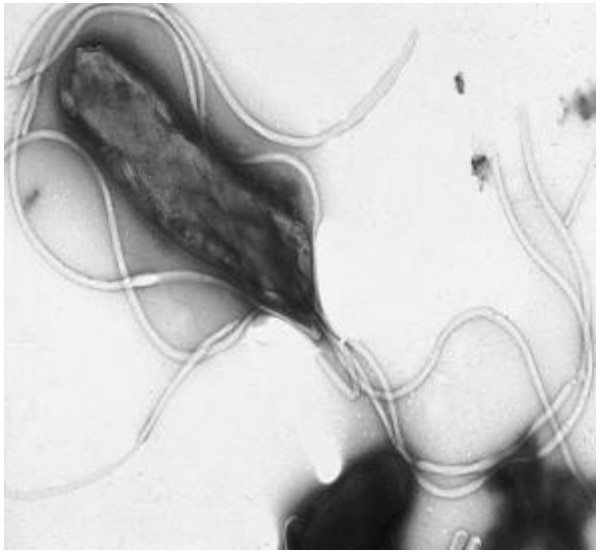
- causative agent of anthrax (*Bacillus anthracis*)
- species that synthesize important antibiotics, and enzymes for detergents.

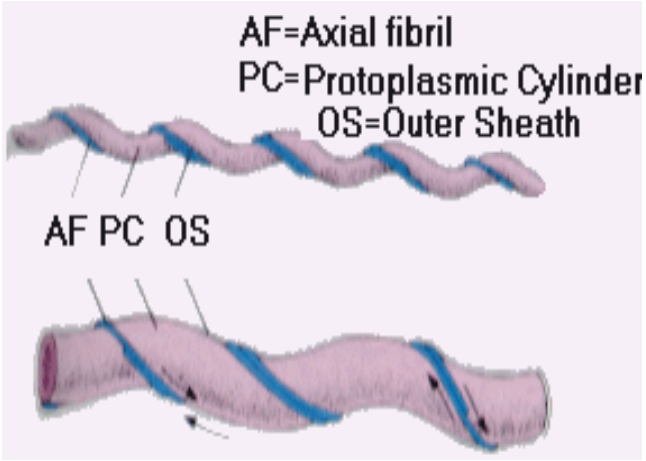
Due to extreme tolerance to both heat and disinfectants, used to test heat sterilization techniques and chemical disinfectants.

Images: *Bacullus subtilis*, T. Port: *B. anthracis*, Gram stained, CDC; Endospore stain, Tami Port

Prokaryotes – Surface Appendages

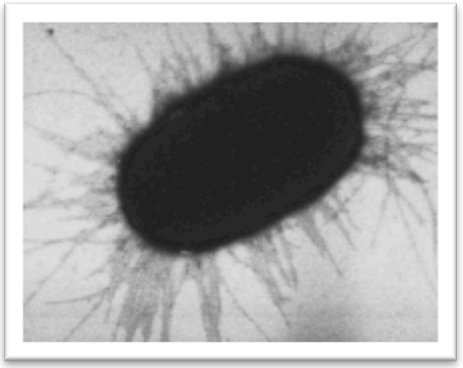
- Some prokaryotes have distinct appendages that allow them to move about or adhere to solid surfaces.
- Consist of delicate stands of proteins.
- **flagella**: Long, thin extensions that allow some bacteria to move about freely in aqueous environments.
  (singular: flagellum)
- **axial filament (endoflagella)**: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





