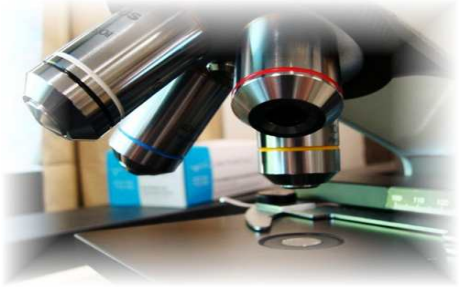


About Science Prof Online PowerPoint Resources

• 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.

Alicia Cepaitis, MS
Chief Creative Nerd
Science Prof Online
Online Education Resources, LLC
alicia@scienceprofonline.com

Tami Port, MS
Creator of Science Prof Online
Chief Executive Nerd
Science Prof Online
Online Education Resources, LLC
info@scienceprofonline.com

Image: Compound microscope objectives, T. Port

Meet the Microbes:

Prokaryotes

HI
my name is:

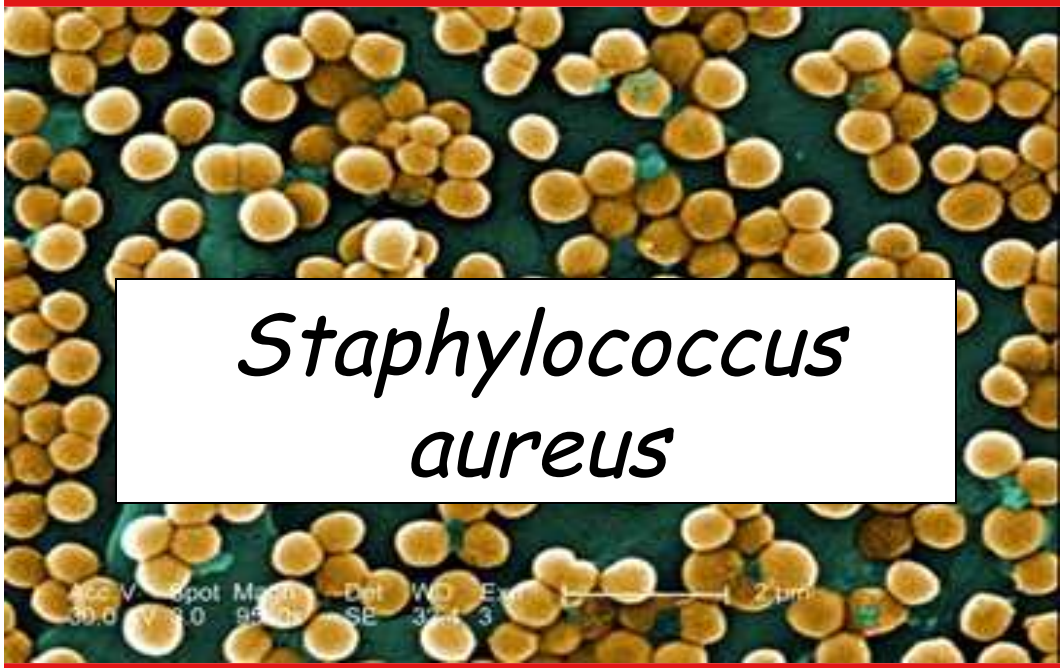
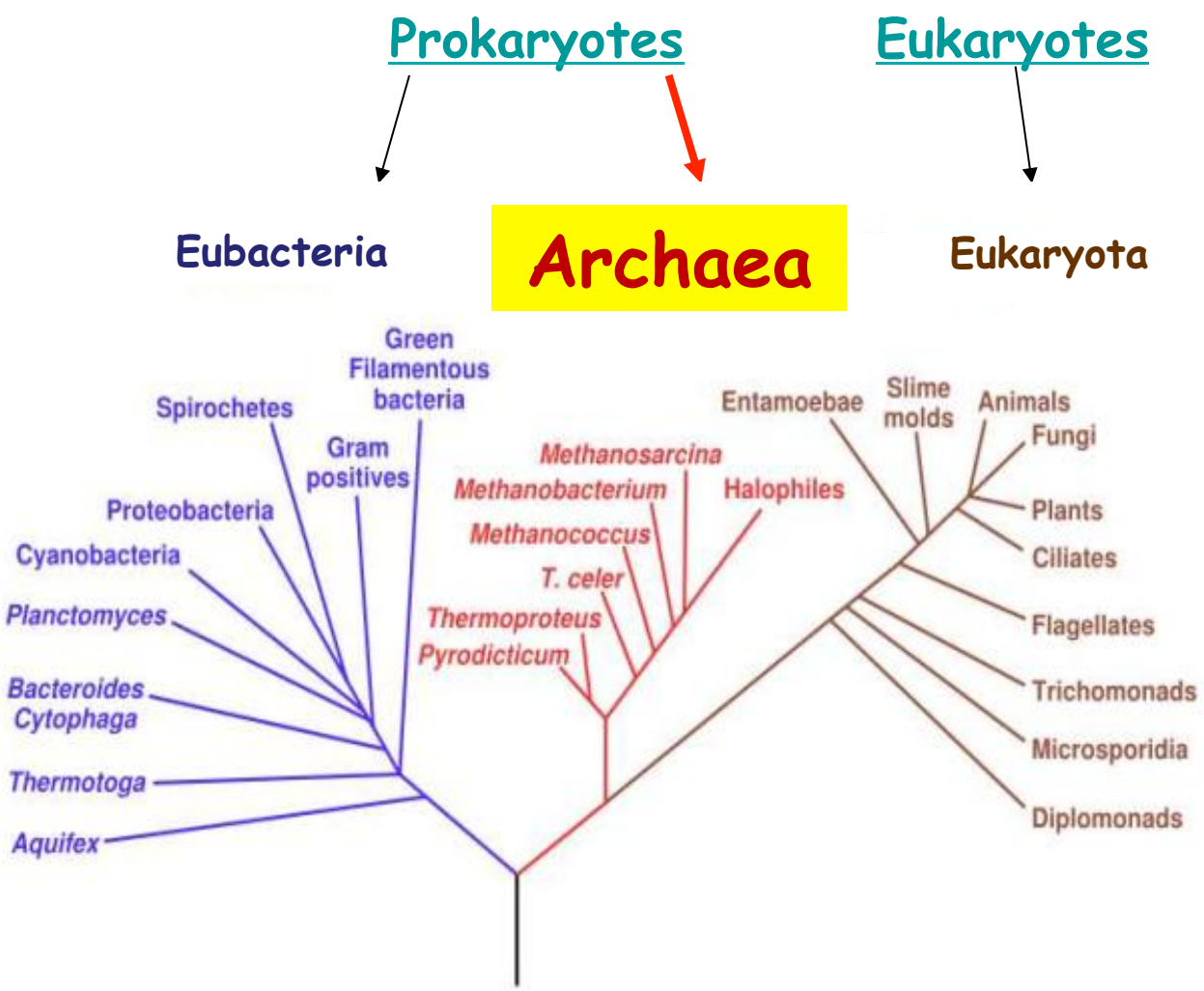
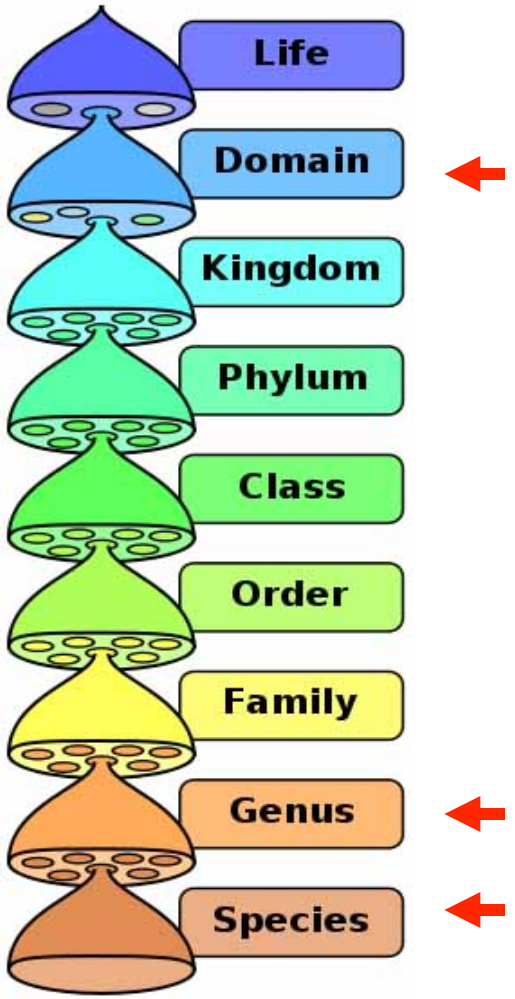


Image: *Staphylococcus aureus*, Janice Haney Car , PHIL #10046

Classifying Living Things





From ScienceProfOnline.com, free science education website.

