Pathogenicity and Virulence of bacteria

Learning objectives

By the end of this lecture student should be able to:

- Definition : Pathogens, pathogenicity, virulence, Opportunistic pathogens
- virulence Factors which help bacteria to :
- 1. Adherence factors
- 2. Invasion

Learning objectives



By the end of this lecture student should be able to:

- Stages of Bacterial Pathogenesis
- compare between endotoxin and exotoxin

Host microbial relationships



Infection :

- It is a process by which the **organism enters into a relationship with the host** (Growth and Multiplication within the body).
- Microbial infections occur frequently,

Host microbial relationships

- **I-INFECTIOUS DISEASE (clinical Disease):**
  - **Refers to pathological change** and with **clinical manifestations**.

- **II-Subclinical, silent** or **abortive infection**.
  - Infections **without pathological changes** and or **not manifested** as clinical disease.

Host microbial relationships

- Outcome of bacterial infections depends on the **Bacteria** and **the host**
- According the Bacteria relationship with other host **classified into:**

I. **Saprophytic bacteria**:
   - **Live free in nature, on decaying organic matter.**
   - **Not require a living host.**

Host microbial relationships

II. Parasitic bacteria:

Live on or in a living host.

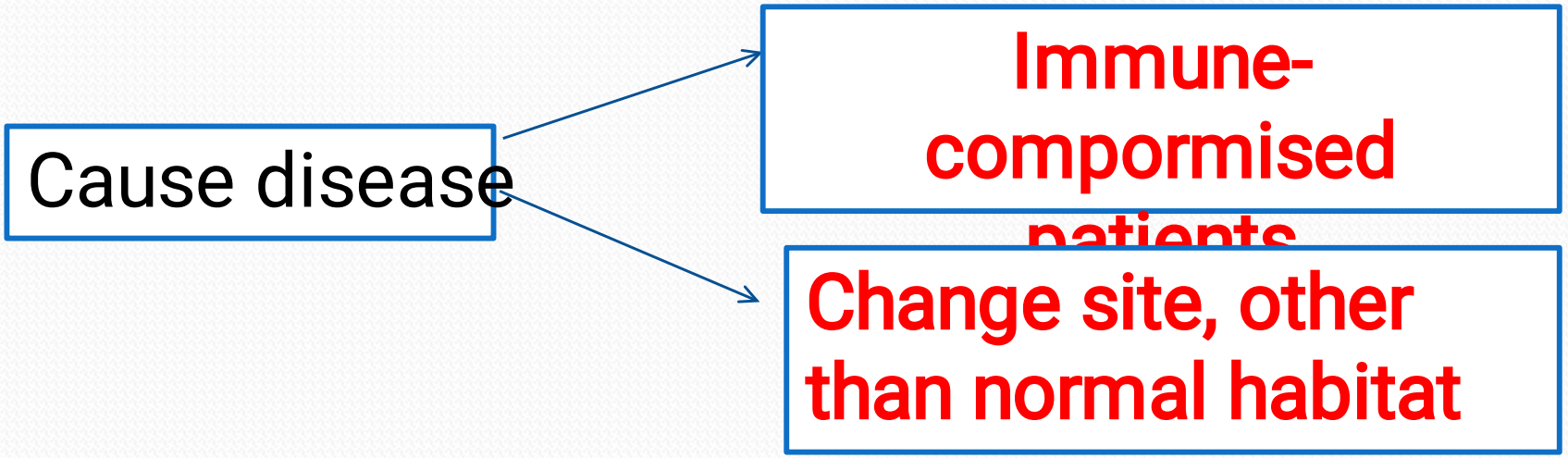
❖ **Parasitic bacteria** are divide into :

- **A-Pathogen**: Microorganism that is able to cause disease. **Capable producing disease)**
- **B-Non-pathogen :**
  - **1-Commensal or normal flora**
    Bacteria that **don't cause disease**, and are part of the **normal flora**.
  - **2-Opportunistic pathogens**:

Host microbial relationships

- **Opportunistic pathogens**:

- -Potentially pathogenic bacteria
- –In normal conditions do not cause disease



– Many of opportunistic pathogens are originally commensals as part of normal flora.