Images: *Helicobacter pylori*; Axial filament, Source unknown

Prokaryotes – Surface Appendages

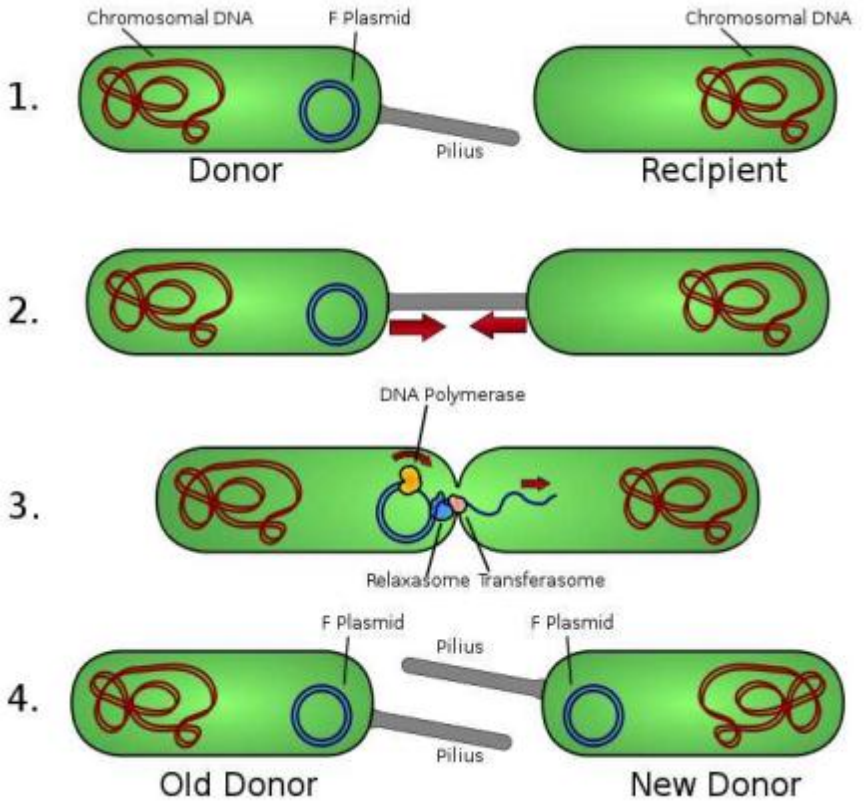


- **fimbriae**: Most Gram-negative bacteria have these short, fine appendages surrounding the cell. Gram+ bacteria don't have.

  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.

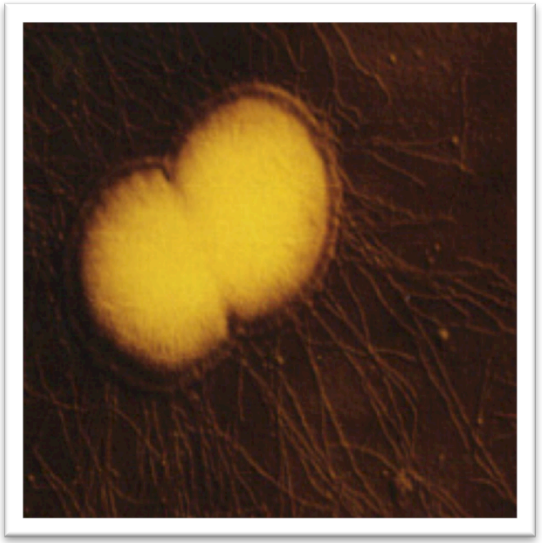
  Use for movement, like grappling hooks, and also use conjugation pili to transfer plasmids. (singular = pilus)

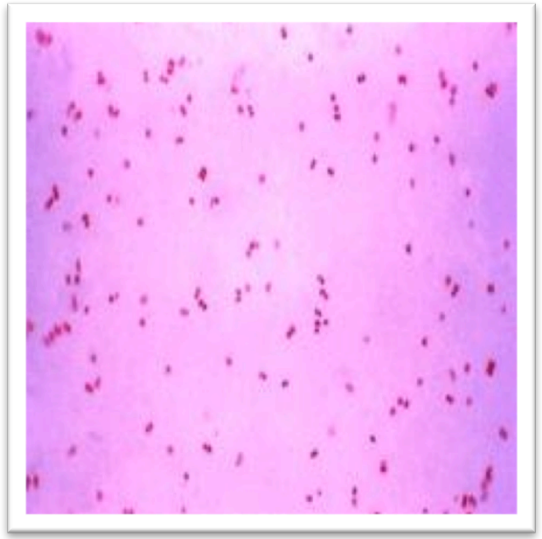


Images: E. coli fimbriae, Manu Forero; Bacterial conjugation, Adenosine

Meet the Microbe! *Neisseria* and its Fimbiriae

- **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.



