Chapter 14
Principles of Disease and Epidemiology

**Normal Microbiota and the Host**

*Define normal and transient microbiota.*

- Transient microbiota may be present for days, weeks, or months, but then disappear
- Normal microbiota permanently colonize the host
- Symbiosis is the relationship between normal microbiota and the host
- Animals/humans are usually germ-free in utero, but colonization soon begins after birth

*Representative normal microbiota*

- Bacteria on skin
- Plaque on teeth enamel
- Bacteria in large intestine

*Normal Microbiota and the Host:*

*Compare commensalism, mutualism, and parasitism, and give an example of each.*

- In commensalism, one organism is benefited and the other is unaffected. (+ 0)
- In mutualism, both organisms benefit. (+ +)
- In parasitism, one organism is benefited at the expense of the other. (+ -)
- Some normal microbiota are opportunistic pathogens if they gain access to other parts of the body.
- Microbial antagonism—normal microbiota can prevent pathogens from causing infections.
- Cooperation among microorganism species can make it possible for one to cause disease or greater symptoms

*Normal Microbiota and the Host:*

*Contrast normal and transient with opportunistic microbes.*

- Locations of normal microbiota on and in the human body
- If E. coli gains access to other body sites than large intestine, it becomes an opportunistic pathogen
- AIDS often accompanied by opportunistic infections (low immunity)
Microbial antagonism is competition between microbes.

Normal microbiota protect the host by:
- occupying niches that pathogens might occupy
- producing acids
- producing bacteriocins

Probiotics are live microbes applied to or ingested into the body, intended to exert a beneficial effect.

Koch's Postulates

1. Same pathogen present in every case of disease
2. Pathogen isolated from diseased host and grown in pure culture
3. Pathogen from pure culture must cause disease when in healthy host animal
4. Pathogen reisolated from inoculated animal is original organism

Exceptions:
- Etiologies of viruses and some bacteria not grown on artificial media
- Tetanus which has unequivocal signs
- Pneumonia caused by variety of microbes
- Some pathogens causing several diseases
- HIV causes disease in humans only

Classifying Infectious Diseases

Communicable disease
A disease that is easily spread from one host to another. (direct/indirect)

Contagious disease
A disease that is easily spread from one host to another.

Noncommunicable disease
A disease that is not transmitted from one host to another.

Define herd immunity.
Incidence Fraction of a population that contracts a disease during a specific time.

Prevalence Fraction of a population having a specific disease at a given time.

Sporadic disease Disease that occurs occasionally in a population.

Endemic disease Disease constantly present in a population.

Epidemic disease Disease acquired by many hosts in a given area in a short time.

Pandemic disease Worldwide epidemic.

Herd immunity Immunity in most of a population.

Acute disease Symptoms develop rapidly.

Chronic disease Disease develops slowly.

Subacute disease Symptoms between acute and chronic.

Latent disease Disease with a period of no symptoms when the patient is inactive.

Local infection Pathogens limited to a small area of the body.

Systemic infection An infection throughout the body.

Focal infection Systemic infection that began as a local infection.

Bacteremia Bacteria in the blood.

Septicemia Growth of bacteria in the blood.

Toxemia Toxins in the blood.

Viremia Viruses in the blood.

Primary infection Acute infection that causes the initial illness.

Secondary infection Opportunistic infection after a primary (predisposing) infection.

Subclinical disease No noticeable signs or symptoms (inapparent infection).

Notice 12 years for first 250 K cases, then 3 and 5 years for next 250 K.

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Identify four predisposing factors for disease.

Make the body more susceptible to disease

- Gender
- Short urethra in females
- Inherited traits such as the sickle-cell gene
- Climate and weather
- Fatigue
- Age
- Lifestyle
- Chemotherapy
## Development of a Disease

1. Incubation period: time interval between initial infection and first appearance of signs/symptoms
2. Prodromal period: appearance of first mild signs/symptoms
3. Illness period: disease at height and all signs/symptoms apparent
4. Decline period: signs and symptoms subsiding
5. Convalescence period: body returns to prediseased state

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## Reservoirs of Infection

**Define reservoir of infection.**

Contrast human, animal, and nonliving reservoirs, and give one example of each.