III-Stage of the infectious process

1. Source of infection:

- **-Man (**Case or Carrier)
- -**Animal**
- -**Soil** or **environment**

III-Stage of the infectious process

2 . Mode of transmission:

e.g. droplet, inhalation, ingestion, injection, insects, contact and transplacental.

Stage of the infectious process



- **3. Portal of entry**

e.g. Genital tract, Respiratory tract, gastrointestinal tract, skin ... etc.

-Vertical (mother to fetus) or horizontal transmission(p-p)

-The organism then starts to **multiply** within the host causing tissue damage (disease).

- **4. Portal of exit**

e.g. urine, stools, blood, respiratory or genital discharge, from which the organism is transmitted to a new host.

MICROBIAL PATHOGENICITY

- The outcome of infection depends on :
  - Bacteria (The virulence of the pathogen)
  - Host (Host resistance factors (immunity).

Definition

- **Pathogens : is microorganism that is able to cause (produce) disease.**
- **Pathogenicity** : The Ability to produce disease.
- **Virulence**: : the Degree of pathogenicity.

Microbial Virulence



- **Pathogenicity**
  - ✓The **ability** of the pathogen species to cause disease.
  - ✓Qualitative description
  - ✓The measure of the pathogenicity of a microorganism by **Virulence**

Microbial Virulence

Virulence

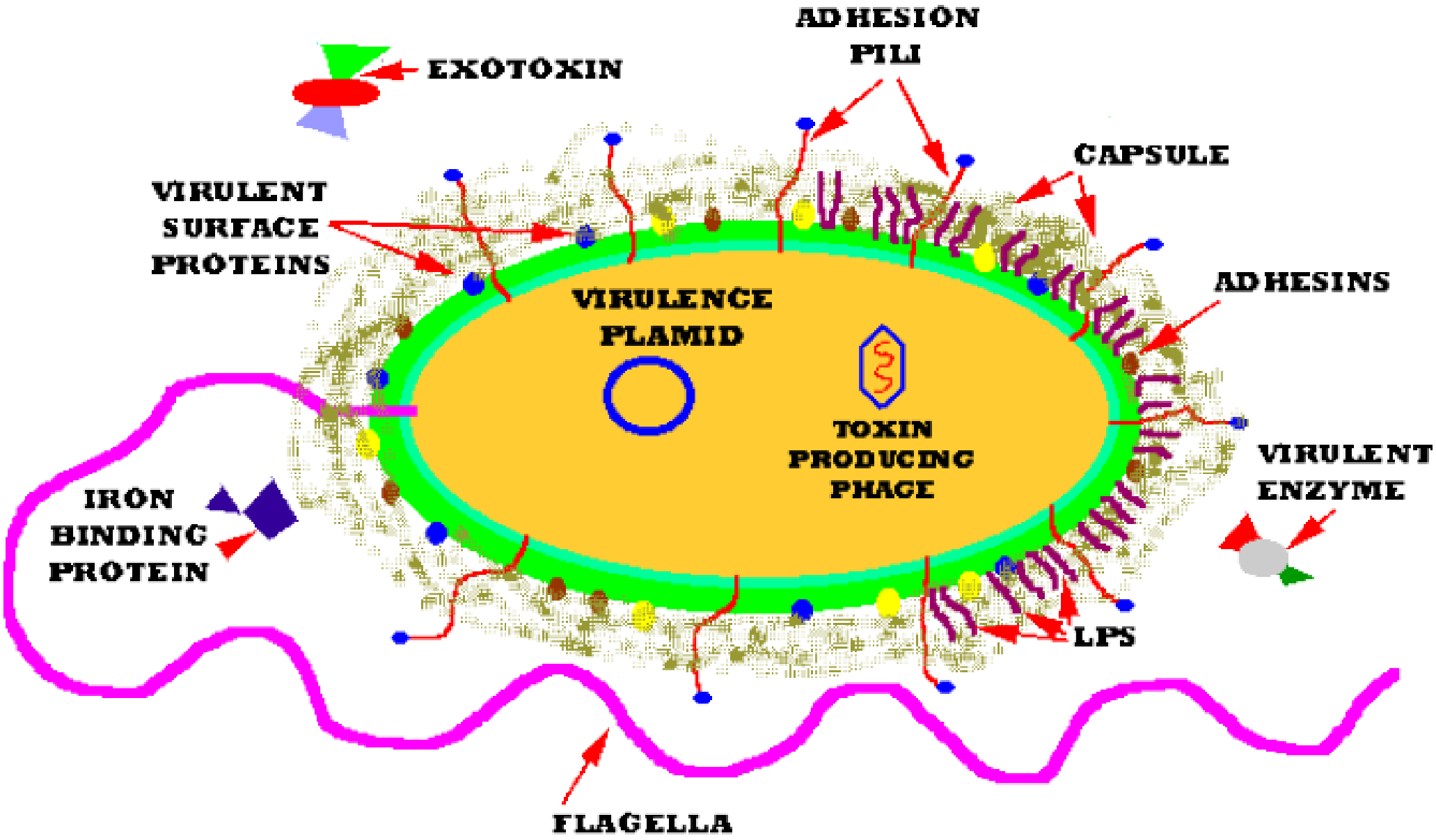
- ✓Degree of pathogenicity
- ✓Quantitative character
- ✓Virulence of a microbe is determined by virulence factors, such as capsules, exotoxins, or endotoxins.

