# Medical Bacteriology – Lecture 4

- **Bacterial avoiding Host Defences**
- **Bacterial Toxins**

# Bacterial avoiding Host Defenses

Most successful pathogens, possess structural or biochemical traits which allow them to resist the host defense (**the phagocytosis and immune responses**).

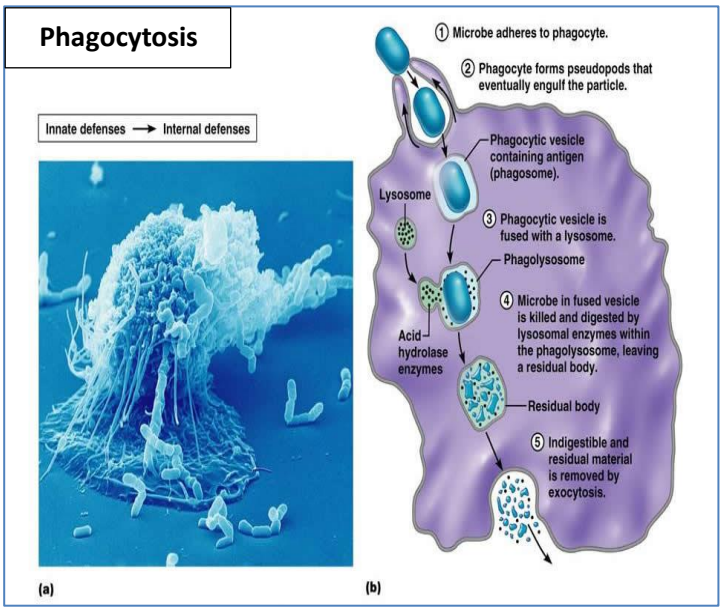
Some pathogenic bacteria are inherently able to resist the bactericidal components of host tissues. For example;

The **capsule of *Bacillus anthracis*** protects against cell **lysis by cationic proteins in serum or in phagocytes**.

Pathogenic **Mycobacteria** have a **waxy cell wall** that **resists digestion by most tissue bactericides.**

**Lipopolysaccharides (LPS)** of gram-negative pathogens may protect the cells from **complement lysis or the action of lysozyme**

## A- Overcoming Host Phagocytic Defenses




### 1. Avoiding Contact with Phagocytic Defenses

-Pathogens may **remain in regions inaccessible to phagocytes**.
- Some bacteria or their products **inhibit phagocyte chemotaxis**. (Streptococcal streptolysin which also kills phagocytes, suppresses neutrophil chemotaxis).
- Cover the surface of the bacterial cell with a host component (**hides the antigenic surface** of the bacterial cell). For example, *S. aureus* produces cell-bound coagulase and clumping factor which clots fibrin on the bacterial surface.

### 2. Inhibition of Phagocytic Engulfment (Ingestion)

**a. Polysaccharide capsules** of *Streptococcus pneumonia* and *Klebsiella pneumoniae*
b. **Protein M** and **fimbriae** of *Streptococcus pyogenes*
c. **Biofilm** by *Pseudomonas aeruginosa*
d. **O polysaccharide** associated with LPS of *E. coli*

**3. Survival Inside of phagocytes Cells** (Either neutrophils or macrophages)
Bacteria that can resist killing and survive or multiply inside of phagocytes or other cells are considered **intracellular parasites**, such as ***Mycobacterium tuberculosis, Salmonella typhi***.

The intracellular environment of a phagocyte may be protecting the bacteria during the early stages of infection or until they develop a full complement of virulence factors.

The intracellular environment also protect the bacteria against extracellular bactericides, antibodies, drugs, etc.

**4. Products of Bacteria that Kill or damage Phagocytes** (bacterial enzymes or toxins)

**a) Killing phagocytes before ingestion** **b) Killing phagocytes after ingestion**
**e. g.** Mycobacteria, *Brucella*, *Listeria* usually destroy macrophages.