- Reservoirs of infection are continual sources of infection.
  - Human — AIDS, gonorrhea
  - Carriers may have inapparent infections or latent diseases
  - Animal — Rabies, Lyme disease
  - Some zoonoses may be transmitted to humans
  - Nonliving — Botulism, tetanus
  - Soil or water

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## Transmission of Disease

- **Contact**
  - Direct Requires close association between infected and susceptible host
  - Indirect Spread by fomites (inanimate objects)
  - Droplet Transmission via airborne droplets
  - Vehicle By medium like water, food, air
  - Airborne Carried on water droplets or dust > 1 m
  - Arthropod Vectors carry pathogens between hosts

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## Zoonoses

Zoonoses are diseases that affect wild and domestic animals and can be transmitted to humans.

<table>
<thead>
<tr>
<th>Table 14.2 Selected Zoonoses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td><strong>Viral</strong></td>
</tr>
<tr>
<td>Rabies</td>
</tr>
<tr>
<td>Western equine encephalitis</td>
</tr>
<tr>
<td>Necrotizing pulmonary syndrome (NPS)</td>
</tr>
</tbody>
</table>

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### Figure 14.6a & b

**Transmission of Disease**

**Zoonoses**

*Contact*  
*Droplet transmission*
**Transmission of Disease**

- **Vehicle**: Transmission by an inanimate reservoir (food, water)
- **Vectors**: Arthropods, especially fleas, ticks, and mosquitoes
- **Mechanical**: Arthropod carries pathogen on feet
- **Biological**: Pathogen reproduces in vector

**Nosocomial (Hospital-Acquired) Infections**

Define nosocomial infections and explain their importance.

- Are acquired as a result of a hospital stay
- 5-15% of all hospital patients acquire nosocomial infections
Common Causes of Nosocomial Infections

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Percentage of nosocomial infections</th>
<th>Percentage resistant to antibiotics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gram + cocci</td>
<td>34%</td>
<td>28%-87%</td>
</tr>
<tr>
<td>Gram – rods</td>
<td>32%</td>
<td>3-34%</td>
</tr>
<tr>
<td>Clostridium difficile</td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td>Fungi</td>
<td>10%</td>
<td></td>
</tr>
</tbody>
</table>

**Relative frequency of nosocomial infections**

- Urinary tract infections: 24%
- Sternal site infections: 17%
- Lung respiratory infections: 14%
- Bacteria caused primarily by IV catheterizations: 13%
- Other, including skin infections: 13%

Compromised Host

**Define compromised host.**

- Compromised host is one whose resistance to infection is impaired by disease, therapy, or burns.
- Two principal conditions can compromise the host:
  1. Broken skin or mucous membranes
  2. Suppressed immune system.
- Chain of transmission
  1. Direct contact between staff and patients
  2. Fomites (inanimate) like catheters, syringes, respiratory devices

Emerging Infectious Diseases (EIDs)

**List five probable reasons for emerging infectious diseases, and name one example for each reason.**

- Diseases that are new, increasing in incidence, or showing a potential to increase in the near future.
- Contributing factors:
  - Evolution of new strains
    - V. cholerae O139
  - Inappropriate use of antibiotics and pesticides
  - Antibiotic resistant strains
  - Changes in weather patterns
  - Hantavirus
Emerging Infectious Diseases

- Contributing factors:
  - Modern transportation
  - West Nile virus
  - Ecological disaster, war, expanding human settlement
  - Coccidioidomycosis
  - Animal control measures
  - Lyme disease
  - Public Health failure
  - Diphtheria

Epidemiology

- The study of where and when diseases occur (transmission, incidence, frequency)

Epidemiology History

- John Snow 1848-1849: Mapped the occurrence of cholera in London
- Ignaz Semmelweis 1846-1848: Showed the hand washing decreased the incidence of puerperal fever
- Florence Nightingale 1858: Showed that improved sanitation decreased the incidence of epidemic typhus

Defining Epidemiology and Three Types of Epidemiologic Investigation

- Descriptive: Collection and analysis of data regarding occurrence of disease
- Analytical: Comparison of a diseased group and a healthy group
- Experimental: Study of a disease using controlled experiments
- Case reporting: Health care workers report specified disease to local, state, and national offices
- Nationally Notifiable Diseases: Physicians are required to report occurrence