Virulence factors

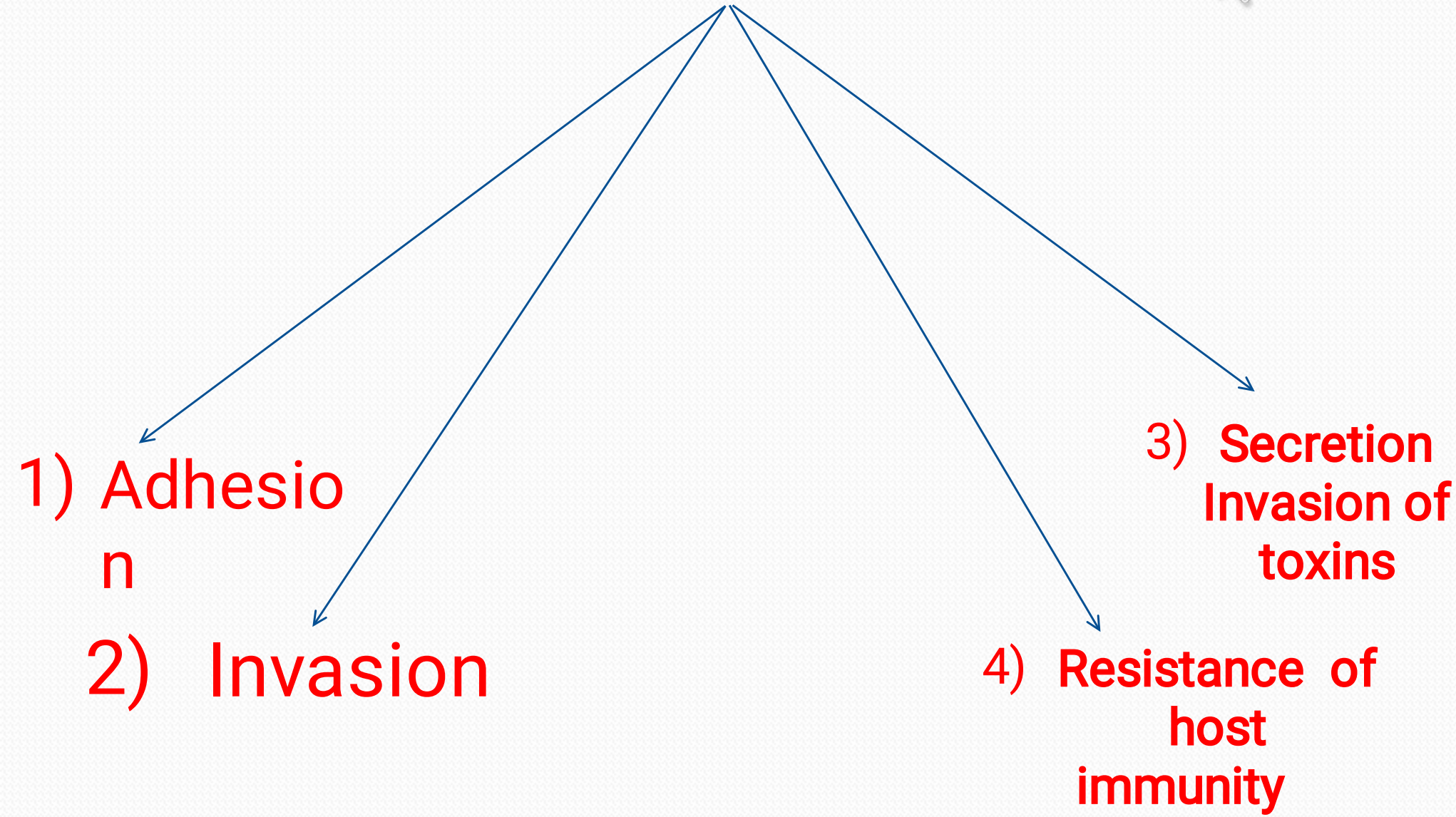
- Factors that **enhancing the pathogenicity** (ability) of bacteria to cause disease (invade and spread within the host)
- **A virulence factor:**
  - 1-**Structure (Capsule, pili \ fimbriae)**
  - 2-**Product (Toxins or enzyme)**
- **Enhancing the pathogenicity** the organism to cause disease.