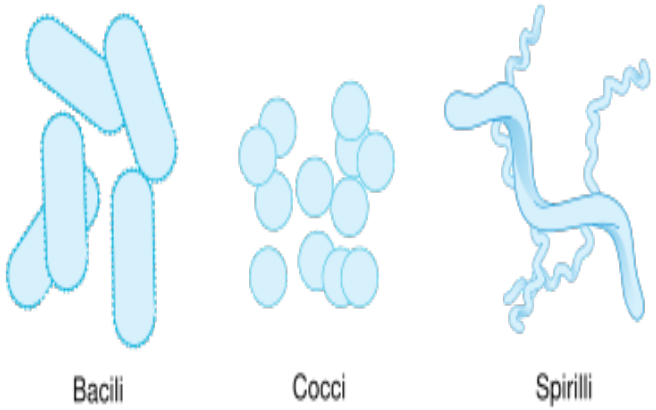


Q: What makes Neisseria so tough?

- 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 classifies according to shape:

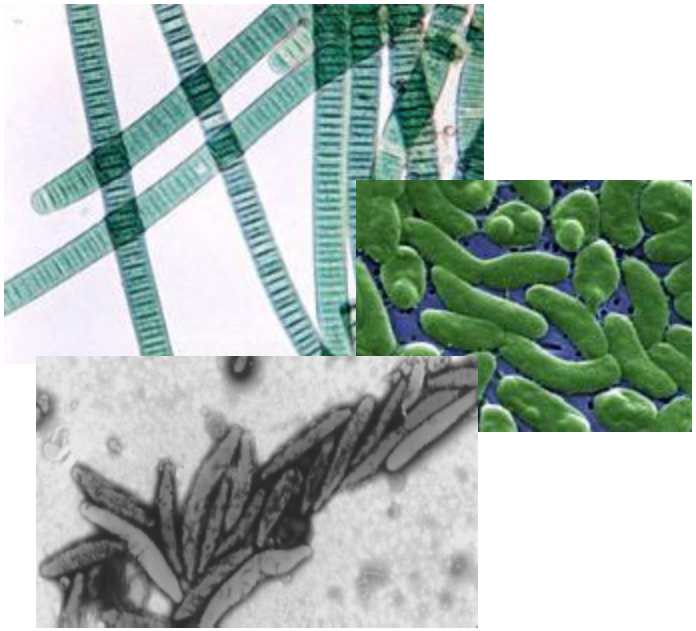
1. **bacillus** *(pl. bacilli)* = rod-shaped

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



There are many more shapes beyond these basic ones. A few examples:

- Coccobacilli = elongated coccal form
- Filamentous = bacilli that occur in long threads
- Vibrios = short, slightly curved rods
- Fusiform = bacilli with tapered ends

Images: Basic bacterial shapes, Mariana Ruiz,
Other examples of bacterial shapes, FDA, Gov.

Prokaryotes – Arrangements of Cells

- Bacteria sometimes occur in groups, rather than singly.

- **bacilli** divide along a single axis, seen in pairs or chains.

- **cocci** divide on one or more planes, producing cells in:
  - pairs (diplococci)
  - chains (streptococci)
  - packets (sarcinae)
  - clusters (staphylococci).

- Size, shape and arrangement of cells often first clues in identification of a bacterium.

- Many "look-alikes", so shape and arrangement not enough for id of genus and species.