Image: Phylogenetic Tree, Eric Gaba, NASA Astrobiology institute; Biological classification diagram, Peter Halasz

ARCHAEA: Extremophiles

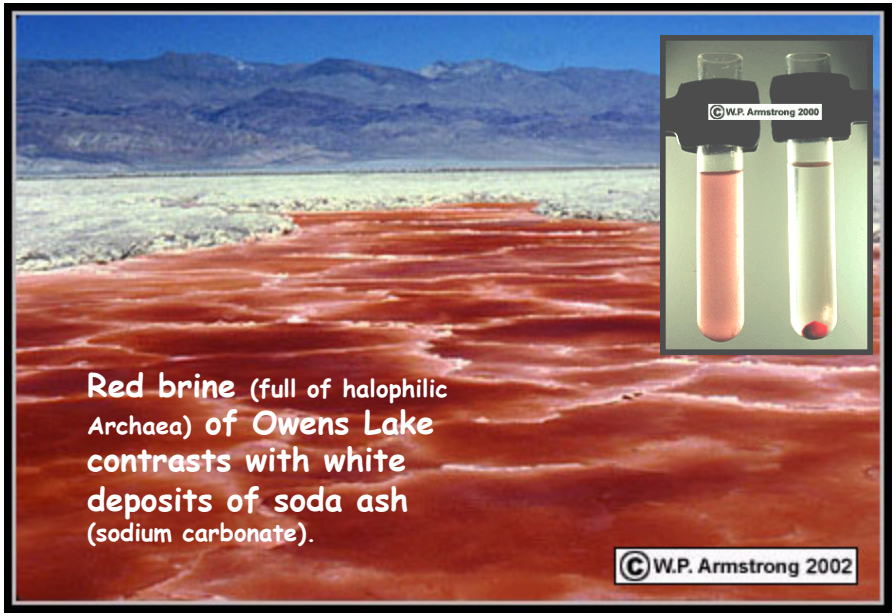
Require extreme conditions of temperature, salinity or pH to survive.

Thermophiles

- Need temperatures > 45°C (113°F) to survive.

Halophile

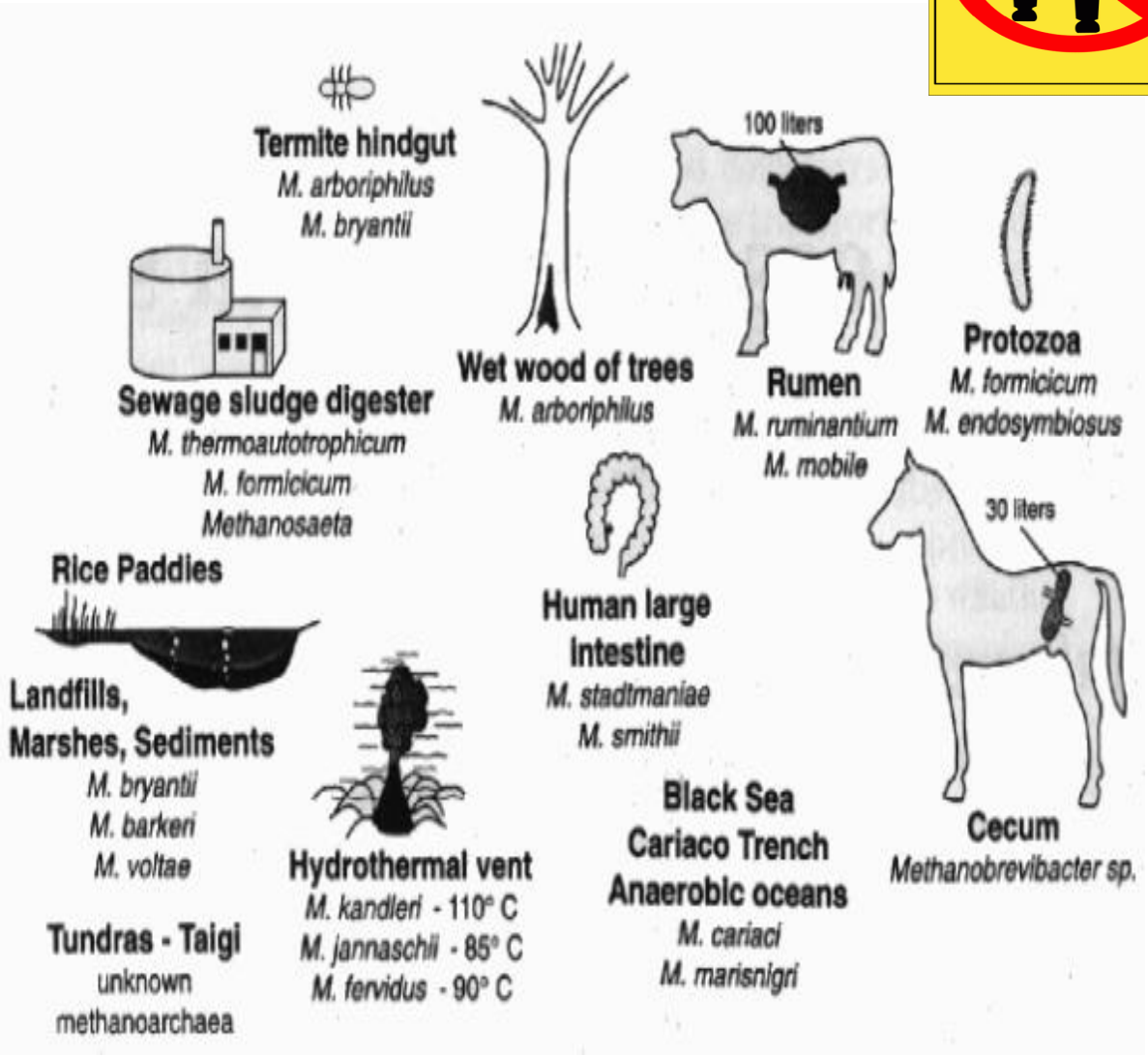
- Colonize extremely saline environments.
- Require salinity > 9% to maintain integrity of cell walls.



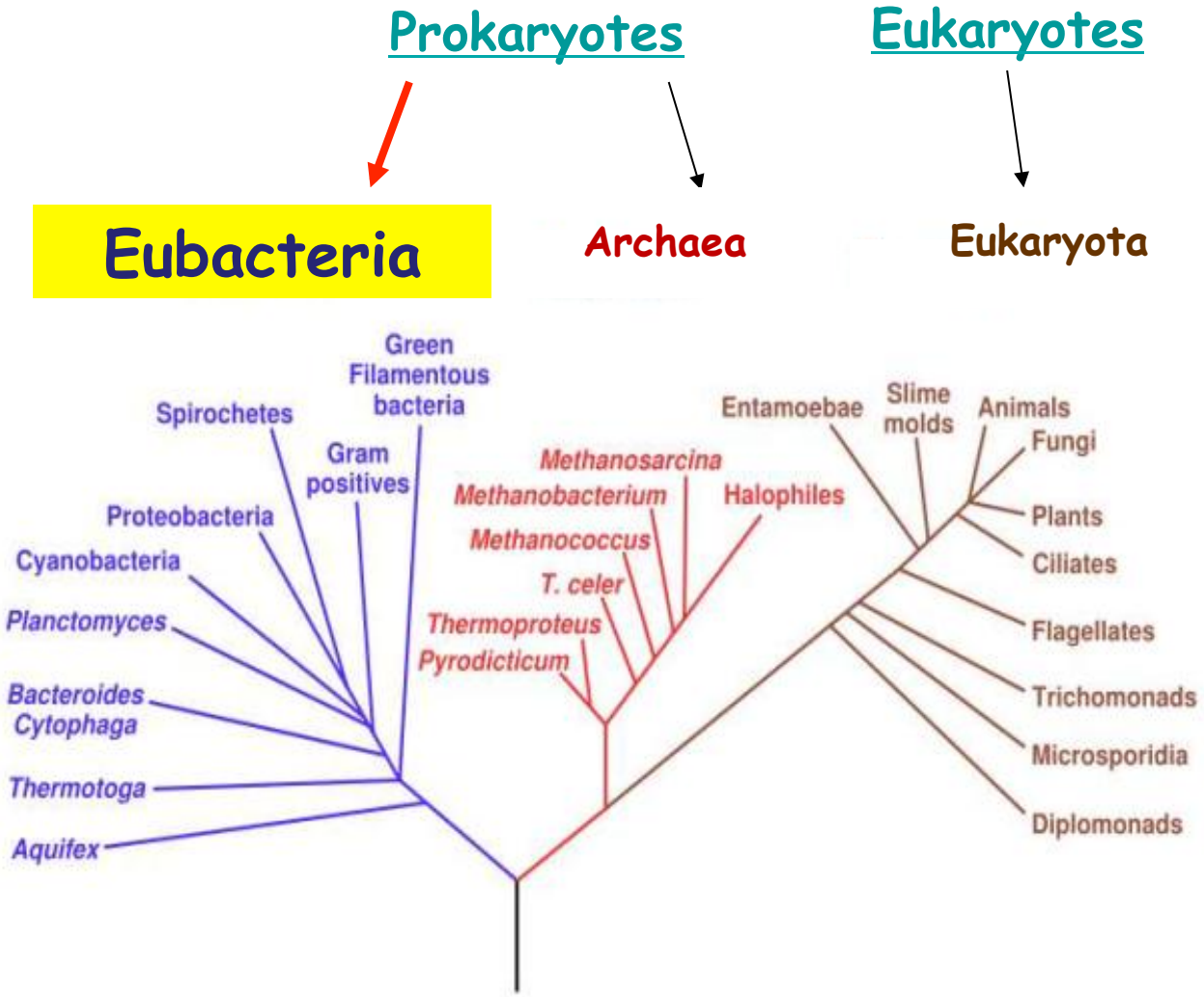
Images: Grand Prismatic Spring, Yellowstone, Jim Peaco, National Park Service; Owens Lake & Test tubes of Searles Lake, right tube centrifuged to separate out halophiles W.P. Armstrong.

