

Life and Times of Bacteria

Bacteria can be classified as normal flora or normal biota or as a pathogen, this depends on whether or not their colonization results in an infection. Normal flora often provides some benefit to the host but is also capable of causing disease, especially if the host's immune system is compromised or suppressed. If the normal flora is allowed to enter a normally sterile site in the body an infection may occur. Examples are a ruptured appendix or perforated bowel.

Progress of an infection:

I. Pathogenicity: the ability to cause disease and Infectivity: the proportion of exposed persons who become infected.

A. Virulence refers to the degree that a microbe can invade and cause disease.

1. True pathogen – a microbe that can cause disease in a healthy person.
2. Opportunistic Pathogen – microbes that cause disease only when host conditions are compromised.

(PPE – personal protective equipment)

II. Step One – Portals of Entry

A. Parenteral – deposition directly under the skin or membrane

B. Skin – because skin is generally a “perfect” protector, bacteria must enter through a break in the skin, hair follicle or sweat gland. A limited few can bore into the skin.

C. Mucous membranes –

1. Respiratory Tract
2. Gastrointestinal Tract
3. Genitourinary Tract
4. To a lesser amount the eyes

The number of organisms necessary for a microbe to cause disease is termed the infectious dose. These pathogens may be termed exogenous or endogenous depending on their source.

III. Step Two – “Digging In”

Microbes must attach to their host; this process is called adhesions or ligands.

This can be accomplished by:

- A. Fimbriae
- B. Capsules (glycocalyx)
- C. Receptors
- D. Pili
- E. Flagella

The adhesions bind to the surface receptors (typically a sugar) on the cells of the host tissue.

IV. Step Three – “Staying Power”

In order for a bacteria to cause disease they must enter the body by a “preferred” route and have numbers sufficient to overcome the host's defense mechanisms.

- A. Some organisms produce leukocidins, substances that are toxic to white blood cells killing the host's phagocytes. Other organisms produce a slime layer that makes it difficult for the phagocytes to engulf them. And still others are able to survive inside the phagocytes engulfing them after ingestion. These methods are called antiphagocytic factors.

- B. Gastrointestinal disease causing bacteria must be able to survive the HCl (aq) of the stomach and the grinding devices of the GI tract.

V. Step Four – “Wreaking Havoc”

A. Virulence Factors: structures or properties that lead to the pathologic effects on the host.

B. Categories:

1. Exoenzymes: digest epithelial tissues and permit the invasion of the pathogens.
2. Toxigenicity: refers to the microbes capacity to produce toxins at the site of colonization
 - a. endotoxin: a toxin shed from the outer membrane, toxic in higher doses
 - b. exotoxin: a toxin secreted by the bacteria into the infected tissue, toxic in small or minute doses
 - c. classifications:
 - a. intoxications – ingestion of the toxin
 - b. toxinoses – adverse effects of the toxin
 - c. toxemia – toxin has spread throughout the body by the circulation of blood
3. Induction of damage to the host response

C. Process of Infection:

1. Incubation Period: bacteria multiplying
2. Prodromal Stage: when the earliest notable symptoms appear
3. Period of Invasion: bacteria exhibits the greatest toxicity and becomes well established
4. Convalescent Period: recovery period

D. Classification of Infections:

*Do the bacteria remain at the site of infection?

1. **Localized infection:** bacteria remain confined to specific tissue
2. **Systemic infection:** bacteria spread to several sites and tissues generally through the bloodstream
3. **Focal infection:** when an infectious agent breaks loose from a local infection and is carried into other tissues

*Are there multiple organisms present?

1. **Primary infection:** initial infection
2. **Secondary infection:** complication of primary infection by a second microbe
3. **Mixed infection (polymicrobial)** – several agents establish themselves at the infection site.

*Persistence of the infection?

1. **Acute infection:** rapid onset, severe, but short lived
2. **Chronic infection:** progress and persist over long periods of time.

E. Signs of an Infection:

1. **Objective symptoms:** evidence that can be observed by a second party
 - a. edema and swelling
 - b. granuloma
 - c. abscess
 - d. lymphadenitis (lymph nodes swollen)
 - e. fever
 - f. lesions
 - g. changes in white blood cell count

2. **Subjective symptoms:** evidence presented by the patient about how he/she feels
 - a. pain/headache/soreness
 - b. chills
 - c. fatigue
 - d. itching
 - e. nausea

Syndrome is a disease that manifests itself as a predictable set of symptoms.

- F. **Lingering – latent stage** – some bacteria may remain after initial infection, reemerging later to reinduce the infection. Long-term damage is called sequelae.

VI. “The Resistance” – mechanisms of resistance

- A. **Biological resistance** – changes that result in the organism being less susceptible to a particular antimicrobial agent.
-Intrinsic or Inherent Resistance: resistance resulting from the normal genetic, structural or physiological state of a microorganism.
- B. **Chemical resistance** – when an antimicrobial susceptibility has been lost to the extent that the drug is no longer effective for clinical use.
- C. **Microorganism mediated resistance** – antimicrobial resistance that is due to genetically encoded traits of the microorganism.
-Acquired Resistance: resistance resulting from changes to a microorganisms genetic code that causes alterations in cell structure or physiology.
 - a. successful mutation
 - b. acquisition of genes from other organisms
 - c. combination of a and b

VII. “Vacating the Premises”

Portal of Exit – the path by which bacteria leave a host. This allows the bacteria access to another host.

- A. Respiratory and Salvia Portals
- B. Skin Scales
- C. Fecal Remains
- D. Urogenital Tract
- E. Blood and Blood Products

VIII. “A Place to Hide”

- A. Reservoirs: a permanent place to reside – human, animal, soil, water, and plants. Sometimes referred to as the carrier.
- B. Vectors: organisms that transmits an infectious agent.
 1. Biological vector: actively participates in the pathogen’s life cycle. Spread by:
 - a. bite
 - b. aerosol
 - c. touch
 2. Mechanical vector: transport pathogen with out becoming part of the life cycle. An indirect or intermediate carrier such as food.

IX. “Finding a New Target” Routes of Transmission

- A. Agents of Disease
 1. Communicable – highly contagious – transfer of disease causing bacteria
 2. non-communicable – generally arises from normal biota in a compromised host

- B. Direct Transmission – portal of exit contact a portal of entrance
- C. Indirect Transmission
 - 1. vehicle – inanimate material that can transmit pathogen
 - 2. fomite – an inanimate object that harbors and transmits the pathogen.
 - 3. droplet nuclei – dried droplets of mucous and saliva
- D. Nosocomial Infections – infection that is acquired during a hospital stay
 - 1. urinary tract – 40%
 - 2. surgical site – 19%
 - 3. respiratory – 15%
 - 4. other (meningitis, gastroenteritis) – 12%
 - 5. skin – 8%
 - 6. septicemia – 6%

IV. **Epidemiology:** The Study of Diseases in Populations

Epidemiologists monitor the prevalence and incidence of diseases and track the morbidity (# of infected people) and mortality rates among the population.

- A. Patterns of infectious disease occurrence
 - 1. Endemic – concentrated in one area at a relatively stable rate.
 - 2. Sporadic occurrence – few cases randomly spread over a wide area.
 - 3. Epidemic – increase in number of cases that often appear in geographic clusters
 - 4. Pandemic – epidemic ranges over more than one continent