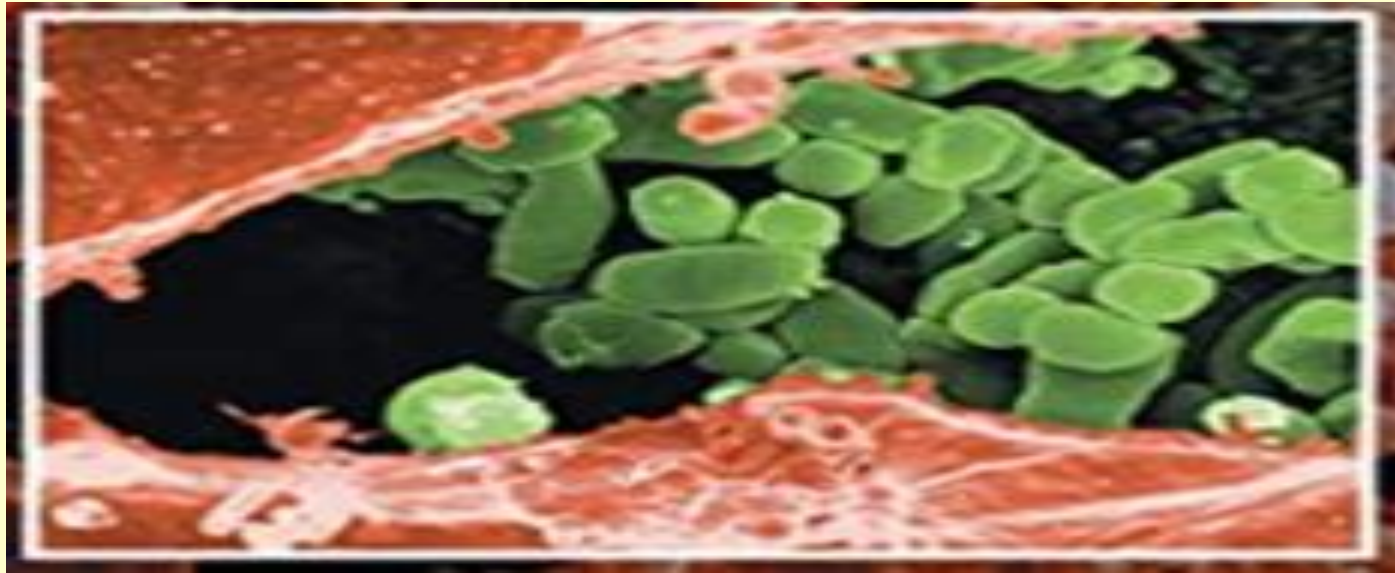




Basrah University
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**2nd Course -Lecture # 4: Bacterial Infection&
pathogenesis**



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Objectives

- *To define the general terms used in pathogenesis
- * To describe the virulence factors and its examples
- * To define the infection and explain its types
- *To understand the mechanism of pathogenesis
- *To clarify the immunopathogenesis



*General Terms Used In Pathogenesis:

pathogen is a microorganism that is able to cause disease in a human, animal, plant or insect.

Pathogenicity is the ability to produce disease in a host organism.

Microbes express their pathogenicity by means of their virulence.

Virulence is a degree of pathogenicity, it depends on invasiveness and toxigenicity of the organism. Hence, the determinants of virulence of a pathogen are any of its genetic (biochemical or structural features) that enable it to produce disease in a host.

Infection : Growth and multiplication of a microbe in or on the body with or without the production of disease.

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

Colonization: Pathogen enters, multiplies, does not invade



Opportunistic Pathogen: Cause disease in immunocompromised people

- (HIV, Solid organ transplant patient, Chemotherapy) .

Opportunistic infection

An infection caused by microorganisms that are commonly found in the host's environment.

Incubation Period: The time interval between the entry of the infectious agent and the onset of clinical manifestations of the disease

This period may be as short as minutes to as long as years .

