Chapter 13

Topics
- Human Host
- Progress of an Infection
- Epidemiology

Human Host

- Acquire resident flora
- New born exposure - how do we acquire our normal flora?

Acquire resident flora

- The human body supports a wide range of habitats
  - temperature, pH, nutrient, oxygen tension
- Wide range of microbes can inhabit
- Resident flora or microflora
  - Microbes (from bacteria to sometimes viruses) that inhabit but do not harm the host

- Beneficial outcome
  - Provide nutrients (Vit K)
  - Microbial antagonism
  - Development of immune system
- Adverse effects
  - Escape immune system
  - Multiply and disrupt tissue → opportunistic!

New born exposure

- Mother’s birth canal
- Mother’s breast milk
- Bottle-feeding
- People

**TABLE 13.1 Sites That Harbor a Normal Flora**

- Skin and its contiguous mucous membranes
- Upper respiratory tract
- Gastrointestinal tract (various parts)
- Outer opening of urethra
- External genitalia
- Vagina
- External ear canal
- External eye (lids, conjunctiva)
Contamination: microorganisms present on or in host

Infection: multiplication of microorganisms on or in hosts

Disease: disturbance in health status of host

Pathogens: any organism capable of causing disease

Pathogenicity: capacity to produce disease

Virulence: degree or intensity of disease

Association between microbes and humans

Progress of an Infection
- Pathogenicity
- Portals of entry
- Attachment
- Surviving host defenses
- Causing disease
- Process of infections and disease
- Portals of exit

True pathogen
- Cause disease in healthy individuals
  - Associated with a specific and recognizable disease
  - Examples:
    - Staphylococcus aureus
    - E. coli O157:H7

Opportunistic pathogen
- Cause disease in immune compromised host
- Gain access (injury) to sterile regions
- Examples:
  - Pseudomonas aeruginosa
  - Staphylococcus epidermidis
  - E. coli
Opportunistic Infections: pathogens that do not cause disease under normal circumstances but under the right conditions…….can cause disease

1) Failure of host defense mechanisms – immunocompromised patients
2) Organisms at unusual sites in body
3) Disturbances in normal microflora – super-infections

Factors that predispose a person to infections

<table>
<thead>
<tr>
<th>TABLE 13.4 Factors That Weaken Host Defenses and Increase Susceptibility to Infection*</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Old age and extreme youth (infancy, prematurity)</td>
</tr>
<tr>
<td>• Genetic defects in immunity and acquired defects in immunity (AIDS)</td>
</tr>
<tr>
<td>• Surgery and organ transplants</td>
</tr>
<tr>
<td>• Organic disease: cancer, liver malfunction, diabetes</td>
</tr>
<tr>
<td>• Chemotherapy/immunosuppressive drugs</td>
</tr>
<tr>
<td>• Physical and mental stress</td>
</tr>
<tr>
<td>• Other infections</td>
</tr>
</tbody>
</table>

These conditions compromise defense barriers or immune responses.

Virulence

• Virulence factors (Any characteristic or structure)
  – Ability to establish itself in the host
  – Cause damage
  – Often associated with toxins

Ports of entry

• Most pathogens have specific portals on entry…..and EXIT!
  – Skin
  – Gastrointestinal tract
  – Respiratory tract
  – Urogenital
  – Placenta
  – Inoculum size

Skin

• Staphylococcus aureus
  – Boils

Gastrointestinal tract

• Salmonella, Shigella, Vibrio
• Viruses – polio, hepatitis A
• Protozoan – Giardia lamblia
• Enter via ingestion or the anal route
Respiratory tract

- *Streptococcus pneumoniae*  
  – Sore throat, meningitis
- Fungi – *Cryptococcus*  
  – pneumonia

Urogenital

- Numerous sexual transmitted diseases (STDs)
  - Virus – human papillomavirus  
    – Genital warts
- Protozoan – *Trichomonas*  
  – trichomoniasis
- Bacteria – *Neisseria gonorrhoeae*  
  – Gonorrhea
- Acquire by intercourse or intimate contact

Placenta

- Some bacteria can penetrate the placenta barrier  
  – Syphilis spirochete
- Birth canal  
  – Herpes simplex virus
  – Remember the STORCH test?