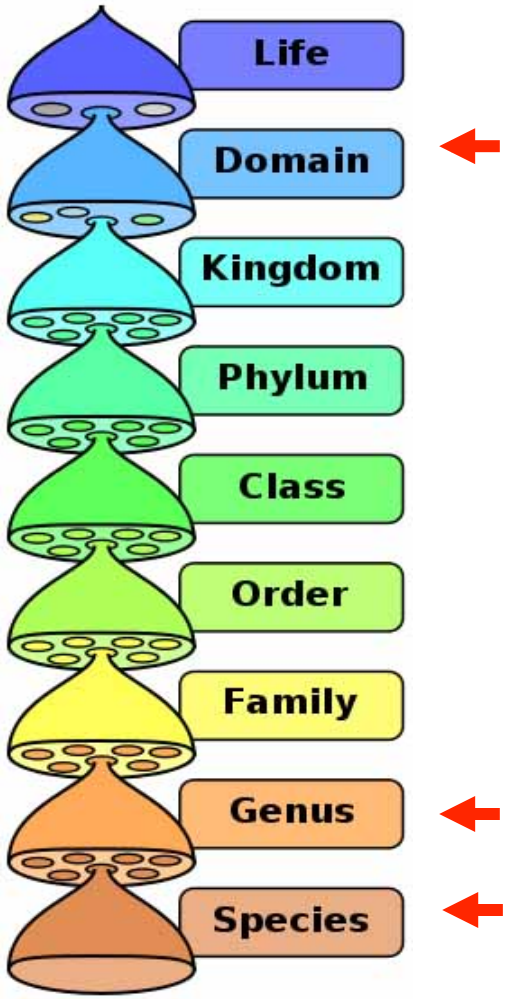
ARCHAEA: Methanogens

- Largest group of Achaea.
- Produce methane as a metabolic byproduct.
- Common in wetlands (responsible for marsh gas).
- In the guts of animals such as ruminants and humans, where they are responsible for flatulence.



Classifying Living Things





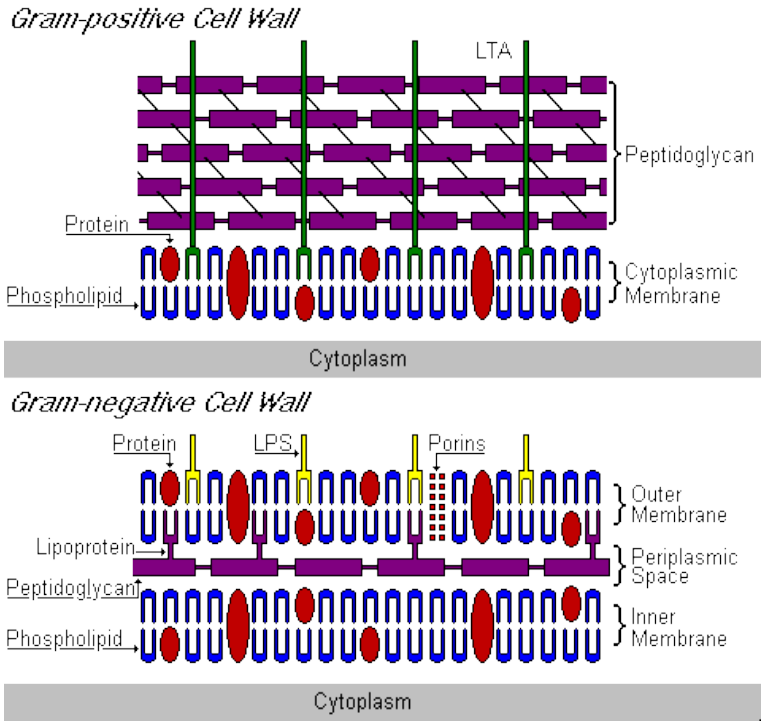
From ScienceProfOnline.com, free science education website.

Image: Phylogenetic Tree, Eric Gaba, NASA Astrobiology institute; Biological classification diagram, Peter Halasz

Classifying Bacteria: Gram-Negative & Gram-Positive

Gram Positive

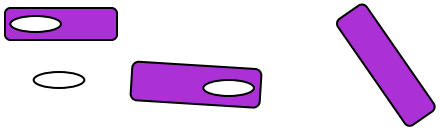
- Peptidoglycan is the thick, outermost layer of their bacterial cell wall.
- About 90% of cell wall is made of peptidoglycan.



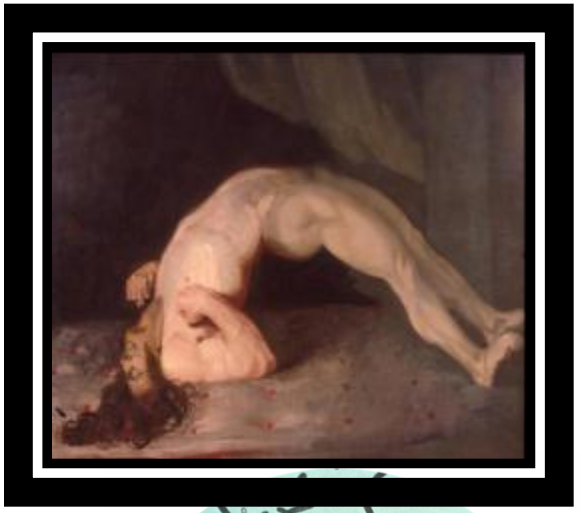
Gram Negative

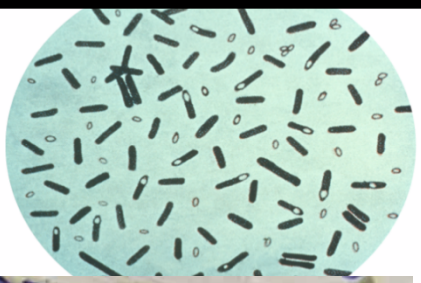
- Cell wall is more chemically complex, thinner and less compact.
- Peptidoglycan only 5 – 20% of the cell wall.
- Peptidoglycan is **not the outermost layer**, but between the plasma membrane and the outer membrane.
- Not accessible to the action of antibiotics.
- Outer membrane is similar to the plasma membrane, but is less permeable and contains lipopolysaccharides (LPS).
- LPS is a harmful substance classified as an endotoxin.

Bacterial Genus : *Clostridium*



GRAM-POSITIVE
Obligate anaerobes
bacillus-shaped
endospore producer





- Members of this genus have a couple of bacterial "superpowers" that make them particularly tough pathogens.
- ***Q**: Anyone remember what those superpowers are?*
- All have a strictly **fermentative** mode of metabolism (Don't' use oxygen).
- Vegetative cells are **obligate anaerobes** killed by exposure to O2, 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.
- ***Q**: What were the four species of Clostridium that were introduced in a previous lecture (History of Microbiology)?*

Images: Man with Tetanus, Sir Charles Bell; Clostridium botulinum, PHIL #2107; Wet Gangrene, Wiki

Bacterial Genus: *Bacillus*

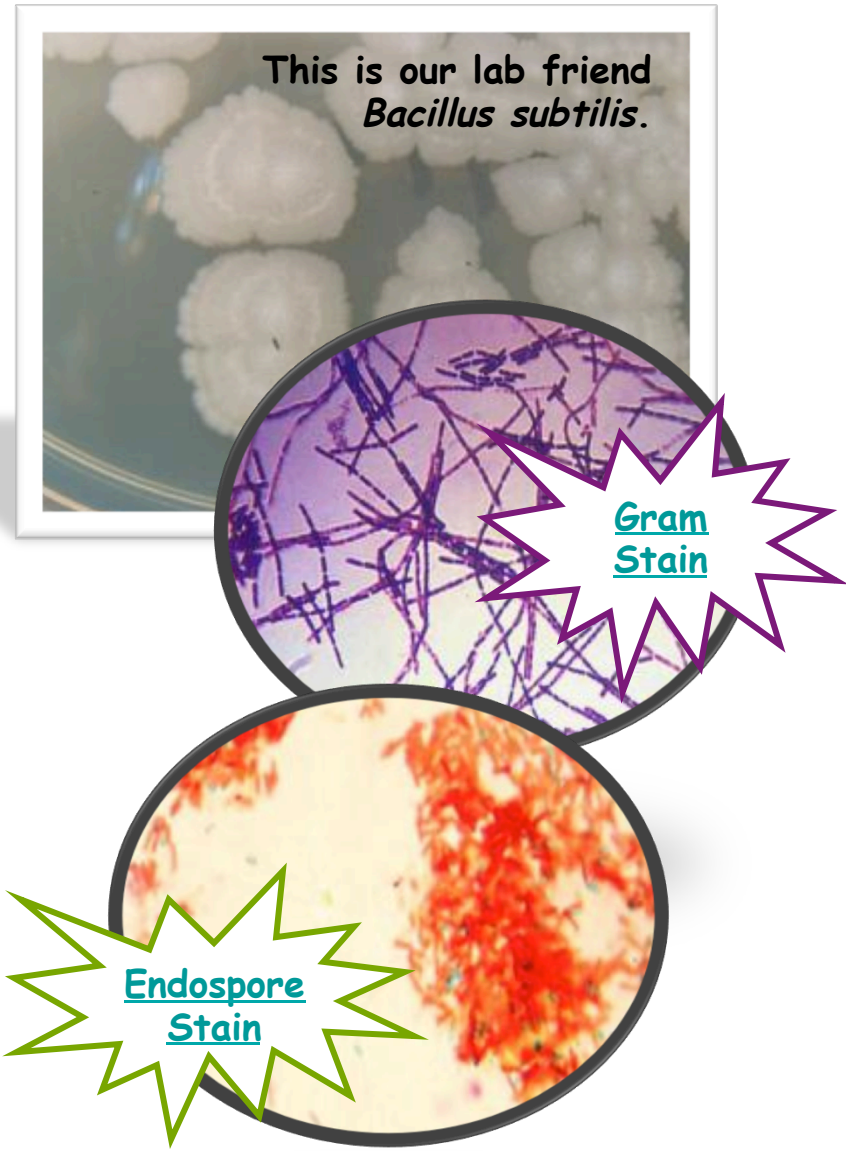
GRAM-POSITIVE
Obligate or facultative anaerobes
bacillus-shaped
Endospore producer

