**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 infection 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

Causes of Disease: Koch’s Postulates
- Four criteria that were established by Robert Koch to identify the causative agent of a particular disease
1. The microorganism or other pathogen must be present in all cases of the disease
2. The pathogen can be isolated from the diseased host and grown in pure culture
3. The pathogen from the pure culture must cause the disease when inoculated into a healthy, susceptible laboratory animal
4. The pathogen must be reisolated from the new host and shown to be the same as the originally inoculated pathogen

Brain Check
1. Symbiosis is an association between:
   - a) two or more species
   - b) one or two species
   - c) two or more hosts
   - 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
   - b) infection
   - c) 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

4. Which of the following microbes easily satisfies Koch’s postulates?
   - a) Fastidious bacteria
   - b) Sepsis for which many microbes are regularly isolated
   - c) Hepatitis C for which there is no suitable animal model
   - d) *Yersinia*, the causative agent of plague as it can be isolated from sick patients
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. Idiopathic diseases
10. Infectious vs. non-infectious:
    - Communicable: spread from one host to another
    - 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
- 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)

Exotoxin - Hemolysin

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**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

**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)

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

**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)
Epidemiology
◦ Prevalence: total number of people infected within the population at any time
◦ Morbidity rate: the number of individuals affected by a disease during a set period in relation to the total population (# of cases/100K ppl per yr)
◦ Mortality rate: the number of deaths due to a disease in a pop. during a specific period in relation to the total population (# of deaths/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

Exogenous Transmission
ControllingTransmission

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

Brain Check

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

3. Pathogens that are delivered by insects follow what mode of disease transmission?
   a) Airborne  c) Vehicleborne
   b) Foodborne   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  c) Direct fecal-oral transmission
   b) Indirect contact transmission  d) Contact transmission

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

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

Bioterrorism

- Threats
- Control measures

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