Chapter 20

VIRUSES & PROKARYOTES
Prokaryotes
The Structure of Bacteria

• 3 basic shapes: rod, spherical & spiral-shaped

• No nucleus

• Cell wall

• Flagella or cilia for movement
How Bacteria Obtain Energy

• Some make their own food (like plants).

• Some obtain their food (like us).

These bacteria eat the nutrients in the agar.
Reproduction in Bacteria

• Most reproduce through binary fission (asexual reproduction), making clones.
• Other bacteria exchange genetic information through **conjugation** (a.k.a. bacteria sex).
  • A hollow bridge forms between the 2 bacteria & genes move from 1 bacterium to the other.

• The advantage- it increases genetic diversity.
Bad Bacteria

• Bacteria that causes illness and disease.
  Ex: diphtheria, tuberculosis, typhoid fever, tetanus, syphilis, cholera, bubonic plague

• How are the diseases caused?
  – Bacteria damage the cells & tissues of an organism by breaking them down for food.
  or
  – Bacteria release toxins (poisons) that travel through the organism’s body.
"Good" Bacteria

• Bacteria that humans use and need in their everyday lives.

Escherichia coli (Esh-er-ish-e-ah coal-eye): one of many that live in your gut. Helps digest your food.

Lactobacillus acidophilus (lack-toe-bah-sill-us acid-off-ill-us): Turns milk into yogurt.

Pseudomonas putida (sue-doe-moan-us poo-tea-dah): Cleans wastes from sewage water at water treatment plants.
Arbuscular mycorrhizas (ar-bus-que-ler my-kuh-rye-zuh): one of a soil-living fungus family. Helps crops take up nutrients from the soil.

Streptomyces (strep-toe-my-seas): soil bacteria that makes streptomycin, an antibiotic.

Bacteria are Useful for:

- Nitrogen Fixation
- Recycling of Nutrients (decomposers)
- Foods & Medicines
- Producers

Ex: *Prochlorococcus* accounts for more $\frac{1}{2}$ of photosynthesis in open oceans.
How Do You Treat a Bacterial Infection?

• If prevention fails, take **antibiotics**.

• Antibiotics kill bacteria without harming the cells of humans or animals.
  - They interfere with the cellular processes of bacteria.

• Many antibiotics are produced naturally by living organisms.
  Ex: penicillin

• Others are synthetic (man-made).
Viruses
Virus Facts

• NONLIVING: can’t grow, develop, or respire and cannot replicate on their own.

• $\frac{1}{2}$ to 1/100 the size of the smallest bacterium.
What do viruses look like?

- Made of a core of genetic material surrounded by a protein coat (capsid).
- Come in a variety shapes: rod or tadpole-shaped; helical; cube like
How do viruses reproduce?

- Viruses insert their genetic material into a host cell.
  - The capsid (outside protein) “tricks” the cell into allowing it inside.

- Once inside, the viral genes take over.

- The “hijacked” cell transcribes the viral genes, using the host cells own enzymes.

- Lytic or Lysogenic Cycles
Viral Replication Cycles

**Lytic cycle:** Virus infects the cell, copies itself & causes the host cell to burst (lyse).
- ex: influenza (flu), cold, rabies, AIDS

**Lysogenic cycle:** Virus infects the cell & inserts its genetic material into the host's DNA. The host cell is not harmed.
- ex: Herpes, Varicella (chicken pox), HIV

http://www.youtube.com/watch?v=Rpj0emEGShQ
• Because viruses bind precisely to proteins on the host cell’s surface & use its genetic system, most viruses infect very specific types of cells.
   Ex: plant viruses infect plant cells, bacterial viruses infect bacteria (bacteriophages)
RETROVIRUSES

• Contain RNA as their genetic material.
  Ex: HIV

• Retroviruses infect a cell and produce a DNA copy of their RNA. (retro = backward; RNA is copied into DNA)

• This DNA is inserted into the host cell's DNA.
How Can You Protect Yourself From Viral Infections?

• The best way: vaccines
  - Weakened or killed virus or viral proteins.
  - When injected, the vaccine stimulates the immune system.
  - Sometimes produces permanent immunity.

• Protect yourself!
  - Stay away from known sick people.
  - Wash your hands often.
The Immune System and Disease
Chapter 35
Infectious Disease
infectious disease: changes to body physiology that disrupt normal body functions caused by microorganisms.

pathogen: a disease-causing agent; causes infection

-includes viruses, fungi, bacteria, protozoans & parasites
How are Diseases Spread?