The suffix “**-emia**” A suffix meaning “presence of an infectious agent” in bloodstream

Bacteremia = Presence of the bacteria in bloodstream

Viremia = Presence of the virus in bloodstream

Fungemia = Presence of the fungus in bloodstream

Septicemia = Presence of an infectious agent with its toxins in the bloodstream

Toxemia : Presence of the microbial toxins in bloodstream



Infection:

*Infection: The growth of a parasitic organism (a "germ") within the body. e.g. Bacteria or etc.

*Types Of Infections:

1. Communicable Infection:

An infection that can be transmitted from one individual to another either directly by contact or indirectly by fomites and vectors.

2. Asymptomatic Infection:

a disease is considered asymptomatic if a patient is a carrier for a disease or infection but experiences no symptoms.

* A condition might be asymptomatic if it fails to show the noticeable symptoms.

*also called subclinical infections.



3.Symptomatic Infection:

a disease is considered symptomatic if a patient is a carrier for a disease or infection and express symptoms . e.g. fever.

■ **Pandemic infection:**

pandemic is an epidemic of infectious disease that is spreading through human populations across a large region; for instance multiple continents, or even worldwide.

■ **Epidemic infection:**

A disease condition present in a greater than usual percentage of a specific population

■ **Endemic infection:**

Endemic infection Prevalent in or restricted to a particular region, community, or group of people.



