Pathogenesis of Bacterial Diseases and Epidemiolog

Basic Terminology

Pathology: Study of disease

Pathogenesis: Development of disease

Pathogen: any microorganism that has the capacity to cause disease

Etiology: the science dealing with causes of disease.

Infection: invasion and growth of pathogens in the body

Incubation period: Time between infection and appearance of disease symptoms can be measured in hours, days, weeks, or even years

Disease: Abnormal state in which the body is not functioning normally.

Virulence: Degree of pathogenicity,

- Virulence factors contribute to virulence
  - Adhesion factors
  - Biofilms
  - Extracellular enzymes
  - Toxins
  - Anti-phagocytic factors

➢ Epidemiology

Epi = upon Demos = people Ology = science

Epidemiology: the study of the distribution, frequency and determinants of health problems and disease in human populations

- Epidemiologists study sick and well people to determine the crucial difference between those who get disease and those who are spared

Epidemiological Terminology

Depending on the spread of infectious diseases in community, they may be classified as

Sporadic disease: Disease that occurs sometimes in a population (e.g., bacterial meningitis)

Endemic disease: Disease constantly present in a population (e.g., the common cold, Typhoid fever)

Epidemic disease: Disease acquired by many hosts in a given area in a short time (e.g., Influenza is an example of a disease that may occur suddenly and unexpectedly in a family)

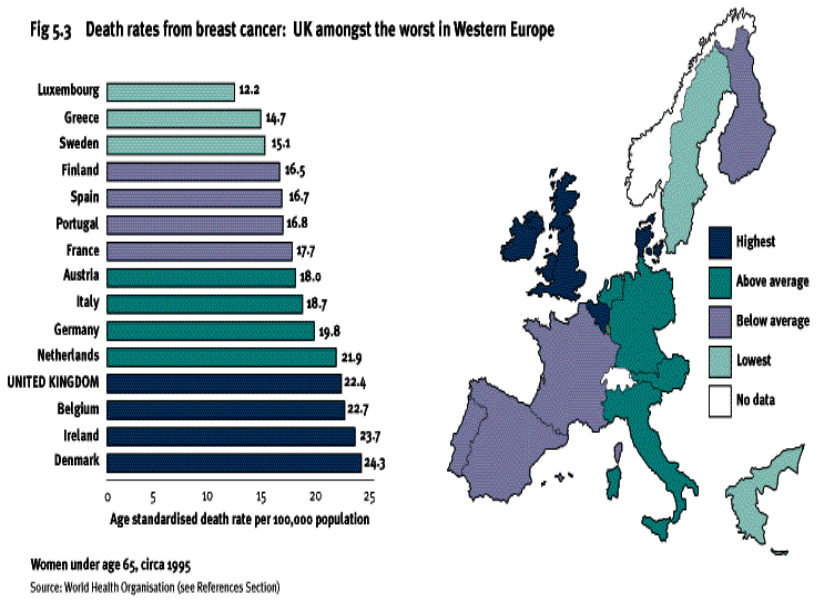
Pandemic disease: Worldwide epidemic (The global H1N1 influenza outbreak of 1918 is a good example and cholera)

Types of epidemiology

1. **Descriptive epidemiology**
   - Describing patterns and trends in health and disease in populations
2. **Analytical epidemiology**
   - Examining associations and causation

Purposes of Epidemiology

1. To study the cause (or etiology) of disease(s), or conditions, disorders, disabilities
2. To study natural history and prognosis of health-related problems
3. To identify causes and risk factors
4. define the mode of transmission
5. To provide foundation for public policy



