Bacterial Mechanisms of Pathogenicity

1st Lecture

Introduction & Definitions
Infection and Disease

A. Definitions

B. Generalized Stages of Infection

C. Virulence Factors and Toxins
A. Definitions

• Disease and Infectious Disease
  – Disease
    • Any deviation from a condition of good health and well-being
  – Infectious Disease
    • A disease condition caused by the presence or growth of infectious microorganisms or parasites
A. Definitions

• Pathogenicity and Virulence
  – Pathogenicity
    • The ability of a microbe to cause disease
    • This term is often used to describe or compare species
  – Virulence
    • The degree of pathogenicity in a microorganism
    • This term is often used to describe or compare strains within a species
Definitions

• Acute infection vs. chronic infection
  – Acute Infection
    • An infection characterized by sudden onset, rapid progression, and often with severe symptoms
  – Chronic Infection
    • An infection characterized by delayed onset and slow progression
Definitions

• Primary infection vs. secondary infection
  – Primary Infection
    • An infection that develops in an otherwise healthy individual
  – Secondary Infection
    • An infection that develops in an individual who is already infected with a different pathogen
Definitions

- Localized infection vs. systemic infection
  - **Localized Infection**
    - An infection that is restricted to a specific location or region within the body of the host
  - **Systemic Infection**
    - An infection that has spread to several regions or areas in the body of the host
Definitions

• Clinical infection vs. subclinical infection
  – Clinical Infection
    • An infection with obvious observable or detectable symptoms
  – Subclinical Infection
    • An infection with few or no obvious symptoms
Definitions

• Opportunistic infection
  – An infection caused by microorganisms that are commonly found in the host’s environment. This term is often used to refer to infections caused by organisms in the normal flora.
Definitions

- The suffix “-emia”
  - A suffix meaning “presence of an infectious agent”
    - Bacteremia = Presence of infectious bacteria
    - Viremia = Presence of infectious virus
    - Fungemia = Presence of infectious fungus
    - Septicemia = Presence of an infectious agent in the bloodstream
Definitions

• The suffix “-itis”
  
  – A suffix meaning “inflammation of”

• Examples:
  
  – Pharyngitis = Inflammation of the pharynx
  
  – Endocarditis = Inflammation of the heart chambers
  
  – Gastroenteritis = Inflammation of the gastrointestinal tract
Definitions

- **Epidemiology**
  - The study of the transmission of disease

- **Communicable Disease**
  - A disease that can be transmitted from one individual to another

- **Noncommunicable Disease**
  - A disease that is not transmitted from one individual to another
Definitions

• **Endemic Disease**
  – A disease condition that is normally found in a certain percentage of a population

• **Epidemic Disease**
  – A disease condition present in a greater than usual percentage of a specific population

• **Pandemic Disease**
  – An epidemic affecting a large geographical area; often on a global scale
Definitions

• Reservoir of Infection
  – The source of an infectious agent

• Carrier
  – An individual who carries an infectious agent without manifesting symptoms, yet who can transmit the agent to another individual

• Fomites
  – Any inanimate object capable of being an intermediate in the indirect transmission of an infectious agent, such as clothes utensils and furniture
Definitions

– **Animal Vectors**

– An animal (nonhuman) that can transmit an infectious agent to humans

– Two types: mechanical and biological

– Mechanical animal vectors: The infectious agent is physically transmitted by the animal vector, but the agent does not incubate or grow in the animal; e.g., the transmission of bacteria sticking to the feet of flies

  • Biological animal vectors: The infectious agent must incubate in the animal host as part of the agent’s developmental cycle; e.g., the transmission of malaria by infected mosquitoes
Definitions

• Direct Mechanisms of Disease Transmission
  – Directly From Person to Person
  – Examples:
    Direct Skin Contact
    Airborne (Aerosols)
Definitions

• Indirect Mechanisms of Disease Transmission

  – Examples:

    Food & Waterborne Transmission

    Fomites

    Animal Vectors
<table>
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<tr>
<th>Term</th>
<th>Definition</th>
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<tr>
<td>Bacteremia</td>
<td>Bacteria circulating in the bloodstream</td>
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<tr>
<td>Colonization</td>
<td>Establishment and growth of a microorganism on a body surface</td>
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<tr>
<td>Disease</td>
<td>Noticeable impairment of body function</td>
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<td>Immunocompromised</td>
<td>A host with weaknesses or defects in the innate or adaptive defenses</td>
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<td>Inapparent infection</td>
<td>Infection with no obvious symptoms</td>
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<td>Infectious disease</td>
<td>Disease caused by an infecting microorganism or virus</td>
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<td>Latent infection</td>
<td>Infection in which the infectious agent is present but not active</td>
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<td>Opportunistic pathogens</td>
<td>Organisms that cause disease only when introduced into an unusual location or into an immunocompromised host</td>
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<tr>
<td>Parasite</td>
<td>An organism that benefits at the expense of another organism, the host</td>
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<tr>
<td>Pathogen</td>
<td>Any disease-causing microorganism or virus</td>
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<tr>
<td>Pathogenic</td>
<td>Disease-causing</td>
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<td>Primary infection</td>
<td>Infection in a previously healthy person</td>
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<td>Secondary infection</td>
<td>An additional infection that occurs as a result of a primary infection and that occurs during or immediately following the primary infection</td>
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<td>Septicemia</td>
<td>Acute illness caused by infectious agents or their products circulating in the bloodstream</td>
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<td>Systemic infection</td>
<td>Widespread infection through blood or lymph</td>
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<td>Toxemia</td>
<td>Toxin circulating in the bloodstream</td>
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<td>Viremia</td>
<td>Viruses circulating in the bloodstream</td>
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<td>Virulence determinants</td>
<td>Attributes of a microorganism or virus that promote pathogenicity</td>
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Pathogenicity - ability to cause disease
Virulence - degree of pathogenicity

- Many properties that determine a microbe’s pathogenicity or virulence are unclear or unknown
- But, when a microbe overpowers the host’s defenses, infectious disease results!
Molecular Determinants of Pathogenicity

- Attachment to host tissues
- Production and delivery of various factors
- Replication and evasion of immunity
- Damage to host tissues
Microbial Mechanisms of Pathogenicity: How Microorganisms Cause Disease

- **Portals of Entry**
  - Mucous membranes
  - Respiratory tract
  - Gastrointestinal tract
  - Genitourinary tract
  - Conjunctiva
  - Skin
  - Parenteral route

- **Number of Invading Microbes**

- **Penetration or Evasion of Host Defenses**
  - Capsules
  - Cell wall components
  - Enzymes

- **Adherence**

- **Damage to Host Cells/Cytopathic Effects**
  - Direct damage
  - Toxins
  - Exotoxins
  - Endotoxins
  - Hypersensitivity
Portals of Entry

• 1. Mucus Membranes

• 2. Skin

• 3. Parenteral (e.g., injection)
1. Mucus Membranes

A. Respiratory Tract

- microbes inhaled into mouth or nose in droplets of moisture or dust particles
- Easiest and most frequently traveled portal of entry
Common Diseases contracted via the Respiratory Tract

- Common cold
- Flu
- Tuberculosis
- Whooping cough
- Pneumonia
- Measles
- Diphtheria
Mucus Membranes

• B. Gastrointestinal Tract
  – microbes gain entrance thru contaminated food & water or fingers & hands
  – most microbes that enter the G.I. Tract are destroyed by HCL & enzymes of stomach or bile & enzymes of small intestine
Common diseases contracted via the G.I. Tract

- **Salmonellosis**
  - *Salmonella* sp.
- **Shigellosis**
  - *Shigella* sp.
- **Cholera**
  - *Vibrio choloreaa*
- **Ulcers**
  - *Helicobacter pylori*
- **Botulism**
  - *Clostridium botulinum*

*Clostridium botulinum*
Fecal - Oral Diseases

• These pathogens enter the G.I. Tract at one end and exit at the other end.

• Spread by contaminated hands & fingers or contaminated food & water

• Poor personal hygiene.
Mucus Membranes of the Genitourinary System - STD’s

Gonorrhea
- Neisseria gonorrhoeae

Syphilis
- Treponema pallidum

Chlamydia
- Chlamydia trachomatis

HIV

Herpes Simplex II
Mucus Membranes

• D. Conjunctiva –
  – mucus membranes that cover the eyeball and lines the eyelid

• Trachoma
  – *Chlamydia trachomatis*
2nd Portal of Entry: Skin

• Skin - the largest organ of the body. When unbroken is an effective barrier for most microorganisms.

• Some microbes can gain entrance through openings in the skin: hair follicles and sweat glands, wound ... etc
PHYSICAL BARRIERS

Prevent approach of and deny access to pathogens
3rd Portal of Entry: Parenteral

- Microorganisms are *deposited* into the tissues below the skin or mucus membranes
  - Punctures and scratches
  - injections
  - bites
  - surgery