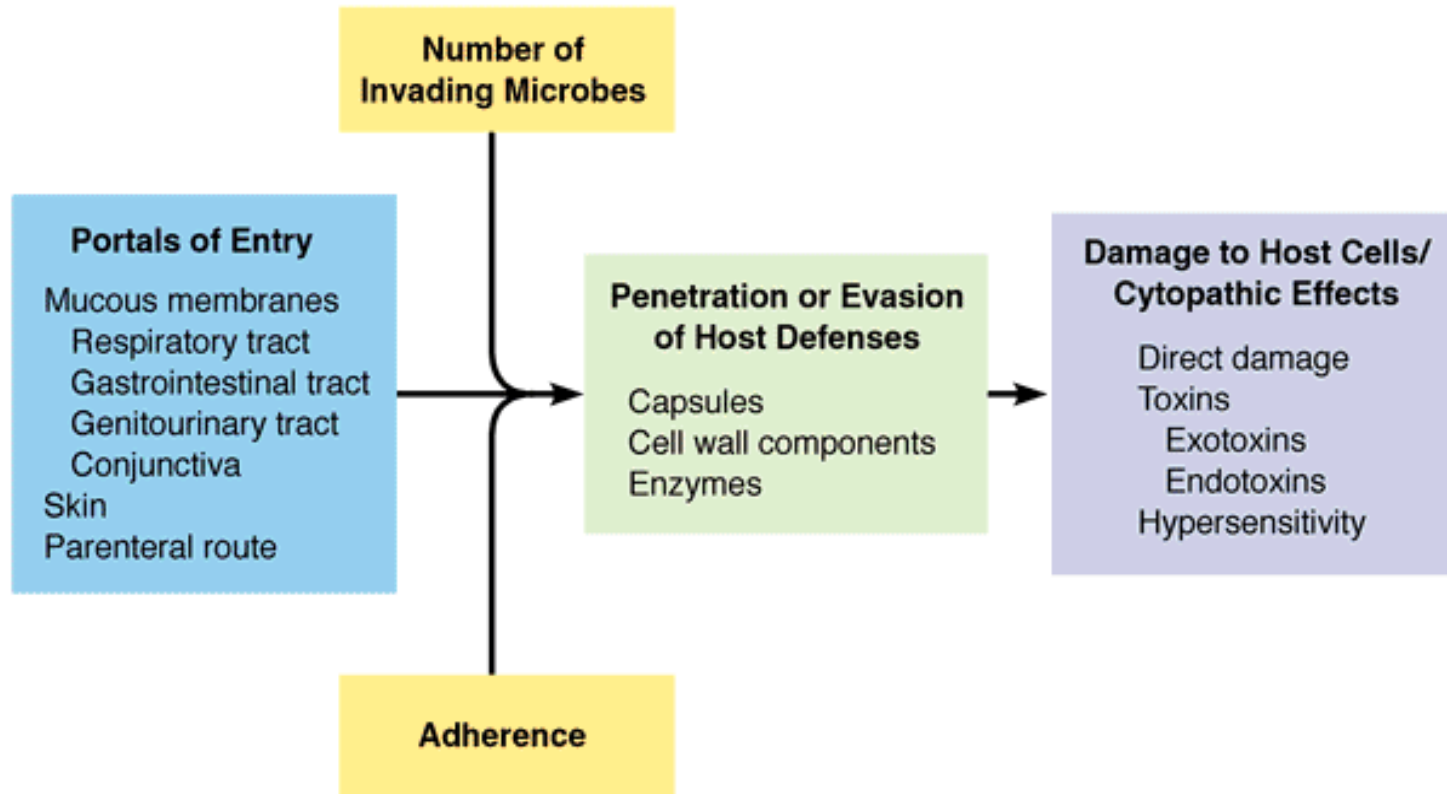
Characteristics of Pathogenic Bacteria

1. Transmissibility
2. Adherence to host cells
3. Invasion of host cells and tissue
4. Evasion of the host immune system
5. Toxigenicity : ability to produce toxins.

Bacteria may produce two types of toxins:

- i. Exotoxins
- ii. Endotoxins.

Microbial Mechanisms of Pathogenicity





Chain of Infection

Infectious Agents

Micro-organisms capable of causing disease or illness

- Bacteria
- Fungi
- Parasites
- Prions

Place in which infectious agents live, grow and reproduce

Reservoirs

- People
- Water
- Food

Ways in which infectious agent leaves the reservoir

Portals of Exit

- Blood
- Secretions
- Excretions
- Skin

Ways in which the infectious agent is spread from the reservoir to the susceptible host

Modes of Transmission

- Physical Contact
- Droplets
- Airborne

Individuals may have traits that affect their susceptibility and severity of disease

Susceptible Host

- Immune Deficiency
- Diabetes
- Burns
- Surgery
- Age

Ways in which the infectious agent enters the susceptible host

Portals of Entry

- Mucous Membrane
- Respiratory System
- Digestive System
- Broken Skin



Mode of transmission:

Entry into human body

1. Ingestion : (food or water)

Salmonella typhi

Shigella dysenteriae

Vibrio cholerae

2. Inhalation: (Respiratory Tract)

Mycobacterium tuberculosis:

Streptococcus pneumonia

Haemophilus influenzae

3. Direct contact

Break in the skin (wounds): *Staphylococcus aureus*

Burns: *Pseudomonas aeruginosa*

Trauma : *Clostridium tetani*



Entry into human body

4. Sexual transmission :

Neisseria gonorrhoeae (gonorrhea)

Treponema pallidum (syphilis)

Chlamydia trachomatis

5. Blood borne transmission

Needle stick injuries / Blood transfusion / Intravenous drug abuse:

HIV, HBV

6. Vector borne:

Mechanical: Flies spreading bacteria to food (*Salmonella/ shigella*)

Biological: *Y. pestis* multiplying in flea gut

7. Vertical transmission

Toxoplasma

Cytomegalo virus



Virulence factors :

Factors enhancing the ability of bacteria to cause disease. or molecules expressed and secreted by pathogens (bacteria, viruses, fungi and protozoa) that enable them to achieve the following: Colonization, Immuno evasion , Immunosuppression, entry into and exit out of cells (if the pathogen is an intracellular one) and to obtain nutrition from the host.

Pathogens possess a wide array of virulence factors. Some are intrinsic to the bacteria (e.g. capsules and endotoxin) whereas others are obtained from plasmids (e.g. some toxins).