- Coughing, sneezing, physical contact
- Exchange in body fluids
- Contaminated food & water
- Animal contact (zoonosis)
  - **vector**: animal carrier who transmits the disease, but doesn’t get sick themselves.
Defense Against Infection
Nonspecific Defenses

• General defense against many different pathogens.

• Include skin, tears & other secretions, inflammatory response, interferons & fever.
First Line of Defense

- Include skin, saliva, mucus, & tears.

- As long as they remain intact, they can keep out many pathogens.
Second Line of Defense

1.) interferons: chemicals released by virus-infected cells that slow down the progress of infection & buy time for the immune system to respond

2.) fever: higher body temperature slows down or stops the growth of some pathogens
3) inflammatory response

- A tissue response to injury or infection, producing redness, swelling, heat & pain.
- Chemicals released by damaged tissues attract white blood cells to the site.
- The mass of white blood cells, bacterial cells & damaged tissue forms pus.
Specific Defenses = the Immune System

- Very precise.
- Recognize “self” & “other” (& kill the “other”).
- Also known as immune response.
- Slower to respond than non-specific defenses.
Antigens & Antibodies

**antigen:** specific foreign molecules that trigger an immune response; usually located on a cell’s surface

**antibodies:** tag antigens for destruction by the immune system
- Shape allows it to bind to specific antigen. Body makes up to 10 billion different antibodies.
- Antibodies may be free floating or attached to B cells.
Lymphocytes (White Blood Cells)

Two Types:

B cells
- Produced & mature in red bone marrow.
- Have embedded antibodies.
- Discover antigens in body fluids.

T cells
- Produced in bone marrow & mature in thymus.
- Must be presented with antigens by infected body cells or immune cells.
The Immune System

• Two main types of specific immune response:
  1.) humoral immunity (pathogen is in fluids)
  2.) cell-mediated immunity (pathogen has invaded a cell)
Humoral Immunity

1.) Antibodies on B cells bind to antigens in body fluids (like blood & lymph).

2.) This stimulates rapid growth & division of B cells, both Plasma & Memory B cells.

3.) Plasma B cells make more antibodies that tag the antigens for destruction.

4.) Memory B cells remain alive after infection ends & quickly produce more Plasma B cells if the pathogen returns. (Why vaccinations work!)
Cell-mediated Immunity

- T cells destroy body cells containing viruses, fungi & cancer.
  1.) Infected cell displays antigen on its outer surface.
  2.) T cells are activated & kill infected cells.
  3.) Memory T cells are also produced to respond quickly if the pathogen returns.
- This is what causes organ rejection.

Humoral and cellular immunity
(antibody mediated or cellular)
Fighting Infectious Disease & Health
Vaccination

• Consists of pathogens that have been weakened or killed so they cannot cause a serious infection.

• Includes antigens that stimulate an immune response, but do not produce the severe symptoms of disease.
How Vaccines Work

1. A weakened or nonliving form of the germ is introduced through the skin.

2. B cells in the body make antibodies to kill the germs.

3. If exposed to the germ in the future. The antibodies will effectively kill or neutralize the germs.
Acquired Immunity

Active Immunity: Person produces an immune response to the antigen (including memory B & T cells) from either direct exposure (fighting the infection) or vaccination.

Passive Immunity: Antibodies produced against a pathogen by other individuals or animals produce temporary immunity. Ex: rabies antibody serum, mother to fetus, breast milk
Public Health Prevention of Diseases Spreading

1.) Regulating food and water supplies.
   - Cholera, Typhoid, Guinea worm
Public Health Prevention of Diseases Spreading

2.) Promoting vaccinations.

Herd Immunity

- Sustained transmission:
  - Transmitting case → Susceptible → Transmitting case → Susceptible
- Transmission terminated:
  - Transmitting case → Immune (indirectly protected) → Susceptible

Figure – The principle underlying herd immunity is that the presence of enough immune persons in a community interrupts the transmission of an infectious agent, thereby providing indirect protection for unimmunized (or “susceptible”) persons.
Herd Immunity
Public Health Prevention of Diseases Spreading

3.) Promoting behaviors that avoid spread of infection.
New and Re-Emerging Diseases

• Many diseases were eliminated or were under control in the 1980s (e.g. polio & smallpox).
• Over the past decade, we have had a resurgence of old diseases and introduction of new diseases (Ebola, SARS, hantavirus).
• Why has this happened??
Reasons for New and Re-Emerging Diseases

1.) Changing interactions with Animals:
   - Human & animal habitats combine.
   - Trade of exotic animals.
Reasons for New and Re-Emerging Diseases

2. Misuse of Antibiotics & medications:
   - Not following instructions on medication.
   - Overuse of antibiotics is causing resistance.