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

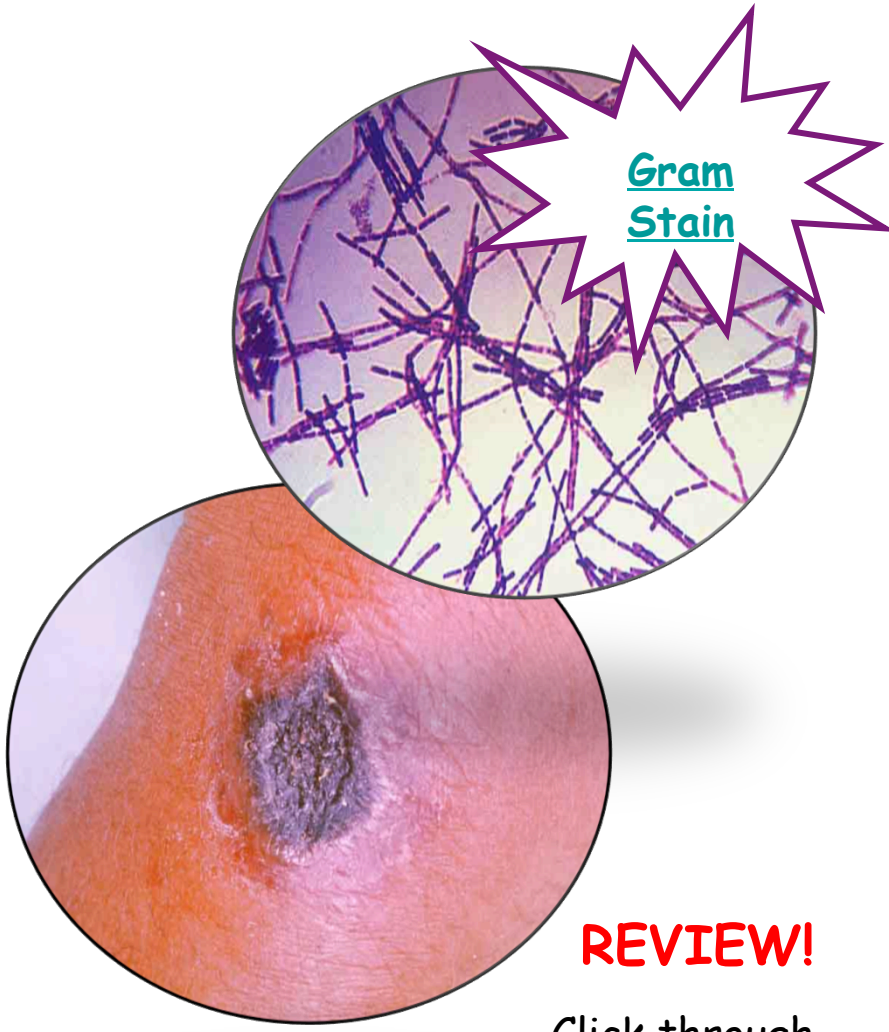
Disease, Please: Anthrax

Organism: Caused by the **Gram +**, endospore-forming bacterium ***Bacillus anthracis.***

Infection can occur in three forms:
- cutaneous (skin)
- inhalation
- gastrointestinal

Transmission:
- Endospores can remain in soil for many years.
- Humans can become infected by handling products from infected animals or by inhaling spores.

Cutaneous Anthrax Infection:
- Most (about 95%) anthrax infections occur when the bacterium enters a cut or abrasion on the skin.
- Skin infection begins as a raised itchy bump that resembles an insect bite. Within 1-2 days develops into painless ulcer, with a characteristic black necrotic (dying) area in the center.
- About 20% of untreated cases result in death. (Death rare with appropriate antimicrobial therapy).



REVIEW!

Click through animated lesson on Koch's Postulates connecting ***Bacillus anthracis*** with the disease anthrax.

Images: *B. anthracis*, Gram stained, CDC; Anthrax skin lesion, James H. Steele, CDC

Bacterial Genus: *Micrococcus*

GRAM-POSITIVE

Facultative anaerobe, cocci

- Thick cell wall, ~50% of cell's mass. *(When you Gram stain it, the cells are intensely purple.)*
- Found in many places throughout the environment human skin, animals, water, dust, and soil.
- *M. luteus* on human skin transforms chemicals in sweat into **body odor**.
- Grow well even with little water or **high salt** concentrations. *(You may find it growing on your Mannitol Salt nasal sample.)*
- **Normal flora** that can become opportunistic in immune compromised.

Images: *M. luteus*, Janice Carr, PHIL #9761; *M. luteus* colonies on streak plate; M. luteus and other bacteria growing on arm plate, T.Port.

Bacterial Genus: *Streptococcus*

GRAM-POSITIVE, **Facultative anaerobe,** coccus-shaped

Diverse genus, some normal flora, some pathogens that produce **toxins**.

Pairs or chains of cocci.

Classified by **hemolysis pattern** on blood agar; alpha, beta and gamma hemolysis.

Beta-hemolytic Strep fall into two groups:

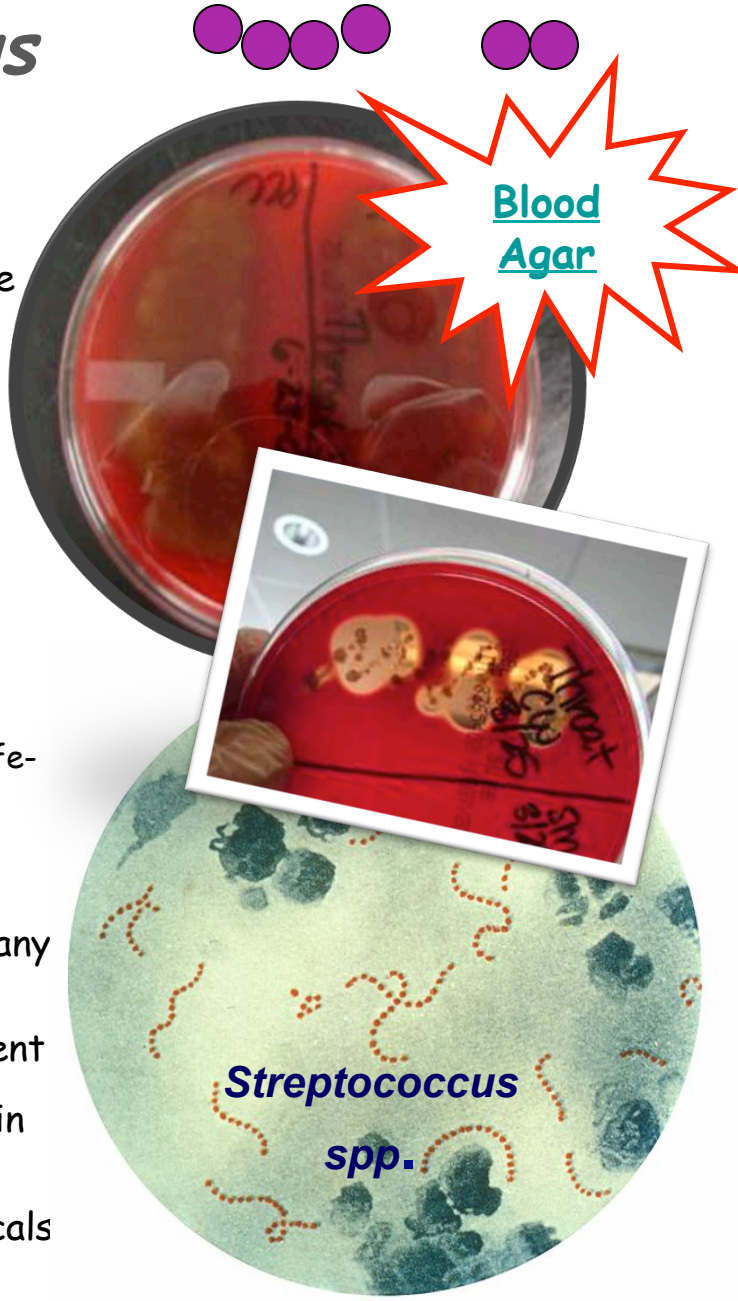
- Group A streptococci *(S. pyogenes)* cause diseases including strep throat, necrotizing fasciitis (flesh-eating disease), scarlet fever, postpartum fever, and streptococcal toxic shock syndrome.

