Unit 7 Epidemiology
Chapters 14 & 15

Host-Microbe Relationships

- **Symbiosis**: an association between two organisms
  - 3 Types:
    - Mutualism
    - Commensalism
    - Parasitism

Symbiotic Relationships

- **Mutualism**: symbiosis in which both species benefit
  > Ex. *E.coli* in the digestive system

- **Commensalism**: symbiosis in which one species benefits while the other is neither harmed nor helped
  > Ex. Bacteria on human skin that use our secretions

- **Parasitism**: symbiosis in which one species benefits and the other/host is harmed
  > Ex. Pinworm infections

Host Invasion Terms

- **Contamination**: the presence of microorganisms

- **Infection**: multiplication of any parasitic organism within or on the host; called an infestation when its worms or arthropods

- **Disease**: disturbance in the state of health & the body is unable to carry out all of its normal functions

Pathogenicity

- **Depends on microbial count**: (the number of infectious organisms that enter the body)

- **Virulence**: intensity of the disease produced by pathogens

- **Attenuation**: the weakening of the disease-producing ability of the pathogen (repeated subculturing to weaken it)
  > Rabies virus passed through rabbits so much that it adapts to them & no longer affects us as harshly when re-infected...how Pasteur created the rabies vaccine
Normal (Indigenous) Microflora

- $10^{14}$ microbes + $10^{13}$ body cells

Normal/resident microflora
- Not in the stomach, nervous system, or blood

Transient microflora
- Last for hours or months
- Chickenpox as an adult & you had a past infection

Opportunism

1. Host defense failure (immunocompromised people)
   - Malnutrition, another disease, young/elderly, treatment with radiation or immunosuppressant drugs

2. Microbes in unusual locations
   - E. coli in burns, urinary tract, or surgical wounds

3. Microflora disturbances
   - Microbial antagonism: when normal microflora are disturbed by antibiotics & pathogens that aren't the drug target cause infections

Brain Check

1. Symbiosis is an association between:
   - a) two or more species
   - c) two or more hosts
   - b) one or two species
   - d) no species but all hosts

2. A healthcare worker fails to follow aseptic procedures while cleaning a wound, but he washes his hands properly afterwards and suffers no ill effects—this is an example of:
   - a) commensalism
   - c) infestation
   - b) infection
   - d) contamination

3. All of the following refer to the normal microflora except
   - a) no microflora is found in the fetus
   - b) resident microorganisms normally do not cause disease
   - c) some microorganisms are resident while others are transient
   - d) resident microorganisms are found in nervous system and blood

Disease Types

- Infectious vs. non-infectious:
  - Infectious: diseases caused by a pathogen
  - Non-infectious: diseases caused by any factor other than pathogens

  1. Inherited diseases
  2. Congenital diseases
  3. Degenerative diseases
  4. Nutritional deficiency diseases
  5. Endocrine diseases
  6. Mental disease
  7. Immunological diseases
  8. Neoplastic diseases
  9. Latrogenic diseases
  10. Idiopathic diseases

Disease Types

- Communicable vs. non-communicable:
  - Communicable: spread from one host to another
  - Non-communicable: not spread from one host to another; Ex. Food poisoning from enterotoxins

  **Communicable Diseases**
  - HIV/AIDS
  - Influenza
  - Malaria
  - Polio
  - Tuberculosis
  - Hepatitis

  **Non-Communicable Diseases**
  - Cardiovascular disease
  - Cancer
  - Injury
  - Chronic Respiratory Disease
  - Diabetes
  - Other
Bacterial Pathogenicity

- Adherence factors
  - Cell structures that allow attachment to the host’s cell membrane (capsule, pili, slime layer, etc)
  - Adhesins: proteins or glycoproteins on attachment pili

- Enzymes
  - Enzymes can speed up invasion by invasiveness or their chemical properties
  - Invasiveness: the ability to invade and grow in host tissue
  - Hyaluronidase: a spreading factor because it dissolves the hyaluronic acid that helps hold certain cells in tissues together