The steps for infections by pathogenic bacteria include

1. Portals of Entry

The route by which an infective agent enters the body

Four major pathways

1. Skin
2. Mucous membranes

A. Respiratory tract ex (**Tuberculosis**)

B. Gastrointestinal tract ex (**Salmonellosis**)

C. Genitourinary tract ex (**Syphilis**)

D. The conjunctiva

3. Placenta

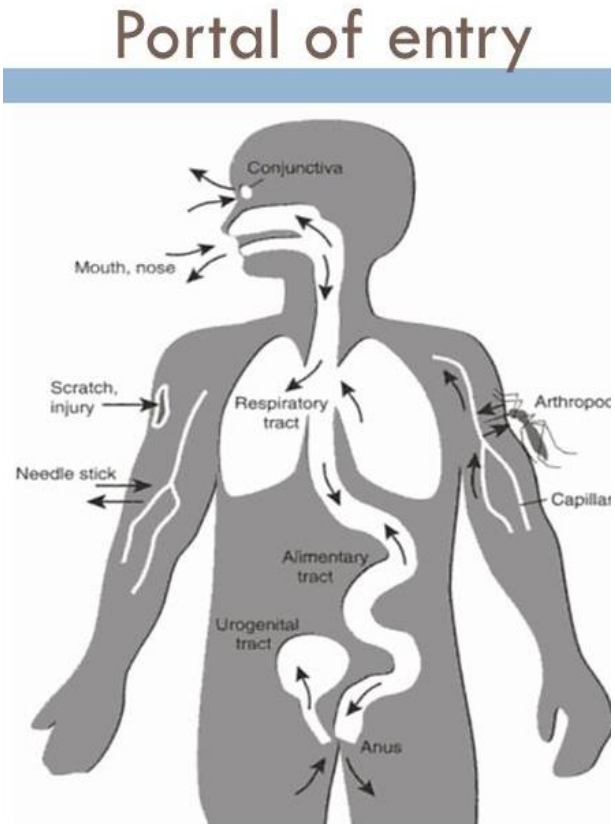


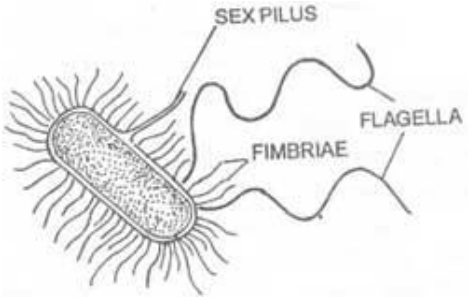
Figure 1-1 portal of entry of bacteria through the human body

2. Attachment (Adherence)

Adhesion : Process by which microorganisms attach themselves to cells.

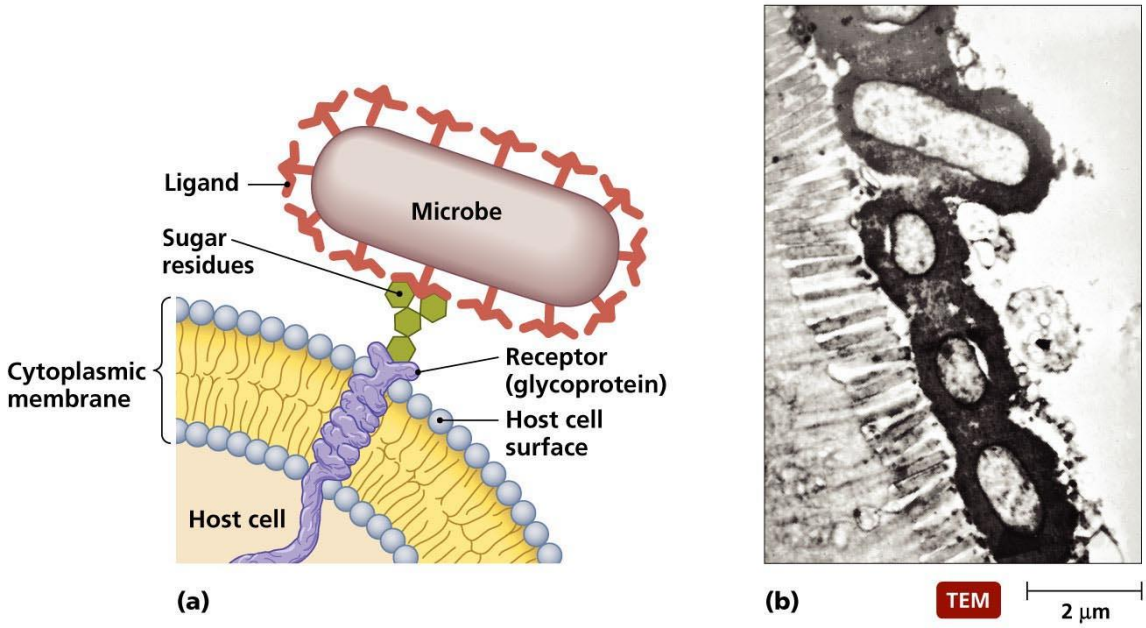
The attachment between pathogen and host is accomplished by means of surface molecules on the pathogen called **adhesins** or **ligands** that bind specifically to complementary surface **receptors** on the cells of certain host tissues