Table 14.4 Emerging Infectious Diseases

<table>
<thead>
<tr>
<th>Microorganism</th>
<th>Year of Emergence</th>
<th>Disease Caused</th>
<th>Geographic Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacillus anthracis</td>
<td>1854</td>
<td>Anthrax</td>
<td>22</td>
</tr>
<tr>
<td>Streptococcus pneumoniae</td>
<td>1876</td>
<td>Pneumonia, bacteremia</td>
<td>24</td>
</tr>
<tr>
<td>Staphylococcus pyogenes</td>
<td>1910</td>
<td>Staphylococcal toxic shock syndrome</td>
<td>23</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>1886</td>
<td>Typhoid fever, bacillary dysentery</td>
<td>26</td>
</tr>
<tr>
<td>Pneumococcus</td>
<td>1895</td>
<td>Pneumonia</td>
<td>25</td>
</tr>
<tr>
<td>Typhoid</td>
<td>1881</td>
<td>Typhoid fever</td>
<td>23</td>
</tr>
<tr>
<td>Malaria</td>
<td>1894</td>
<td>Malaria</td>
<td>31</td>
</tr>
<tr>
<td>Rabies</td>
<td>1885</td>
<td>Rabies</td>
<td>35</td>
</tr>
<tr>
<td>Diphtheria</td>
<td>1881</td>
<td>Diphtheria</td>
<td>22</td>
</tr>
<tr>
<td>Plague</td>
<td>1894</td>
<td>Plague</td>
<td>22</td>
</tr>
<tr>
<td>Typhoid</td>
<td>1885</td>
<td>Typhoid fever</td>
<td>31</td>
</tr>
<tr>
<td>Yellow fever</td>
<td>1881</td>
<td>Yellow fever</td>
<td>22</td>
</tr>
<tr>
<td>Smallpox</td>
<td>1881</td>
<td>Smallpox</td>
<td>22</td>
</tr>
<tr>
<td>Anthrax</td>
<td>1854</td>
<td>Anthrax</td>
<td>22</td>
</tr>
</tbody>
</table>

Table 14.6 Nationally Notifiable Diseases, 2002

<table>
<thead>
<tr>
<th>Disease</th>
<th>Year of Description</th>
<th>Disease Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute respiratory disease (ARD)</td>
<td>2002</td>
<td>Acute respiratory disease</td>
</tr>
<tr>
<td>Anthrax</td>
<td>2004</td>
<td>Anthrax</td>
</tr>
<tr>
<td>Bubonic plague</td>
<td>2004</td>
<td>Bubonic plague</td>
</tr>
<tr>
<td>Cholera</td>
<td>2004</td>
<td>Cholera</td>
</tr>
<tr>
<td>Coccidioidomycosis</td>
<td>2004</td>
<td>Coccidioidomycosis</td>
</tr>
<tr>
<td>Diphtheria</td>
<td>2004</td>
<td>Diphtheria</td>
</tr>
<tr>
<td>E. coli O157</td>
<td>2004</td>
<td>E. coli O157</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>2004</td>
<td>Escherichia coli</td>
</tr>
<tr>
<td>Francisella tularensis</td>
<td>2004</td>
<td>Francisella tularensis</td>
</tr>
<tr>
<td>Influenza</td>
<td>2004</td>
<td>Influenza</td>
</tr>
<tr>
<td>Legionnaires disease</td>
<td>2004</td>
<td>Legionnaires disease</td>
</tr>
<tr>
<td>Meningococcal disease</td>
<td>2004</td>
<td>Meningococcal disease</td>
</tr>
<tr>
<td>Mumps</td>
<td>2004</td>
<td>Mumps</td>
</tr>
<tr>
<td>Pertussis</td>
<td>2004</td>
<td>Pertussis</td>
</tr>
<tr>
<td>Poliomyelitis, paralytic</td>
<td>2004</td>
<td>Poliomyelitis, paralytic</td>
</tr>
<tr>
<td>Rabies</td>
<td>2004</td>
<td>Rabies</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>2004</td>
<td>Rotavirus</td>
</tr>
<tr>
<td>Scarlet fever</td>
<td>2004</td>
<td>Scarlet fever</td>
</tr>
<tr>
<td>Shigellosis</td>
<td>2004</td>
<td>Shigellosis</td>
</tr>
<tr>
<td>Tetanus</td>
<td>2004</td>
<td>Tetanus</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>2004</td>
<td>Tuberculosis</td>
</tr>
<tr>
<td>West Nile virus</td>
<td>2004</td>
<td>West Nile virus</td>
</tr>
</tbody>
</table>

Epidemiology History

- Florence Nightingale 1858: Showed that improved sanitation decreased the incidence of epidemic typhus
Collects and analyzes epidemiological information in the U.S.


Morbidity: incidence of a specific notifiable disease
Mortality: deaths from notifiable diseases

Morbidity rate = number of people affected/total population in a given time period

Mortality rate - number of deaths from a disease/total population in a given time