Bacterial Toxins

Endotoxins
- Gram negative
- Released at cell death
- aka LPS (part of the cell wall)
- Fever
- Shock

Exotoxins
- Gram positive
- Secreted
- Proteins, usually enzymes (Ex. leukocidins for WBCs)
- Potent effects
- Specialized tissue damage (hemolysins, neurotoxins, enterotoxins)

Viral Pathogenicity

- Cytopathic effects

- Latent infections
  - Chickenpox

- Persistent infections
  - Hepatitis B on the liver

Eukaryotic Pathogen Effects

- Algae: direct skin cell invasion
- Fungi: mycotoxins & allergic reactions
- Protozoa: invade & reproduce in RBCs, attachment to linings, digest cells & tissues of host
- Helminths: attachment to linings, digest cells & tissues of host, release toxic wastes and antigens, produce allergic reactions
Disease stages
1. Incubation: time between the initial infection and the first signs or symptoms (various periods on p. 417)
2. Prodromal: mild symptoms; non-specific or specific
3. Invasive Disease: intense and major symptoms
   - Acme: the time when signs & symptoms are at their peak
4. Decline: when the host defenses and the effects of treatment finally overcome the pathogen
5. Convalescence: tissues are repaired, healing occurs, and the body regains strength & recovers

Factors influencing Infectious Disease Prevention
- Health care availability
- Emergence of new pathogens
- Social migration/Change
- Immigration

Brain Check
1. Which of the following is not a stage of an infectious disease?
   a) Invasive
c) Syndrome
b) Incubation
d) Prodromal

2. A leukocidin (a bacterial toxin):
   a) is an altered toxin that retains its antigenicity
b) is an endotoxin
c) is insoluble in host tissues
d) destroys or damages neutrophils (WBC’s)

Epidemiology
Definition: branch of microbiology that studies the factors and mechanisms involved in the frequency and spread of diseases and other health-related problems within human populations

- Incidence: the number of new cases contracted within a set pop. during a specific period of time (# new cases/100K ppl per yr)

Diseases in Populations
- Endemic: a disease that is continually present in the population of a particular geographical region, but both the # of cases & severity are too low to constitute a public health problem; Ex. chickenpox
- Epidemic: when a disease suddenly has a higher than normal incidence in a population; Ex. An outbreak of herpes in Birmingham
- Pandemic: when an epidemic spreads worldwide; Ex. AIDS, cholera
- Sporadic: occurs in a random and unpredictable manner
Diseases in Populations & Epidemiologic Studies

- Common source outbreak: an epidemic that arises from contact with contaminated substances (water contaminated with fecal material or improperly handled food)

- Types of epidemiologic study
  - Descriptive: physical aspect of the existing disease & its spread (# of cases, pop. affected, and the locations & time periods of the cases)
  - Analytical: establishes cause & effect relationships of the disease
  - Experimental: designs experiments to test hypotheses, usually related to treatment of diseases

First Epidemiologic Study Cholera in London 1854

Brain Check

1. The worldwide spread of an infectious disease is called a/an:
   a) epidemic  c) sporadic
   b) endemic  d) pandemic

2. An epidemiologist that studies the number of cases of a disease, those segments of the population affected by a disease and the locations and time periods of a disease while the outbreak occurs deals with what type of epidemiology?
   a) Analytical  c) Experimental
   b) Descriptive  d) None of these choices

Reservoirs of Infection

- Reservoir: since pathogens cannot survive outside the host for very long, these are places where they can maintain their ability to infect

1. Human: carriers; subclinical or inapparent infections—signs & symptoms are too mild for recognition unless special tests are done

2. Animal: zoonoses—diseases that can be transmitted under natural conditions to humans from other vertebrates (domestic pets & rabies; mosquitoes & malaria)