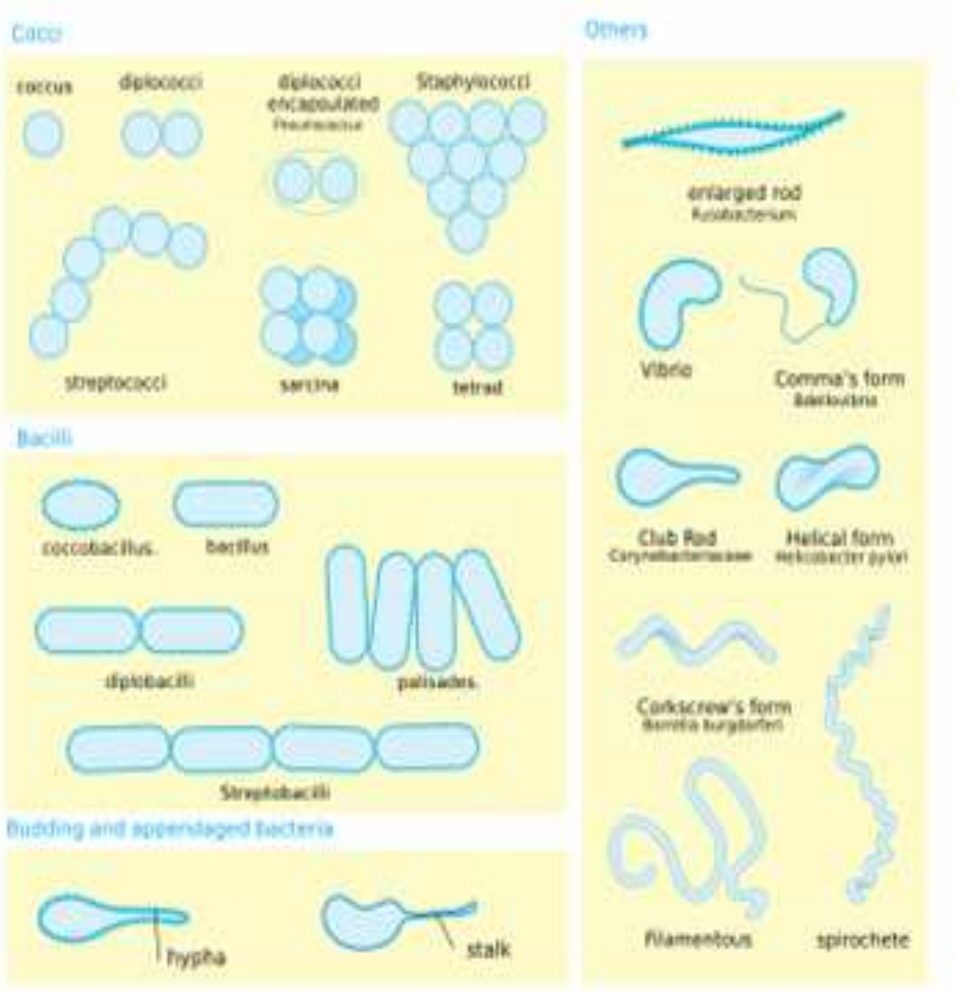
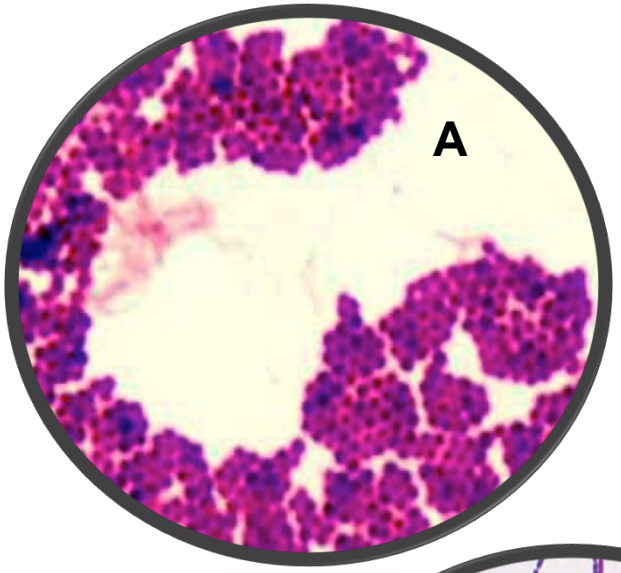