Summary

Virulence factors



Virulence Factors



MECHANISMS OF PATHOGENICITY

Transmissibility

↓

Adherence

↓

Penetration/invasion of host defense

↓

Damage to host cell

A-Adherence factors

- They enable bacteria to **attach** to the host surfaces,
- Contributing to the **establishment (Colonization)** of the infection. For example:.

➢1. Fimbriae (short Pili) :

- *Neisseria gonorrhoeae* and *E. coli* help the attachment of these organisms to the **urinary tract epithelium**.

➢2. Glycocalyx :

- *Staphylococcus epidermidis* and viridans streptococci allows the organisms to adhere strongly to the heart valves.
- Mutants that lack these factors are often avirulent.

2-Adherence

- **Adherence enhances virulence** by preventing the bacteria from removing by physical or washing from organs.
- Adherence helps **bacterial cell to form microcolony**.
- **Importance of adhesion :**
  - Neisseria gonorrhoeae in which strains that **lack pili** are **not pathogenic**

B-INVASION

- **Definition:**
- The ability of microorganisms to entry \ penetrate and spread in the tissues.

- **Invasive factors are:**
  A. **Enzymes**:
  B. **Antiphagocytosis**
  C. **Toxigenicity**

B-INVASION

A. **Enzymes**:

- **Collagenase :**
  - Breaks down collagen in connective tissue
- **Hyaluronidase**
  - Spreading Factor”
  - Digests or breaks down hyaluronic acid

B-INVASION



- **Leukocidin** : Destruction the neutrophils, macrophages
- Immunoglobulin A protease:
  - Degrades sIgA

B-INVASION

B. Antiphagocytosis

- **Capsule :** prevents adherence of phagocytic cells
  - S. pneumoniae and N. meningitidis.
- **Cell wall proteins** of gram-positive cocci,:
  - – **M protein of Group A streptococci**: Antiphagocytic
  - – **Protein A of Staphylococcus**: Binds IgG lead to block complement activation e.g. : Staphylococcus

Coagulase

- Coagulates blood proteins
- Providing a “hiding place” for bacteria within a clot.
- Formation clot can protect the bacteria from phagocytosis

B-INVASION

C. Toxins

- – **Toxigenicity** : Capacity of microorganisms to produce toxins.
- **Two Types of Toxins**
- • 1. Exotoxins
- – Secreted outside the bacterial cell
- • 2. Endotoxins
- – part of the **outer cell wall** of Gram negative bacteria.

DIFFERENCES BETWEEN EXOTOXIN AND ENDOTOXIN

		Exotoxin	Endotoxin
1	Produce by or Source	**Secreted outside cell by both Gram positive and Gram negative bacteria**	**Part of GRAM NEGATIVE Released after lysis of Gram negative cells wall**
2	**Composition**	**Protein**	**Lipopolysaccharide**
3	**Effect of heat**	**Heat labile destroyed at 60 C°**	**Heat stable (upto 100°c)**
4	Antigenicity	Highly antigenic Induce antibody (antitoxin)	Less antigenic
5	Toxicity	Highly toxic in minute dose (microgram is fatal to animals)	Moderately toxic
6	converted to toxoid (inactive toxin)	Can be converted to toxoid Used as vaccine	cannot
7	Encode	Gene located in the plasmid or Bacteriophage	Gene located in the bacterial chromosome