- **Ligands or Adhesins:** Surface molecules on pathogen bind specifically to host cell surface molecules.



The adhesins of bacterial cells are chemical components of **capsules**, cell walls (**lipopolysaccharide**), **glycoprotein**, **pili or fimbriae**, **viral capsid**, or components of the envelope.

- **Receptors:** Surface molecules on host tissues to which pathogen adhesins bind.
  The host receptors are usually **glycoproteins** located on the cell membrane or tissue surface



Copyright © 2006 Pearson Education, Inc., publishing as Benjamin Cummings.

Figure 1-2 interaction between ligand of the bacteria and the receptor in the host

- Ex*: Streptococcus mutans,* a bacterium that plays a key role in tooth decay, attaches to the surface of teeth by its glycocalyx.
- *E. coli* have adhesins on fimbriae that adhere only to specific kinds of cells in certain regions of the small intestine.

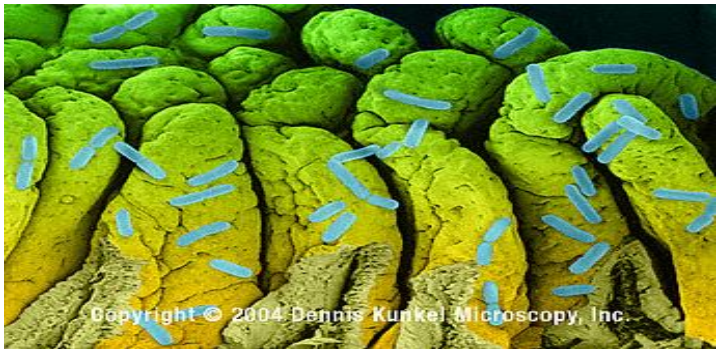


Figure 1-3 E. coli on small intestine surface

3. Bacterial Pathogens Penetrate Host Defenses

Some bacteria has the capacity to evade host defenses and enter into deeper tissues where they will grow and become established this achieved by

1. **Capsules** - prevent them from engulfment by phagocytes

- *Streptococcus pneumoniae*
- *Haemophilus influenza*
- *Bacillus anthracis*
-

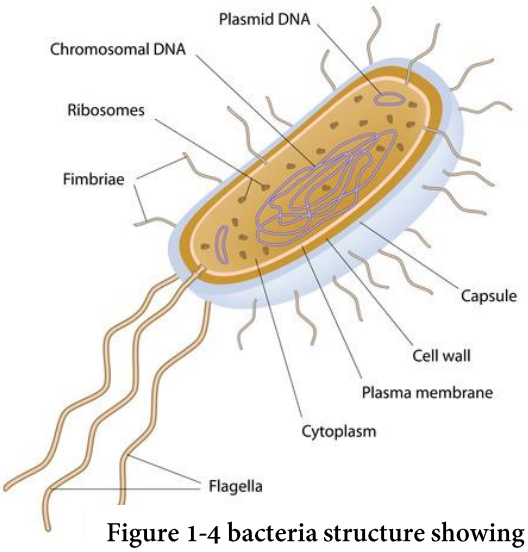


Figure 1-4 bacteria structure showing the capsule

2. Cell Wall Components

Proteins in the cell wall prevent a pathogen from being phagocytized.