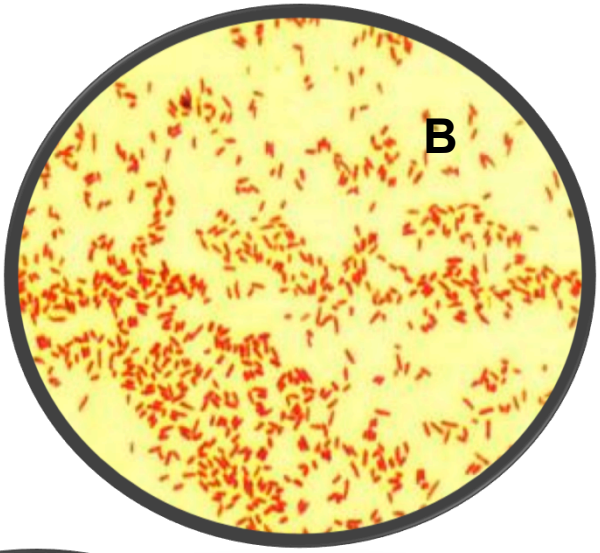
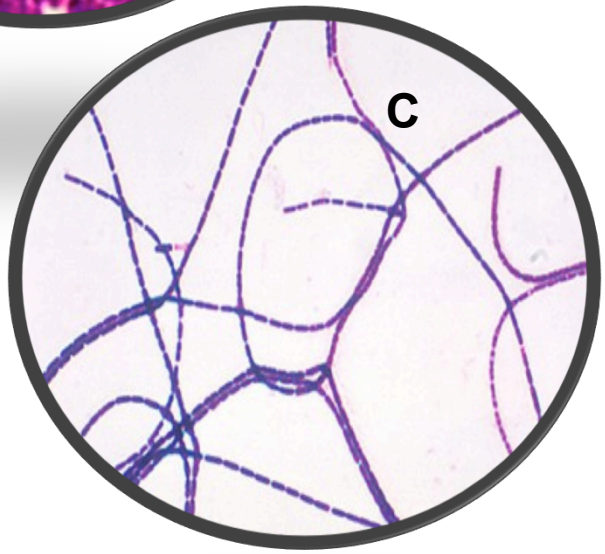