**TABLE 13.5** Incidence of Common Sexually Transmitted Diseases

<table>
<thead>
<tr>
<th>STD</th>
<th>Estimated Number of New Cases per Year in U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human papillomavirus</td>
<td>5,500,000</td>
</tr>
<tr>
<td>Trichomoniases</td>
<td>5,000,000</td>
</tr>
<tr>
<td>Herpes simplex</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Chlamydiases</td>
<td>783,000</td>
</tr>
<tr>
<td>Gonorrhea</td>
<td>361,000</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>77,000</td>
</tr>
<tr>
<td>AIDS</td>
<td>41,002</td>
</tr>
<tr>
<td>Syphilis</td>
<td>32,200</td>
</tr>
</tbody>
</table>
Portal of exit

- Enables pathogen to spread to other hosts
  - Respiratory
  - Salivary
  - Skin
  - Fecal
  - Urogenital
  - Blood
- Persistence

Inoculum size

- Infectious dose (ID)
  - Minimum number of bacteria required to cause disease
  - Low ID = high virulence

Attachment

- Adhesion
  - Binding between specific molecules on both the host and pathogen
- Structures
  - Capsules
  - Pili or fimbriae
  - Hooks or Teeth!!

Surviving host defenses

- Anti-phagocytic factors
  - Capsule
    - Prevent phagocytosis
  - Leukocidins
    - Toxic to phagocytes - WBCs
  - Some microbes survive inside phagocytes
    *Mycobacterium tuberculosis*

Causing disease

- Virulence factors
  - Exoenzymes
  - Toxins
  - Capsule
- Occurrence of infection
- Signs and symptoms
Bacterial toxins

- **Exotoxins**
  - Gram positive and Gram negative cells
  - Excreted (ex. Hemolysins)
  - Highly toxic in small amounts
- **Endotoxins**
  - Gram negative cells
  - Membrane associated
    - Lipopolysaccharide (LPS)
  - Fever associated

Bacteria release substances that damage host tissues

- **Hemolysins** - lyse red cells
- **Leukocidins** - kill white blood cells
- **Coagulase** - accelerates clotting
- **Streptokinase** - digests clots and enables bacteria to spread
- **Hyaluronidase** - digests hyaluronic acid, a glue-like substance that holds the cells together in tissues and allows the organism to penetrate to deeper tissue

Bacteria produce toxins –

- **Endotoxins** - part of the cell wall of gram-negative bacteria and are released when cells die - **LPS**
- **Exotoxins** - produced by and released from bacteria - botulinum toxin - on the other hand toxins can be used to treat disease -
  - Called **neurotoxins** if affect neural tissue
  - Called **enterotoxins** if affect digestive system
- **Toxoids** are inactivated exotoxins that are inactivated and used to stimulate an immune response - **tetanus toxoid**

Bacteria release substances that damage host tissues

- **Hemolysins** - lyse red cells
- **Leukocidins** - kill white blood cells
- **Coagulase** - accelerates clotting
- **Streptokinase** - digests clots and enables bacteria to spread
- **Hyaluronidase** - digests hyaluronic acid, a glue-like substance that holds the cells together in tissues and allows the organism to penetrate to deeper tissue

Endotoxins

- **Cell envelope**
  - **Target organs**
  - **General physiological effects**
Differential characteristics of bacterial exotoxins and endotoxins

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Exotoxin</th>
<th>Endotoxin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toxicity</td>
<td>Toxic in minute amounts</td>
<td>Toxic in high doses</td>
</tr>
<tr>
<td>Effects on the Body</td>
<td>Specific to a cell (poison)</td>
<td>Systemic fever, inflammation</td>
</tr>
<tr>
<td>Chemical Composition</td>
<td>Small proteins</td>
<td>Lipopolysaccharide of cell wall</td>
</tr>
<tr>
<td>Heat Denaturation at 60°C</td>
<td>Unstable</td>
<td>Stable</td>
</tr>
<tr>
<td>Toxic Formation</td>
<td>Can be converted to toxoid*</td>
<td>Cannot be converted to toxoid</td>
</tr>
<tr>
<td>Immune Response</td>
<td>Stimulate antitoxin**</td>
<td>Does not stimulate antitoxin</td>
</tr>
<tr>
<td>Fever Stimulation</td>
<td>Usually yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mode of Release</td>
<td>Secreted from live cell</td>
<td>Released by cell clumping</td>
</tr>
<tr>
<td>Typical Susceptors</td>
<td>A few gram-positive and gram-negative</td>
<td>All gram-negative bacteria</td>
</tr>
</tbody>
</table>