Types of virulence factor

1. Adherence factors
2. Invasion factors
3. Capsules
4. Toxins



Colonization factors; Adherence

The pathogenesis of many bacteria depend on the ability to adhere to mucosal cells (epithelial or endothelial cell linings of bladder, intestine and blood vessels) as a first step

1. Pili (fimbriae) : binds to glycolipids or glycoproteins
2. Adhesins : M protein in *Streptococci pyogenes* , lipoteichoic acids in Gram positive bacteria
3. Biofilms : (Adhere strongly to catheters, heart valves, knee joint replacement prosthesis)



Invasiveness:

The ability to invade tissues. encompasses mechanisms for

- Colonization (adherence and initial multiplication),
- production of extracellular substances which facilitate invasion (invasins) and ability to overcome host defense mechanisms

Invasion of the tissue is enhanced by following factors:

(1) Invasin; (2) Enzymes; (3) Antiphagocytic factor; (4) Intra-cellular survival.

INVASIN: It is the bacterial surface protein that affect physical proportion of tissue matrices , intracellular spaces, thereby promoting the spread of pathogens.

Exoenzymes

- Many bacteria release enzymes that can damage host tissue in a variety of mechanisms , such as collagenase, hyaluronidase , fibrinolysins , proteases, lecithinases



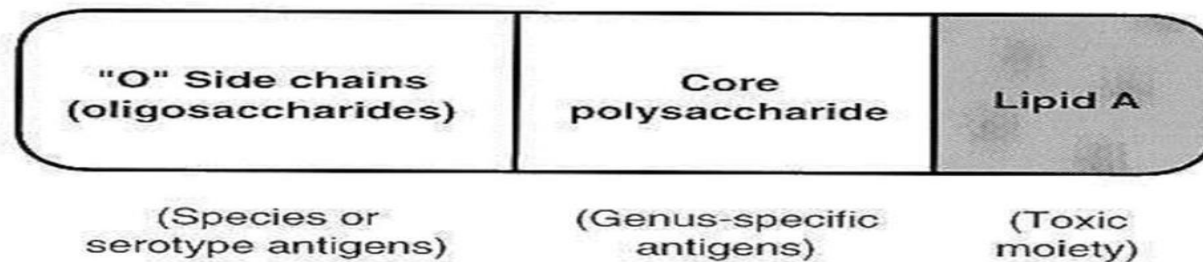
Exotoxins

- *Polypeptide in nature.
 - *Secreted by both gram positive and gram negative species outside of the cell
 - *Induce high titer antibodies called antitoxins.
 - *Toxoid used as vaccine.
 - *Can be divided into three categories:
 - *Cytotoxins , *Neurotoxins , *Enterotoxins
- e.g *Corynebacterium diphtheriae*
Clostridium tetani
Vibrio cholerae
Staphylococcus aureus
Shigella dysenteriae

Endotoxin

- The lipo-polysachharide (**LPS**) component of Gram negative bacterial outer membrane is called the Endotoxin
- Lipid A component of lipo-polysachharide (LPS)
- Stimulates release of acute phase cytokines (IL-1, TNF- α and IL-6) and inflammatory reactions
- Leading to high fever, hypotension and shock

Basic structure of endotoxin





EXOTOXIN

1. Released from the cell before or after lysis
2. Protein
3. Heat labile
4. Antigenic and immunogenic
5. Toxoids can be produced
6. Specific in effect on host
7. Produced by gram-positive and gram-negative org.
8. No fever



ENDOTOXIN

1. Integral part of cell wall
2. Endotoxin is LPS; Lipid A is toxic component
3. Heat stable
4. Antigenic; ??immunogenicity
5. Toxoids cannot be produced
6. Many effects on host
7. Produced by gram-negative organisms only
8. Fever present



Microbial defenses against host immunologic clearance

- Encapsulation (Inhibition of phagocytosis and serum bactericidal effect) e.g. *Neisseria meningitidis*, *Streptococcus pneumoniae*
- Antigenic or phase variation (*Salmonella typhi*)
- Intracellular multiplication (*M. tuberculosis*, *Salmonella typhi*)
- Production of anti-immunoglobulin protease (IgA protease)
- Inhibition of chemotaxis (C5a peptidase)
- Destruction of phagocytes