- M protein resists phagocytosis (*Streptococcus pyogenes*)
- Opa protein inhibits T helper cells (*Neisseria gonorrhoeae*)
- Mycolic acid (waxy lipid) resists digestion (*Mycobacterium tuberculosis*)

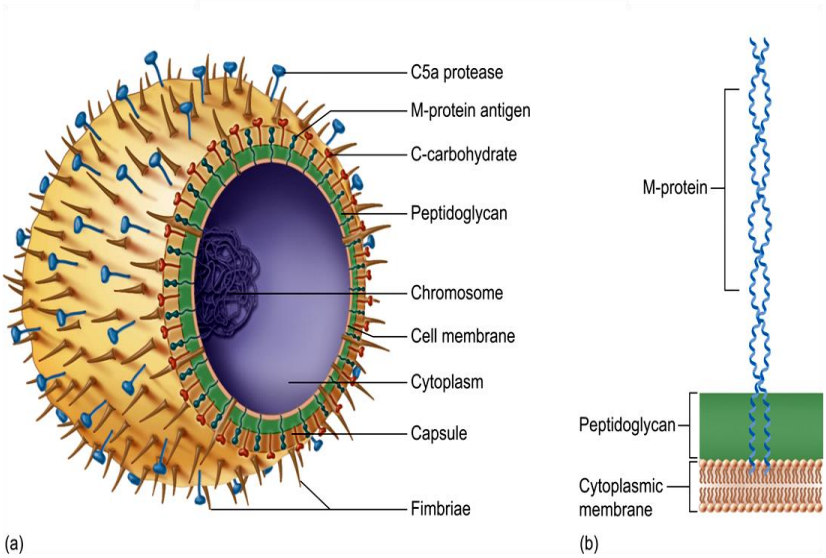


Figure 1-5 *Streptococcus pyogenes* cell wall showing M protein structure

3. Enzymes

Bacteria cell can produce some Enzymes that can play important roles in the penetration to the host cell

- Leucocidins destroy neutrophils and macrophages.
- Coagulase - cause fibrin clot
- Kinases - destroy blood clots

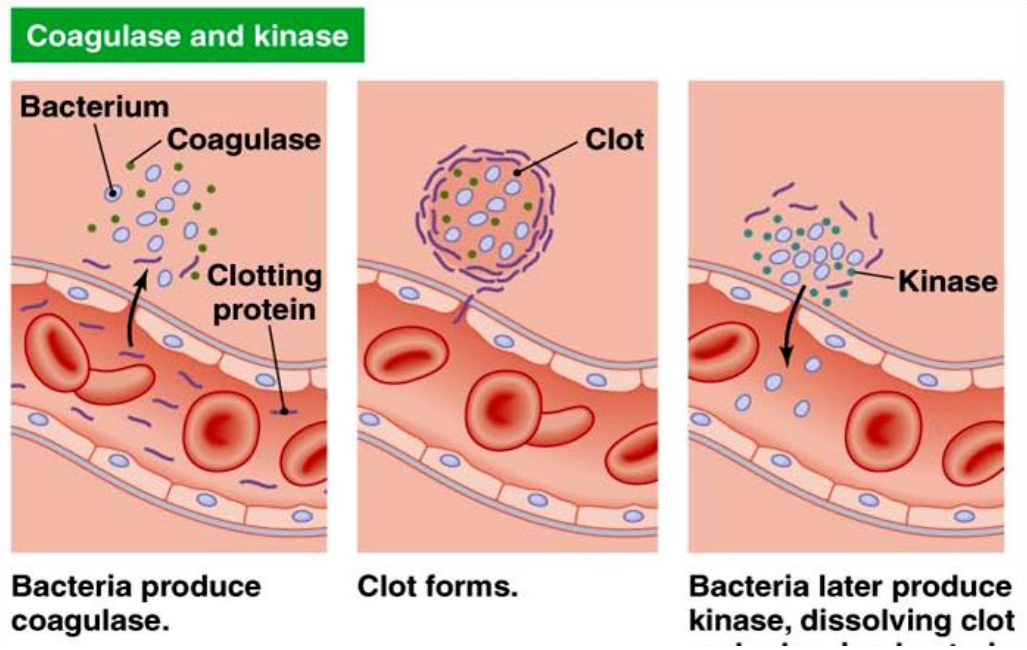


Figure 1-6 penetration in to the inside the cells by using coagulase and kinase enzymes

4. Penetration into the Host Cell Cytoskeleton

Salmonella bacteria produce **invasins**, proteins that cause the actin of the host cell's cytoskeleton to form a "basket" (membrane ruffling) to carry the bacteria into the cell.