- Group B streptococci *(S. agalacitiae;* say a-ga-LAC-tea-ae*)* can cause life-threatening pneumonia and meningitis in newborns the elderly and adults with compromised immune systems.

Group B strep infections are different from other strep infections. Individual can be colonized by the bacteria before any symptoms are obvious.

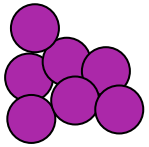
Women screened for GBS during pregnancy. About 10-30 percent carry GBS in vagina or surrounding area. Usually harmless in healthy adults, but may cause stillbirth and serious infections in babies.

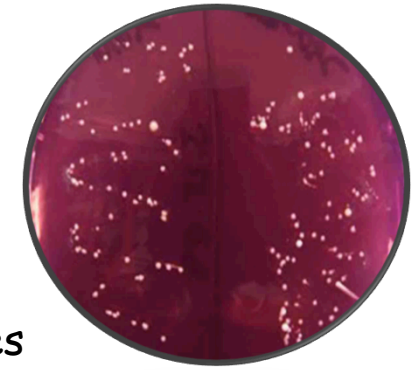
Group A and B distinguished based on **antigens** (specific chemicals that our immune system reacts to) in their cell walls.



Images: Hemolysis patterns on Blood Agar, T. Port; *Streptococcus* bacteria Public Health Image Library 900x,, #2110.

Bacterial Genus: *Staphylococcus*





GRAM-POSITIVE

Facultative anaerobe

coccus-shaped

Coccus-shaped bacteria, which divides in a way that results in grape-like clusters.

- ***Staphylococcus aureus*** (golden staph), most common cause of staph infections.
- Approximately 20–30% of general population "Staph carriers."
- *S. aureus* can cause illnesses ranging from minor skin infections to life-threatening diseases, such as meningitis, toxic shock syndrome (TSS) & septicemia.
- **MRSA** = Methicillin-resistant *Staphylococcus aureus*
- One of the four most common causes of **nosocomial infections**, often causing postsurgical wound infections.
- ***S. epidermidis*** is normal flora which inhabits the skin of healthy humans.

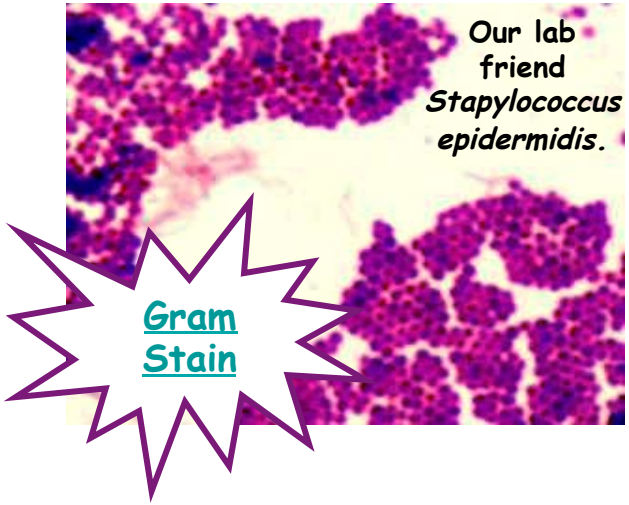


Image: Mannitol salt plates, T. Port; *S. aureus,* Janice Haney Carr , PHIL #10046; Gram stain *Staph,* T. Port

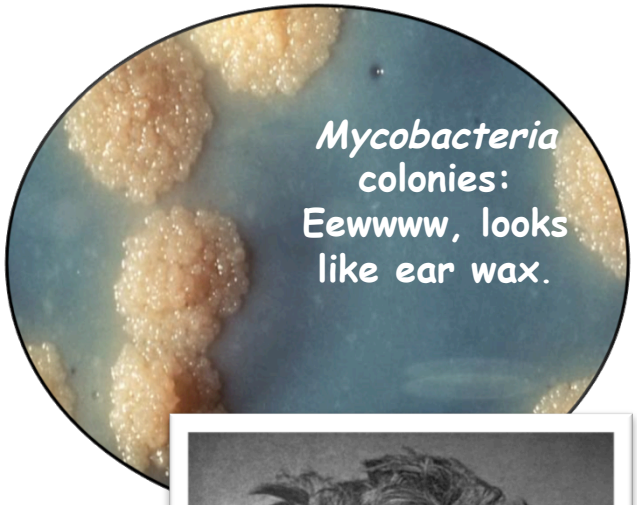
Bacterial Genus: *Mycobacterium*

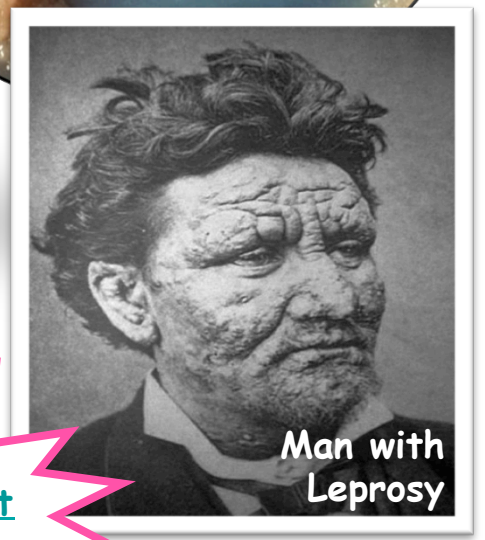
GRAM-variable, obligate aerobe, bacillus-shaped

Q: Why Gram variable?

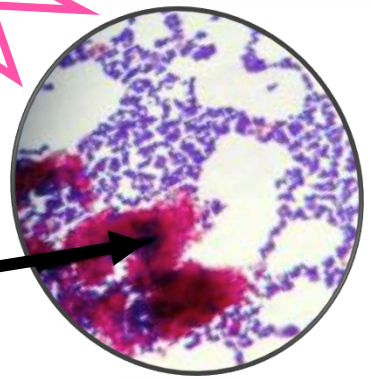
- Both **leprosy** and **tuberculosis** caused by *M. leprae* and *M. tuberculosis* respectively, have plagued mankind for centuries.
- Thought that *M. tuberculosis* and *M. leprae* evolved from a soil bacterium that infected cows, then made jump to humans about the time of animal domestication, 10,000 years ago.
- *M. tuberculosis* doubles population every 18-24 hours,
- *M. leprae* doubles population about every 14 days.

Q: What might be the impact of generation time on the course of the infectious diseases these microbes cause?





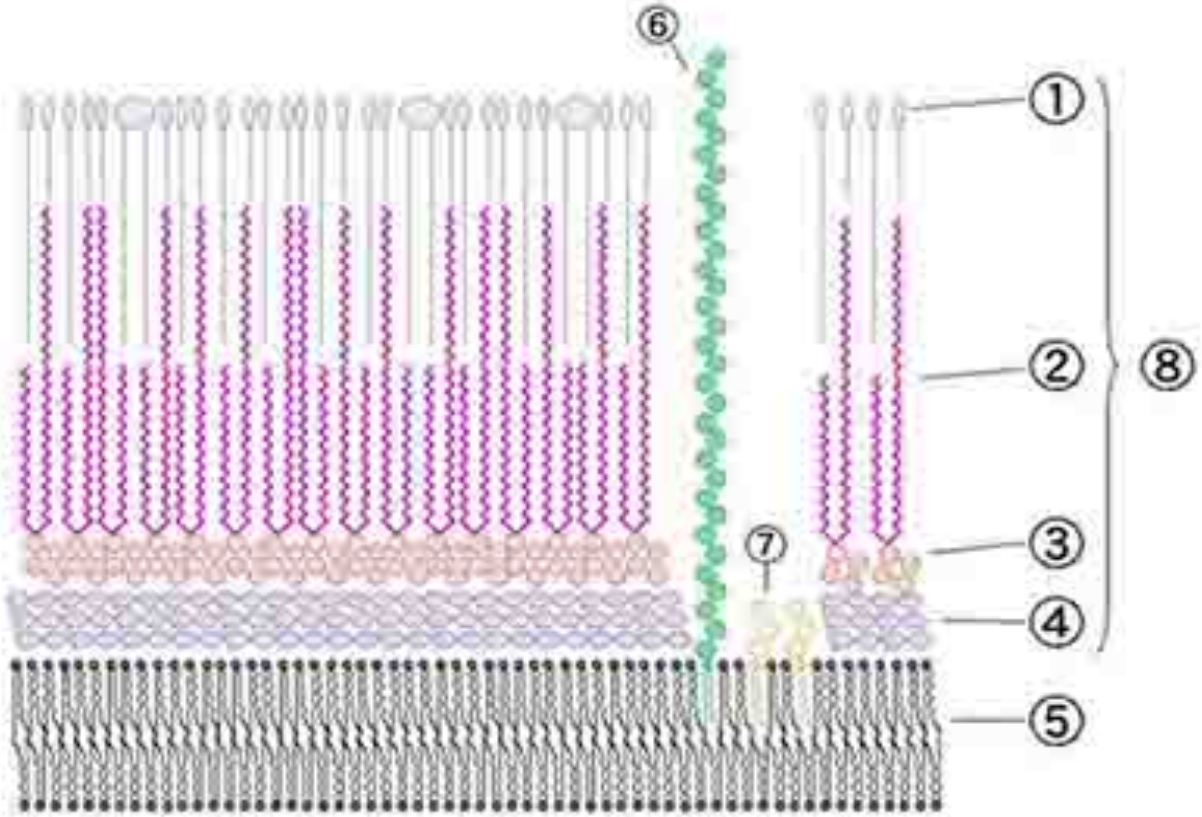
Acid-fast stain



The pink is our lab friend *Mycobacterium smegmatis*

Images: TB Culture, Public Health Image Library (PHIL) #4428, Dr. George Kubica; 24 yo man from Norway, suffering from leprosy; Pierre Arents; Acid fast stain of *Mycobacteria smegmatis* & *Staph*, T. Port

Mycobacterial Cell Wall



1. outer lipids
2. **mycolic acid**
3. polysaccharides
4. peptidoglycan
5. plasma membrane

6 & 7: Molecules involved in evading host immune cells & function.

8. cell wall

Because of waxy cell wall, they can survive exposure to acids, alkalis, detergents, oxidative bursts, lysis by immune system, and many antibiotics.

Image: Mycobacterial cell wall, Ytambe

Bacterial Genera: _____ & _____

GRAM NEGATIVE
Non-lactose fermenters
Facultative anaerobes, bacillus-shaped

Food poisoning: Infection in lining of small intestine caused by bacteria (both G+ & G-), including *Salmonella* and *Shigella*.

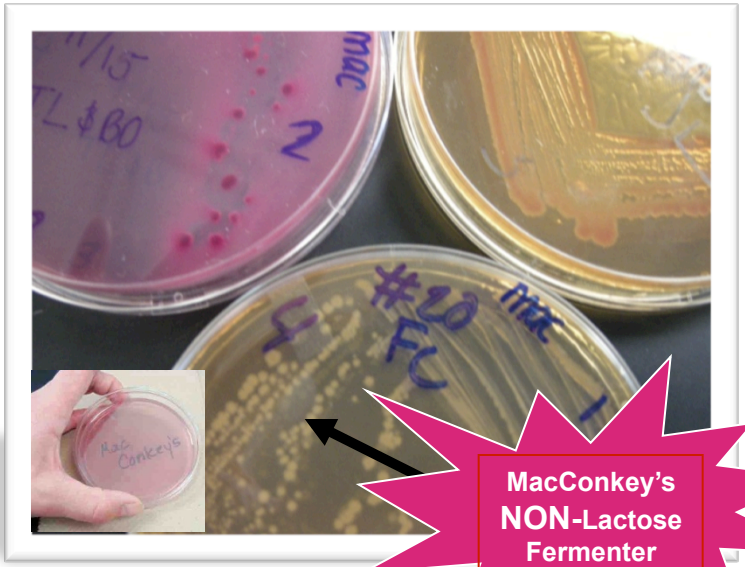
Transmission: Ingesting foods and materials that are fecally contaminated.

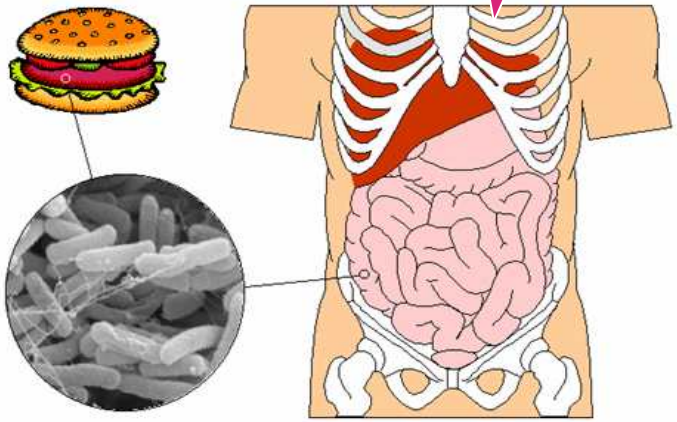
Symptoms / Course: Diarrhea, fever, and abdominal cramps **12 - 72 hours** after infection. Usually lasts **4 to 7 days**. Most recover without treatment. Severe infections may last **several weeks**.

Bacteria shed in feces. Carrier state exists in some people who shed the bacteria for 1 year or more following initial infection.

Treatment: Replace fluids. Don't use anti-diarrheals. May prolong illness.

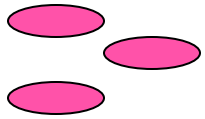
Thorough cooking kills these bacteria. Proper food handling, storage and good hand washing are preventive measures.





Images: MacConkey's media, one growing *Salmonella*, the ther *E. coli* (lactose fermenter); Food poisoning diagram, Shirley Owens, Michigan State University

Disease, Please: UTI



GRAM NEGATIVE Bacteria
Lactose fermenters
Facultative anaerobes, bacillus-shaped

CAUSE: Bacteria, usually *E. coli*, in urinary tract. More common in women due to short urethra and proximity to anus.

Bacteria must be able to "stick" to cause infection (otherwise bacteria would just get peed out).

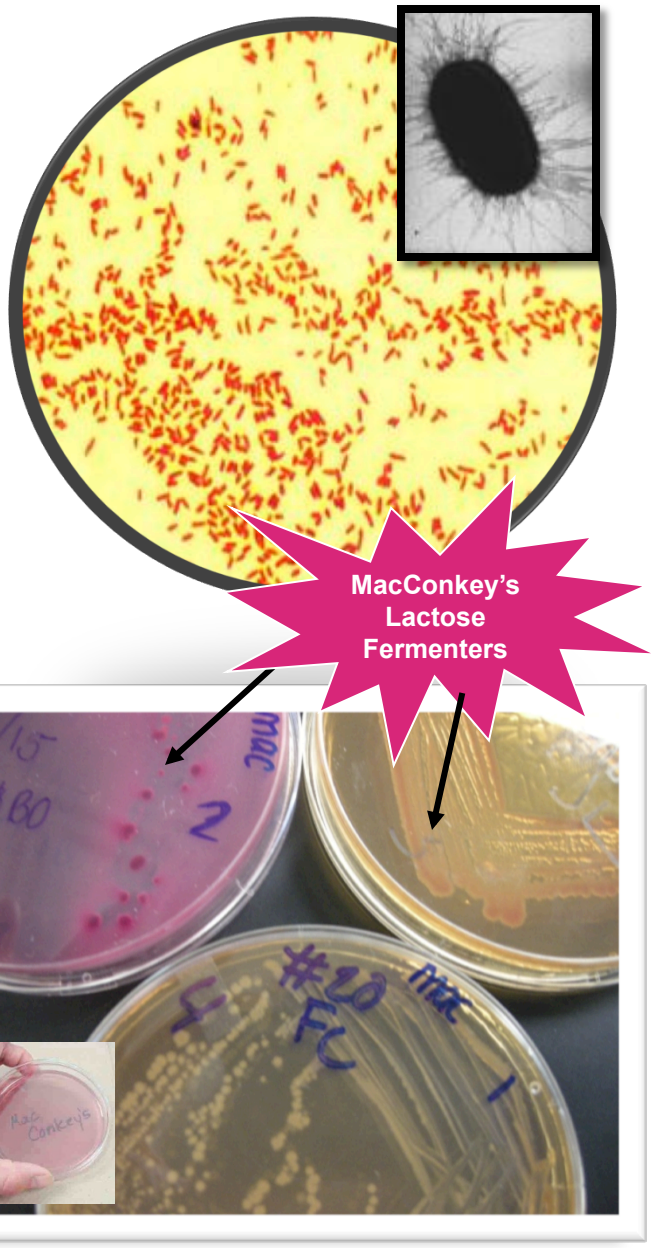
Bladder lined with proteins, to prevent this. *E. coli* has fimbriae to help it stick.

SYMPTOMS: Pain and tenderness in the genital region; burning and itching with urination.

TYPES OF UTIs:
If bacteria only in bladder only, called **cystitis**, a lower UTI.

If kidneys are infected, called **pyelonephritis** (say PIE-el-o-ne-fright-us), an upper UTI.

***Q:** Is penicillin usually prescribed for UTI infections?*



Images: *E.coli* with fimbria, National Library of Science; Gram stain *E. coli*, T. Port; MacConkey's, T. Port

Species: *Bordetella pertussis*

GRAM NEGATIVE

Aerobic, encapsulated coccobacilli

Causative agent of pertussis (whooping cough), a highly contagious disease spread through airborne droplets.

Produces violent coughing fits that make it difficult to breathe.

Disease named whooping cough due to the "whooping" sound that some sufferers make during severe coughing fits as they struggle to breathe.

In adults, symptoms can be mild, but in unvaccinated or undervaccinated babies, pertussis can be deadly.

***B. purtussis* virulence factors:** pertussis toxin, tracheal cytotoxin, filamentous hæmagglutinin (adhesion), pertactin (protein that promotes adhesion) & fimbria.

Prevention of pertussis:
Most effective prevention is immunization.

DTaP combination vaccine, given to children younger than 7, is used to protect against three infectious diseases: diphtheria, pertussis and tetanus.

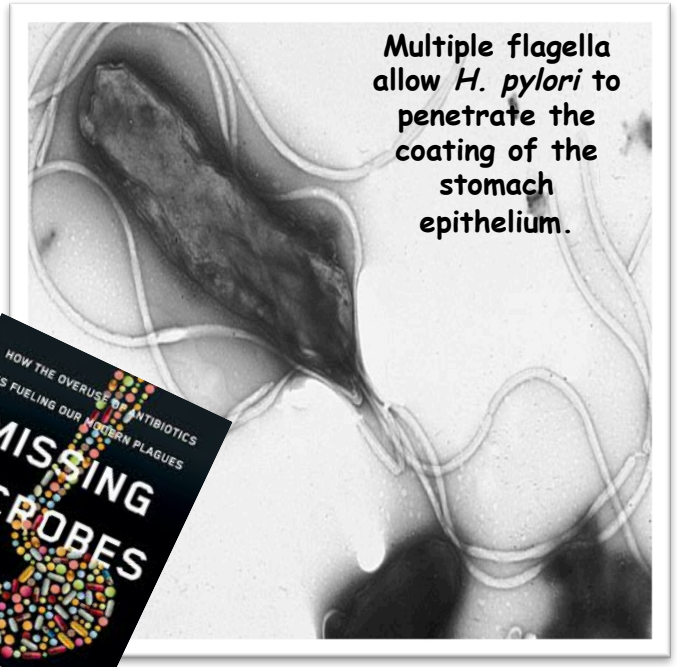
The Tdap and Td (protecting against tetanus and diphtheria only) are reserved for older children and adults.

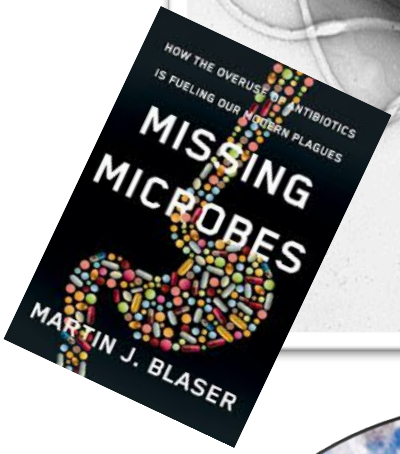
Go to > Whooping Cough Video, Mayo Clinic

Images: Young boy coughing due to pertussis; Gram stained *Bordetella pertussis*;

Species: *Helicobacter pylori*

GRAM NEGATIVE
Microaerophilic, Acidophile
Helically shaped





Robin Warran & **Barry Marshall** identified *H. pylori* in 1982, and discovered link between *H. pylori* and ulcers.

***H. pylori* virulence factors:**
- Make proteins that inhibit acid production
- Flagella propel through stomach lining to epithelial cells
- Have adhesins
- Make enzymes to inhibit phagocytosis

What Is an Ulcer?

A sore or hole in lining of the stomach or duodenum (the first part of the small intestine).

Not caused by stress or eating spicy food, but these factors can make ulcers worse.

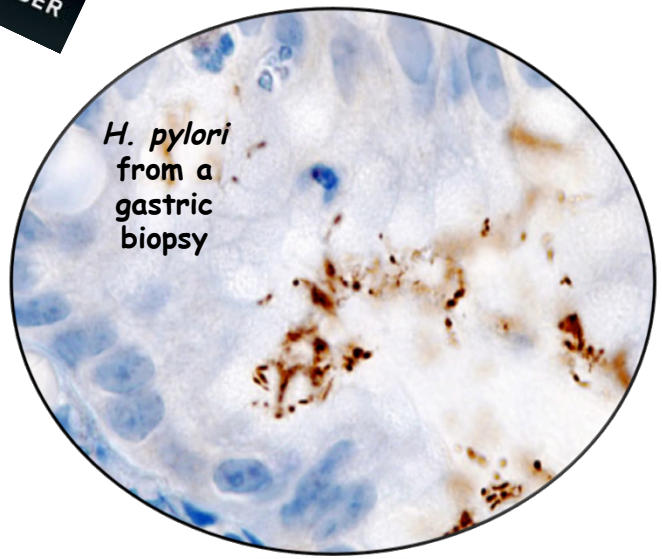
Symptoms:

Most common ulcer symptom is gnawing or burning pain in the abdomen between the breastbone and the belly button.

Incidence:

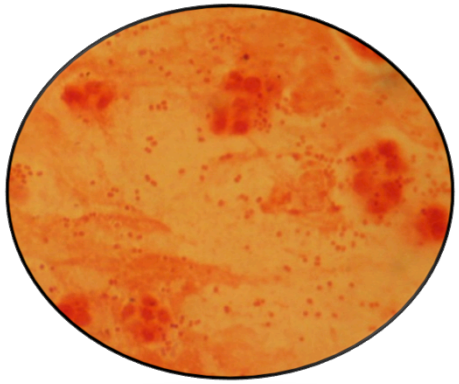
Many people have *H. pylori* infection, but most infected people, do not develop ulcers.

Q: Why doesn't everyone infected with this bacteria develop symptoms?



Images: *Helicobacter pylori*, Yutaka Tsutsumi, M.D; Histopathology of *H.pylori* from a gastric biopsy, KGH

Species: *Haemophilus influenzae*

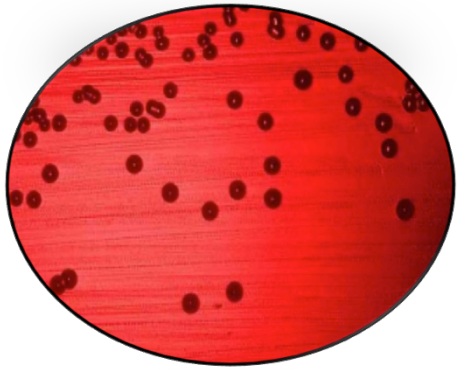


GRAM NEGATIVE (but difficult to Gram stain properly).

Aerobe & facultative anaerobe

H. influenzae first isolated during influenza pandemic of 1890, and mistakenly thought to be cause.

Q: What type of microbe causes influenza?



Fastidiuos microbe. Usually grown on chocolate blood agar because needs both hemin (factor X) and NAD (factor V)to grow.

Encapsulated & Unencapsulted

In 1930, two major categories of *H. influenzae* were defined: unencapsulated & encapsulated.

Q: What does it mean for a bacterium to be encapsulated?

Shape

Shape of *H. influenzae* varies: encapsulated typically coccobacilli, unencapsulated pleiomorphic.

Disease

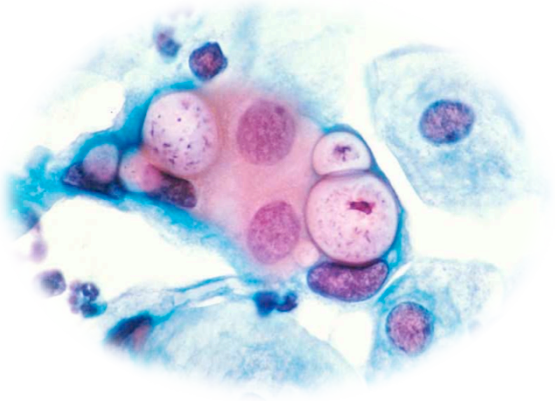
Unencapsulated strains commonly present on mucous membranes as normal flora, but can become opportunistic, causing ear infections (otitis media), eye infections (conjunctivitis), and sinusitis in children, and is associated with pneumonia.

Encapsulated *H. influenzae* are more **virulent**. Type b (Hib), an encapsulated serotype, causes bacteremia, pneumonia, and acute bacterial meningitis.

Hib vaccine decreased incidence of invasive Hib disease from 40-100/100,000 to 1.3/100,000, in U.S. children from 1980-1990.

Images: *H. influenzae*, in Gram stain of sputum sample, Bobjgalindo; H. influenzae colonies on Blood Agar, CDC;

Bacterial Genus: *Chlamydia*



Tiny obligate intracellular pathogen.

Once considered a virus, because of small size and reproduction inside host cells.

Stain **Gram -**, but no cell wall. Surrounded by two membranes, with no peptidoglycan between.

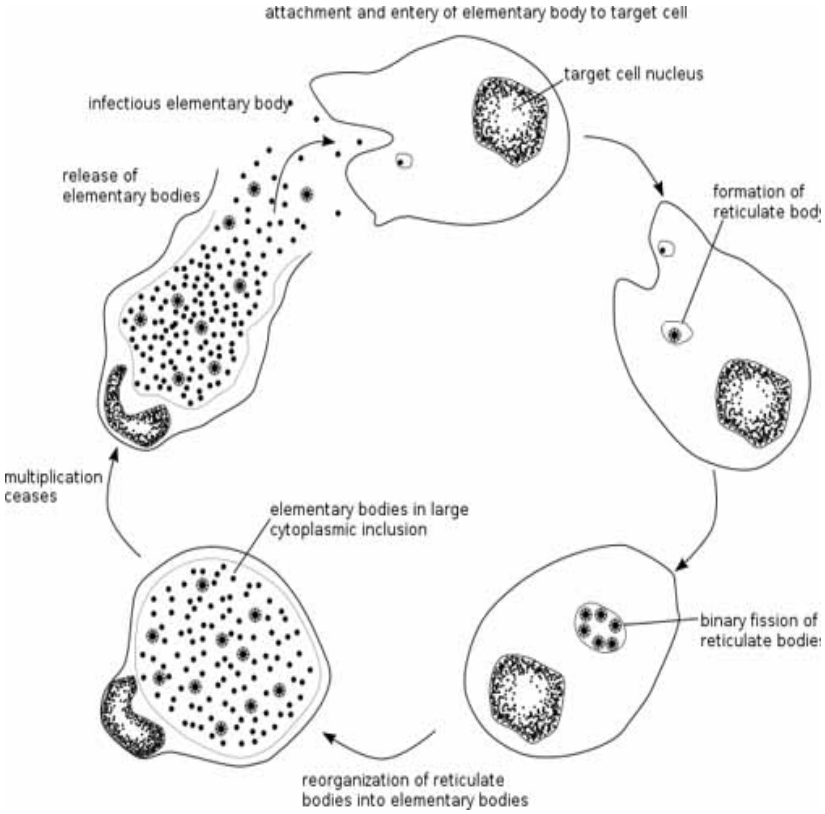
Weird lifecycle that involved two forms:

- Elementary bodies (EB): Dormant, can survive outside of cells, infective form.

- Reticluate bodies (RB): Grow and multiply in the host cell.

Host cell is killed when EB's emerge.

Cell death results in immune response that can damage area, especially if same site is reinfected.



Images:
Human pap smear showing *Chlamydia* in the vacuoles, Dr. Lance Liotta Laboratory; Life

From the Virtual Microbiology Classroom on ScienceProfOnline.com

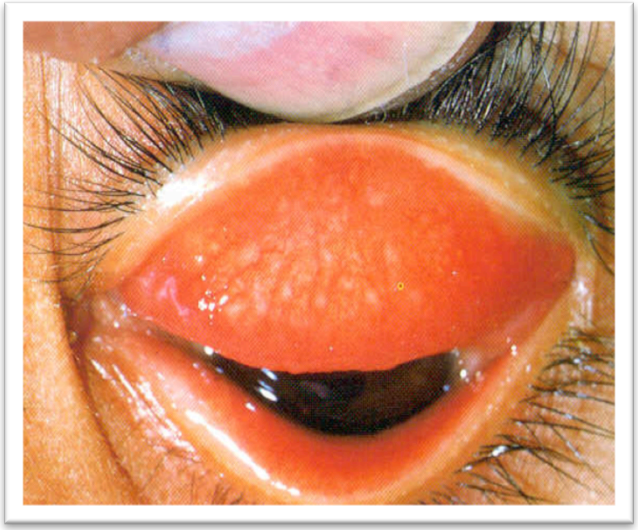
Disease, Please: Chlamydia

STD

- "Silent" disease: Most infected women (85%) and some infected men (25%) have no symptoms.
- Can cause serious complications that resulting in irreversible damage, including infertility.
- Transmitted during sex. Can be passed from an infected mother to her baby during vaginal childbirth.
- Most frequently reported bacterial sexually transmitted disease in the United States…and very underreported. Estimate is 2.8 million new cases annually.

Trachoma

- Infection of conjunctiva.
- Leading cause of non-traumatic blindness.
- Causes scarring of conjunctiva, and eyelid to turn inward. Eyelashes scrape, and scar the cornea, causing it to no longer be transparent.



Disease, Please: Syphilis

Organism: *Treponema pallidum*; identified as causative agent of syphilis in 1913.

Gram-, spirochete. Too thin to be seen without using a special stain such as Steiner silver. So Gram stain not useful.

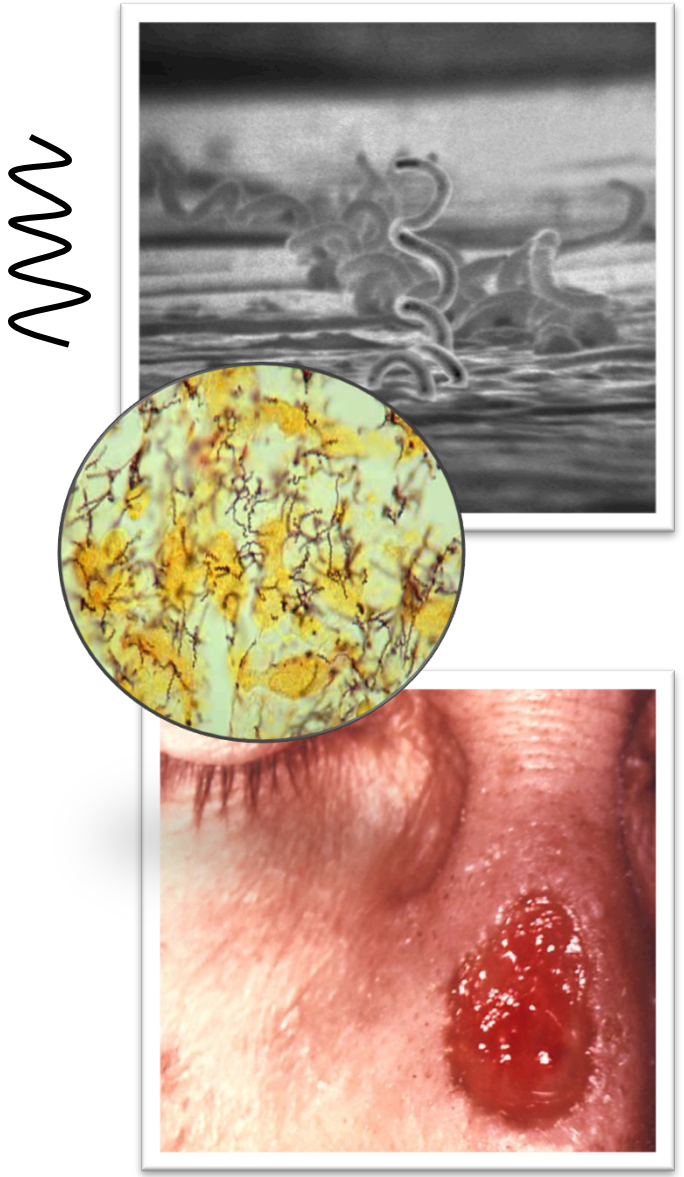
Transmission: Transmitted through direct sexual contact with infectious lesions. Never normal flora.

Symptoms:

- **Primary Stage:** Starts with single sore (chancre). Infection to first symptoms ranges from 10-90 days. Chancre lasts 3-6 weeks.
- **Secondary Stage:** Body rash with possible fever, swollen lymph glands, sore throat, hair loss, headaches, weight loss, muscle aches, & fatigue. Symptoms resolve, but without treatment, infection progresses.
- **Tertiary & Late Stage:** Can last for years. Develops in ~ 15% of untreated people. Can appear 10 – 20 years after infection acquired.

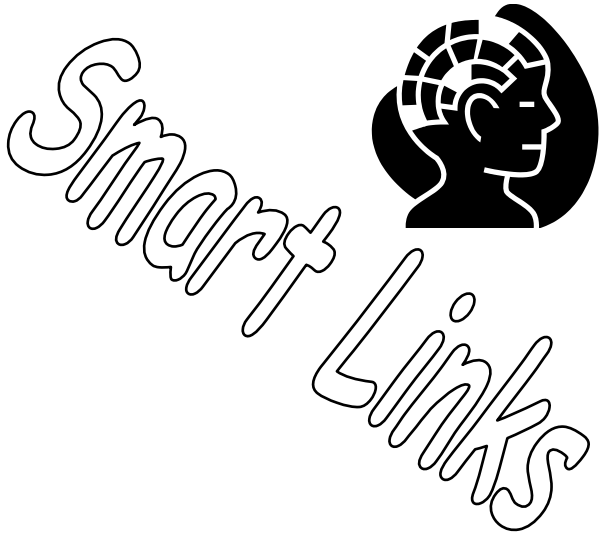
  Disease can cause damage of internal organs throughout body. Symptoms include difficulty coordinating muscle movements, paralysis, numbness, gradual blindness, and dementia. Damage may be serious enough to cause death.

Treatment: Easily treated with antibiotics.



Images *T. pallidum*, PHIL #1977; PHIL 836 *Treponema pallidum* spirochetes in testis of experimentally infected rabbit; Gumma of nose (noncancerous growth characteristic of tertiary syphilis), PHIL #5330

Confused?



Here are links to fun resources that further explain prokaryote taxonomy:

- Prokaryotes: Meet the Microbes Main Page on the Virtual Microbiology Classroom of Science Prof Online.
- "I've Got a Name" song by Jim Croche.
- Giant Microbes, a company that sells adorable stuffed microbes.
- "California's Pink Salt Lakes: A Strange Phenomenon Caused By Red Halobacteria", a webpage with great pictures of halophiles in environment, by WP Armstrong.
- STD Name Game, figure out the STD based on a description of symptoms from WebMD.
- 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.
- "Hey There Chlamydia" music video by the Bob Rivers Show.
- Bacteria Salad, a video game where you try to grow and sell produce without giving your customers bacterial dysentery.

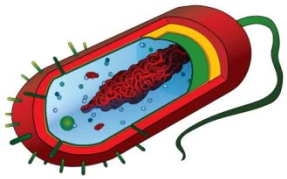
(You must be in PPT slideshow view to click on links.)

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: *Chlamydia*, Giant Microbes; Prokaryotic cell, Mariana Ruiz