3. Non-living: soil, water, & improperly prepared food

Portals of Entry

1. Skin
2. Body openings
3. Mucous membranes (digestive, respiratory, & urogenital systems)
4. Parenteral sites (injured tissue)
5. Placenta

***Pathogenicity may depend on portal of entry

Portals of Exit

1. Waste products
2. Secretions
3. Blood/pus
4. Milk
Modes of Disease Transmission

1. Contact transmission: when there is close association between the infected person and a possible host
   - **Direct**: requires body contact between individuals
     - **Horizontal contact**: shaking hands, kissing, touching sores, sexual contact
     - **Vertical contact**: passed from parent to offspring (placenta, sperm/egg, milk, birth canal)
   - **Indirect**: through **fomites** which are nonliving objects that can harbor and transmit an infectious agent (dishes, utensils, syringes, doorknobs)
   - **Droplets**: coughing, sneezing, or speaking

2. Vehicle transmission: the use of a **vehicle** which is a nonliving carrier from its reservoir to a host.
   - **Waterborne**: fecal-oral transmission
   - **Airborne**
   - **Foodborne**

3. Vector transmission: **vectors** are living organisms that transmit disease to humans; most are arthropods (ticks, fleas, mosquitoes, flies, and lice)
   - **Mechanical vectors**: passive transmission of the pathogen through arthropod feet and body parts
   - **Biological vectors**: when the pathogen reproduces in the vector, and then the vector goes and bites a person

Challenges

- Carrier status
- STDs
- Zoonoses
- Disease cycles
- Herd Immunity

Controlling Disease Transmission

1. **Isolation**: when a patient with a communicable disease is prevented from having contact with the general pop.
2. **Quarantine**: the separation of “healthy” human or animal carriers from the general pop. when they have been exposed to a communicable disease
3. **Immunizations**: use of safe vaccines to increase the herd community (measles, polio, mumps, diphtheria, & whooping cough)
4. **Vector control**: treatment with insecticides or rodenticides
Public Health Organizations

- CDC
- WHO

**Notifiable Diseases:** Infectious diseases potentially harmful to the public's health and must be reported to physicians.

Nosocomial Infections

- **Exogenous versus Endogenous Infections**
  - Exogenous: Infections caused by organisms that enter the patient's body
  - Endogenous: Infections caused by opportunists among the patient's own normal microflora

- **Contributing factors**
  - Patient susceptibility
  - Microbial virulence
  - Chain of transmission:
    1. The staff can give to patient
    2. A patient can give to another patient
    3. Fomites (nonliving) to patient [catheter]
    4. Ventilation system to patient

Common Pathogens in Nosocomial Infection

Controlling Transmission

1. Universal Precautions
2. Minimizing invasive procedures
3. Surveillance
4. Antibiotic use

Exogenous Transmission

Brain Check

1. A site where microorganisms can persist and thus maintain the ability to cause infection:
   a) Control group
   b) Portal of exit
   c) Reservoir
   d) Portal of entry

2. Pathogenic microorganisms that are spread from person to person by unwashed hands contaminated by fecal matter, is an example of what mode of transmission?
   a) Fomite transmission
   b) Vector transmission
   c) Droplet transmission
   d) Direct transmission

3. Pathogens that are delivered by insects follow what mode of disease transmission?
   a) Airborne
   b) Foodborne
   c) Vehicleborne
   d) Vectorborne
Brain Check

4. Transmission of pathogens from person to person via sneezing, coughing or by the affected individual speaking near (less than 1 meter) a susceptible individual are examples of what mode of transmission?
   a) Vertical transmission
   b) Indirect contact transmission
   c) Direct fecal-oral transmission
   d) Contact transmission

5. Pathogenic microorganisms that enter the body via contaminated food or water typically infect:
   a) the respiratory system
   b) the skin
   c) only vertebrate animals
   d) the digestive system

6. An infection acquired in the hospital or other medical facility is:
   a) Zoonotic
   b) notifiable
   c) exogenous
   d) nosocomial

Bioterrorism

- Threats
- Control measures