5. Antigenic Variation

Some organisms change their antigens, either by mutation or by changing expression of the gene that codes for the antigen, to evade host immune responses.

4. Disease Transmissions

The causative agents of disease can be transmitted from the reservoir of infection to a susceptible host by**:**

1. Contact Transmission:

A. **Direct**: (*person-to-person transmission)*

Respiratory illnesses (the common cold and influenza)

Sexually transmitted diseases (STDs) (syphilis, gonorrhea)

B. **Indirect**: Spread by fomites.

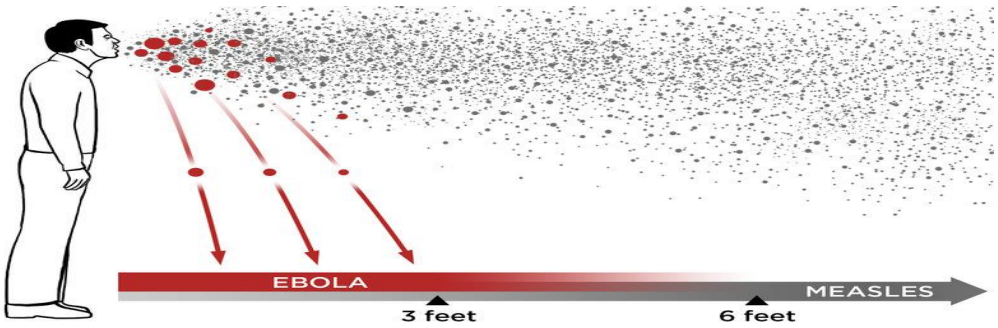
- Fomites are (tissues, handkerchiefs, towels, bedding, diapers, drinking cups, eating utensils, toys...etc.)

(Contaminated syringes serve as fomites in transmitting AIDS and hepatitis B.)

C. **Droplet**: Transmission via airborne droplets from saliva or mucus (coughing or sneezing)

Influenza, pneumonia, and pertussis (whooping cough).

2. Airborne Transmission: Pathogens carried on water droplets or dust for a distance greater than 1 meter bacterium that causes tuberculosis



3. Vehicle transmission is the transmission of disease agents by a medium, such as water, food, or air (typhoid, cholera)

4. Vector Transmission: Arthropods carry pathogens from one host to another (mechanical vector vs. biological vector) (Malaria, Plague)

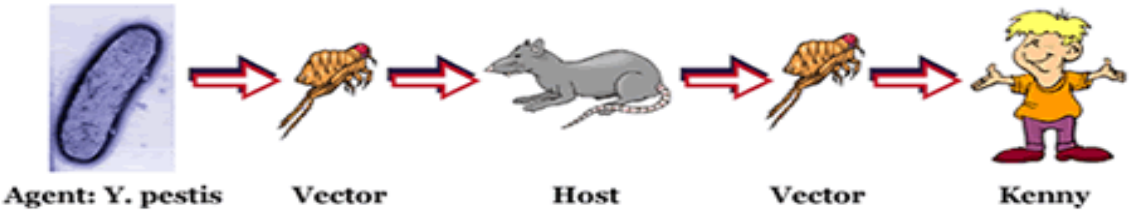


Figure 1-8 how the human get infected with the Plague

For further information you can refer to these books

1. Microbiology _ an introduction 11th ed -Pearson (2013)

2. Foundation in microbiology 9 th ed Kathleen Park, Barry

3. Microbiology Prescott 7Ed.