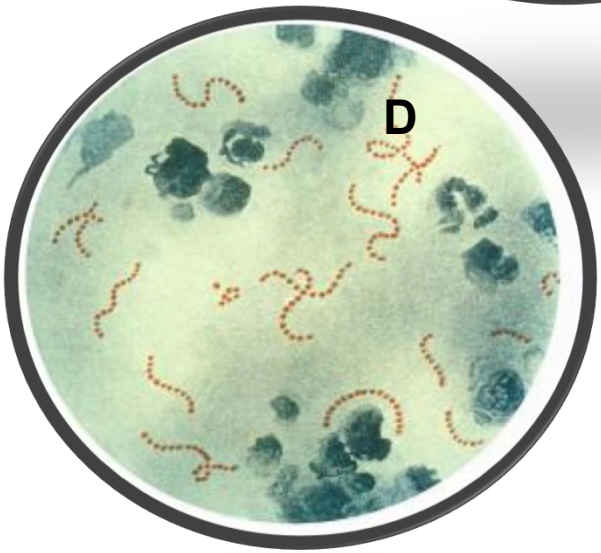
Image: Bacterial shapes and cell

Identify Each Type of Cell Shape & Arrangement







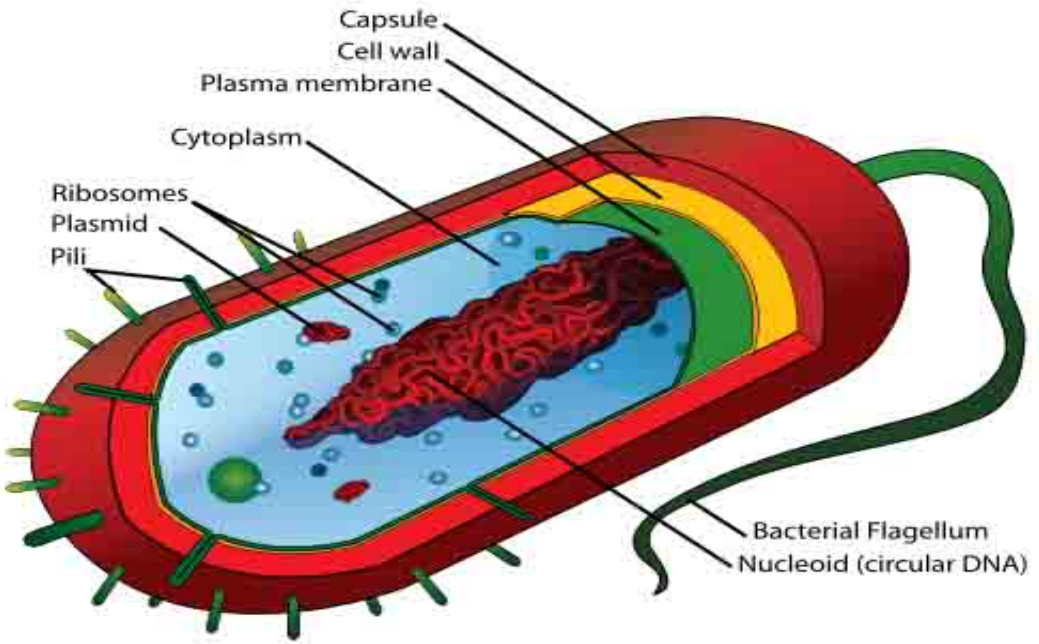


Images: A. *Staph*; B. *E. coli*, T. Port; C. *Bacillus anthracis*, PHIL #2105; D. *Streptococcus bacteria*, PHIL #2110.

REVIEW!

Here's an excellent interactive lesson on

Prokaryote Cell Structure



From the Virtual Microbiology Classroom on ScienceProfOnline.com

Images: Prokaryotic cell diagram, M. Ruiz

Confused?

Here are links to fun resources that further explain aerobic respiration:

Smart Links

- Cell Structure: Prokaryotes Main Page on the Virtual Micrboiology Classroom of Science Prof Online.
- Prokaryotic Cell: Structures, Functions & Diagrams, an article from SPO.
- Prokaryotic & Eukaryotic: Two Types of Biological Cells, an article from SPO.
- "Got the Time" music video by Anthrax.
- 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.
- How Osmosis Works, animation from McGraw-Hill.
- "Germs". Music by Weird Al Yankovic. Video by RevLucio.
- Bacterial Pathogen Pronunciation Station, a webpage with links to audio files containing the pronunciation of the bacterial names, created by Neal R. Chamberlain, Ph.D.
- Biology4Kids – Cell Biology Main Page by Raders.

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

Are microbes intimidating you?

Do yourself a favor. Use the…

Virtual Microbiology Classroom *(VMC)* !

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

- practice test questions
- review questions
- study guides and learning objectives

You can access the VMC by going to the Science Prof Online website
www.ScienceProfOnline.com

Images: *Clostridium difficile*, Giant Microbes; Prokaryotic cell, Mariana Ruiz