* A toxoid is an inactivated toxin used in vaccines.
** An antibody is an antibody that reacts specifically with a toxoid.

Process of infections and disease

- Stages of Disease
  - Incubation
  - Prodromal
  - Invasive
  - Decline
  - Convalescence
- Signs and symptoms

Stages in course of infectious disease

- Signs - objective evidence of disease based on observation
- Symptoms – subjective evidence of disease based on the patient
- Syndrome – sign and symptoms defined a particular disease

Persistence

- Latency
  - Viral
    - Herpes virus
  - Bacterial
    - Tuberculosis
- Sequelae – long-term damage to tissues or organs
  - Meningitis → deafness
Epidemiology

- The study of disease in populations
  - Prevalence – total numbers of cases in the population at any given time
  - Incidence – Number of new cases over a defined period of time
- Center for Disease Control and Prevention (CDC)

Statistical data can be represented graphically, and can be used to predict trends

Patterns of infectious disease occurrence

Reservoirs

- Site at which the organism remains and can potentially infect.
- A) Living Reservoirs
  - Humans → Carriers
  - Animals → Vectors (Zoonosis)
- B) Non-living Reservoirs
  - Soil
  - Water

Two types of vectors

- A) Biological
  - Participates in the pathogen’s life cycle.
  - Infected with the pathogen
  - Transmit by bites, defecation
Two types of vectors

b) Mechanical:
- Not part of pathogen’s life cycle
- Not infected with the pathogen

Nonliving Reservoirs

• Soil
  – Transmit bacteria, protozoa, helminths, fungi
  – Transmit spores, cysts, ova, larvae
• Water – similar to soil

Acquisition and transmission

• Communicable
• Non-communicable
• Patterns of transmission

Kinds of diseases

Infectious disease - caused by infectious agent
Noninfectious disease - caused by some other factor - for example a poison
Communicable or contagious disease - measles, hepatitis, TB
Non-communicable disease - cannot be spread from host to host – own flora, food poisoning

Communicable

• Infected host transmits an infectious agent to another host
• Receiving host must become infected

Non-communicable

• Host acquires infectious agent
  – From self (compromised individual)- microflora
  – Nonliving reservoir – soil

  – cannot be spread from host to host!!!
Patterns of transmission

- Horizontal
- Vertical
- Direct Contact*
- Indirect Contact

Horizontal

- Disease is spread through a population from one infected person to another
  - Kissing, sneezing

The Anatomy of a Sneeze

Vertical

- The disease is transmitted from parent to offspring
  - Ovum, sperm, placenta, milk - remember that milk also provides protection to newborn

Contact Transmission

- Direct - Kissing, sex
- Droplets - Talking
- Vertical – Mother to fetus
- Vector -

Indirect

- Food, water, and biological products (blood, serum, tissue),
- Fomite (door knobs, toilet seats, etc.)
- Air
  - Droplet nuclei (dried microscopic residue)
  - Aerosols (dust or moisture particles)
Summary of how communicable infectious diseases are acquired

Nosocomial infections

- Infectious diseases that are acquired or developed from a hospital stay
  - Urinary tract infections
  - Respiratory infections
  - Surgical incisions

Over 70% of all Nosocomial Hospital infections are caused by biofilms

Infectious disease is due to host-microbe interaction that results in some type of insult to the host. However, the microbe is usually just trying to perpetuate itself however it can. Many diseases can be prevented. Some diseases can be cured, but not all. Then the host-microbe relationship is successful for the microbe and failing for the host.