## B- Bacterial Defense strategies against Specific human Immune Responses.

### Such as:

**1. Antigenic Disguises**

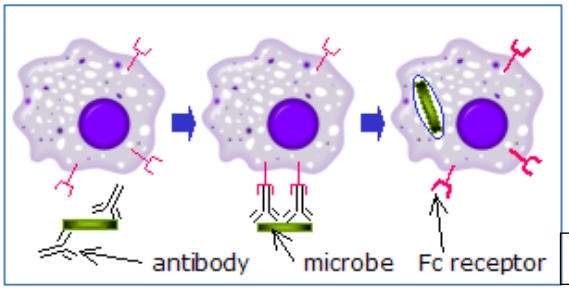
Some pathogens can hide their antigens from opsonizing antibodies or complement.

Bacteria may be able to coat themselves with host proteins such as fibrin, fibronectin, or even immunoglobulin molecules.

a- *S. aureus* produces cell-bound **coagulase** and **clumping factor.** This disguises the bacteria immunologically so that they are not readily identified as antigens and targets for an immunological response.

b- **Protein A** produced by *S. aureus*, and the analogous **Protein G** produced by *Strep. pyogenes*, bind the Fc portion of immunoglobulins, thus coating the bacteria with antibodies and canceling their opsonizing.

**c-** The **fibronectin** coat of *Treponema pallidum* provides an immunological disguise for the spirochete.




**Opsonization**

**2. Induction of Ineffective Antibody (***Neisseria gonorrhea)*

**3. Antigenic Variation**

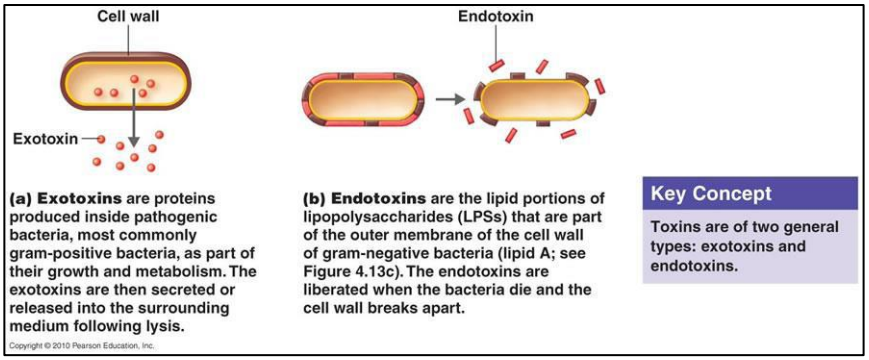
*Neisseria gonorrhea* can change fimbrial antigens during the course of an infection.

# Bacterial Toxins

**Exotoxins** are soluble proteins secreted from bacterial cells and may act at tissue sites removed from the site of bacterial growth.

**Endotoxins** are cell-associated substance (Lipopolysaccharide component) (LPS part) of the outer membrane of gram negative bacteria. such as *E. coli*, *Salmonella*, *Shigella*, *Pseudomonas*.

Endotoxins may be released from cells that are lysed as a result of effective host defense (e.g. lysozyme) or the activities of certain antibiotics (e.g. Penicillins & Cephalosporins).



# Comparison of Bacterial Exotoxins and Endotoxin

| Exotoxins | Endotoxins |
|---|---|
| Produced by both gram-positive & gram-negative bacteria | Produced only by gram-negative bacteria |
| Secreted from living bacterial cells or released upon bacterial lysis | Released upon bacterial lysis (Integral part of cell wall) |
| Composition: protein | Composition : LPS |
| Many types based on structure and function | Only one type |
| Heat labile | Heat Stable (boiling for 30 minutes does not destabilize)- certain oxidizing agents such as superoxide, peroxide & hypochlorite degrade them). |
| Specific receptors on host target cells | Less specific in their reaction- Diverse range of host cells and systems affected |
| Specific effects at specific sites of host | Diverse range effects throughout the body |
| