# MICROBES
## (Viruses & Bacteria)

I. VIRUSES

A. General Characteristics of Viruses

- Viruses are infectious agents with both living and nonliving characteristics.
    - They can infect animals, plants, and even other microorganisms.

1. Living characteristics of viruses
    a. They reproduce at a fantastic rate, but only in living host cells.
    b. They can mutate.
2. Nonliving characteristics of viruses
    a. They are acellular, that is, they contain no cytoplasm or cellular organelles.
    b. They carry out no metabolism on their own and must replicate using the host cell's metabolic machinery.
        * In other words, viruses don't grow and divide. Instead, new viral components are made and assembled within the infected host cell.
    c. They possess DNA or RNA but never both.
3. Criteria used to define a virus
    a. They contain only one type of nucleic acid: DNA or RNA, but not both.
    b. They are totally dependent on a host cell for replication. (They are strict intracellular parasites.)
    c. Viral components must assemble into complete viruses (virions) to go from one host cell to another.

B. Structure

1. DNA or RNA core enclosed in a protein coat (capsid)
    - genetic material only codes for making copies of the virus
2. May have a viral envelope consisting of phospholipids around the capsid
3. No nucleus, cytoplasm, or membranes
4. smaller than a bacterial cell

C. Function

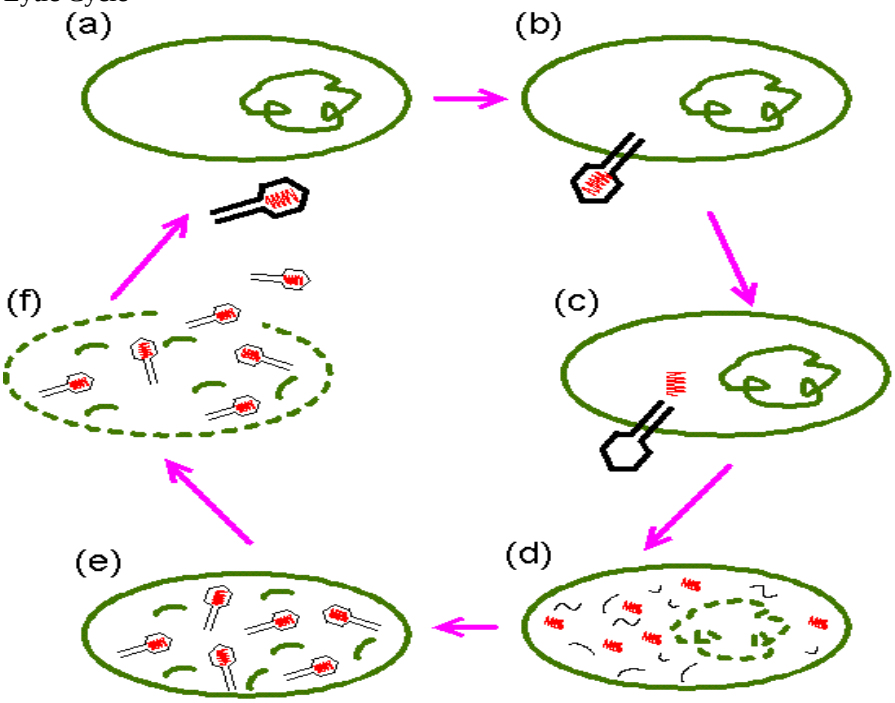
1. obligate intracellular parasites (require a host cell to reproduce)
2. do not carry out cellular fxns (i.e. respiration)
3. do not generate metabolic activity
4. bacteriophage – virus that infects bacteria
    T1-T7 are bacteriophages that infect the common intestinal bacterium *Escherichia coli* (*E. coli*)
5. mycophage - infect only fungi

D. Replication

1. before a virus can enter and reproduce in a cell, it has to recognize and attach to a specific receptor site on the plasma membrane of the host cell.
2. proteins on the surface of each virus has a 3-D shape that matches the shape of a molecule in the plasma membrane of its host cell.
3. once attached to the plasma membrane, the virus has to get inside the cell and take over the cell's metabolism.

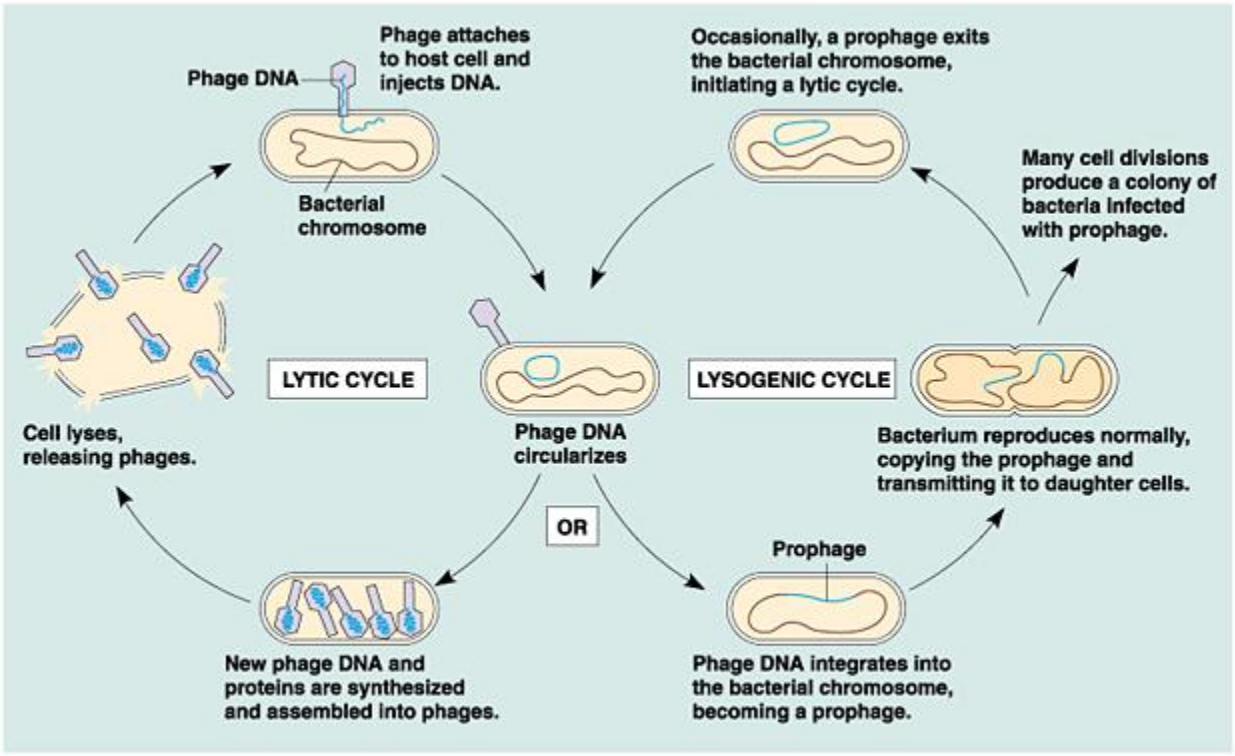
http://www.cat.cc.md.us/courses/bio141/lecguide/unit2/viruses/adlyt.html

Lytic Cycle




4. LYTIC CYCLE – host cell is destroyed
   - ATTACHMENT – (b) Attach to a host cell
   - ENTRY – (c) insert genetic material
   - REPLICATION – (d) Destroy host cell DNA/make new virus particles
   - ASSEMBLY – (e) Assemble new virus particles into new viruses
   - LYSIS and RELEASE – (f) Burst host cell to release virus
   - Attach to new host cell (a)

http://www.cat.cc.md.us/courses/bio141/lecguide/unit2/viruses/adlyso.html




5. LYSOGENIC CYCLE – host cell is not immediately destroyed, viral DNA becomes part of host cell's DNA
    - ATTACH - attach to a host cell
    - ENTRY - insert genetic material
    - INTEGRATION - Viral DNA becomes part of host's genetic makeup (prophage- does not interfere with normal functioning of a host cell)
    - REPRODUCTION - Viral DNA is reproduced each time the cell divides
    - EXIT - prophage "pops out" of the host cell's DNA
        - reasons for prophage popping out is unknown
    - LYTIC CYCLE - Enter into Lytic Cycle (attachment, entry, replication, assembly, lyses and release)

6. Diseases
    a. Cold Sores/Herpes Simplex 1 (Lysogenic cycle)
        - when virus pops out, you get another cold sore
    b. HIV (Retrovirus)
        - works by producing a small # of viruses each time it reproduces
        - as long as cells are producing only a small # of viruses, the person (host) may not show symptoms for some time
            - this shows why most people who have HIV develop AIDS
                - as more cells become infected and the viruses enter the lytic cycle, the WBCs are killed
                - eventually the body's immune system breaks down and can no longer fight off disease

# Kingdom Monera: The Prokaryotes

- Most numerous and widespread organisms
- Only kingdom of prokaryotic organisms
- Have a cell wall of peptidoglycan
    - structural molecule not found in eukaryotes

ARCHAEBACTERIA

- Most ancient of all living things
- 3 types
    1. Thermoacidophiles
        - extremely hot and acidic water
        - moist areas in and around sulfur hot springs
            - die of cold at temps of 55 C (131 F)
    2. Methanogens
        - obligate anaerobes (free Oxygen kills them)
        - 10 known species
        - use $CO_2$ to produce methane ($CH_4$) as waste
        - exist in diverse environments
            - from scalding volcanic deep-sea vents to intestines of mammals
                *this is why you can light a puff of flatulence!*
    3. Halophiles
        - extremely salty conditions
        - pink pigments = conspicuous in large concentrations
            - Dead Sea and Great Salt Lake

EUBACTERIA

Morphology

- shape, size, appearance
- lack membrane-bound nuclei
    - DNA forms a looped-tangle ("nucleoid"), but no membrane surrounds it
    - contain "plasmids" (small loops of DNA) – can be transmitted from one bacteria to another
        - transmitted through conjugation ("sex") or viruses
            - makes bacteria amazingly adaptable
            - beneficial genes (such as those for antibiotic resistance) may spread rapidly through a bacterial pop.
- No membrane-bound organelles (i.e. mitochondria or chloroplasts)
    - photosynthetic bacteria ("cyanobacteria") may be filled with tightly packed inner folds of the outer membrane.
        - increases potential surface area for photosynthesis
- Cell membrane surrounded by a cell wall
    - *except in one group = mollicutes/mycoplasmas
    - composition of cell wall varies
        - is an important tool for identification and classification

Shapes

- important identification and classification tool
- 3 basic types
    1. Bacilli (singular = bacillus)
        - rod-shaped
        - most common
        - *Escherichia coli* that lives in your intestines
        - *Lactobacillus spp.* (agents of tooth decay, ingredient in yogurt)
        - *Bacillus anthracis* (causes anthrax in sheep, cattle and humans)
    2. Cocci (singular = coccus)
        - spherical
        - very common
        - Streptococcus spp. (strep throat in humans)
            -"strepto" = chain

- Staphylococcus spp. (gangrene in untreated wounds)
  - "staphylo" = cluster

3. Spirilla (singular = spirillum)
   - spiral-shaped
   - largest in size
   - easiest to identify

Gram Staining

- developed by Danish physician Hans Christian Gram in 1884
  - most widespread methods of bacterial classification
  - identifies content of bacterial cell wall

Gram Stain Procedure

1. Fix smear of bacteria to a slide
2. (Primary stain) Flood slide with Crystal Violet for 10 seconds (wash with water)
3. (Mordant) Flood with Gram's Iodine for 10 seconds (wash with water)
4. (Decolorizer) Decolorize with 95% ethanol (wash with water)
5. (Secondary Stain) Flood with Safranin (pink) for 10 seconds (wash with water)
6. Air dry
7. Focus under light microscope to view outcome of bacterial appearance

- 2 types of cell walls
  1. Gram Negative Bacteria (G-)
     - appear bright pink to red after the staining procedure
     - have a second membrane surrounding the cell wall made up of lypopolysaccharides (LPS)
       - Crystal Violet dye cannot penetrate the LPS layer, it's rinsed out with the alcohol
     - 75% of known bacteria are G-
     - include rickettsias, chlamydias, and photosynthetic bacteria
  2. Gram Positive Bacteria (G+)
     - appear purple to brown after the staining procedure
     - have a membrane rich in peptidoglycan which attracts the Crystal Violet dye
     - No LPS layer
     - all rod-shaped bacteria are G+
- Cell wall characteristics are related to disease-causing potential
  - effective way to fight bacteria is by interfering with cell wall formation
    - b/c eukaryotic cell walls and membranes don't have a similar chemical makeup, the medicines used have no effect on the eukaryotic (plant or animal) cells

Locomotion

- squirm, glide, propulsion
- flagella is different from those in a eukaryotic cell
  - composed of a protein ("flagellin") not found in eukaryotes
  - rotates to propel organism instead of whip-like as in eukaryotes

Reproduction

- Conjugation
  - form of sexual reproduction
  - swapping genetic information
- Binary Fission
  - most bacteria reproduce this way
  - do not go through mitosis b/c of DNA structure

1. circular DNA molecule is replicated
2. then the cell splits into two identical cells each containing an exact copy of the original cell's DNA.

MYCOPLASMAS

- smallest living things ever discovered
- have the MIN amt. of DNA needed for a fxnal cell
- do not have cell wall characteristics of other bacterial types

- intracellular plant or animal parasites
    - protects them from changes in environmental and water pressures
- Penicillin (kills most other bacteria by interfering with cell wall fxning) does not work against Mycoplasmas b/c they have no cell wall

**Bacteria and Humans**

**Human microbiota** (or "flora"): microbial inhabitants of the human host

- approx half of the cells of a human are bacterial cells
- **Resident microbiota** - the collection of bacteria that form stable symbiotic relationships with us are called the
- **Transient microbiota** - bacteria just passing through
    - - includes the **Opportunistic pathogens**(cause disease if given a chance)

2. Where does the microbiota come from?
    - fetus is sterile (or nearly sterile)
        - -it is thought that the newborn picks up some bugs in the birth canal, most others in the hospital
        - newborn microbiota resembles that of a sick adult in many ways
        - by two years of age, the microbiota matures to closely resemble the adult ecosystem
3. What is the resident microbiota good for?
    - the general term for the association between microbes and us is **symbiosis**
        - **mutualism** - both we and microbes benefit from the symbiosis
        - **commensalism** - the microbe benefits without helping or harming us
        - **parasitism** - the microbe benefits, and harms us in the process
    - examples of mutualism
        - **immunoprotection**: providing antigens that will help us ward off later infections
        - providing vitamins
    - **commensalism** can become **parasitism** due to changes in location
4. Where the microbiota is (and isn't)
    - bacteria are not found (in healthy humans) in the…
        - **blood**: if bacteria are there, we call it bacteremia or blood poisoning
        - **cerebrospinal fluid** (tissue surrounding the brain and spinal chord): meningitis is the name of this infection
        - tissues
            - lungs-pneumonia
            - heart-endocarditis
            - brain-encephalitis
    - Where bacteria are (basically, every exposed area of our bodies)
        - skin
        - nasal area
        - eyes and ears
        - alimentary canal (mouth to anus) and genitourinary tract
5. What we do to keep out transients

- the nature of the mucosal surface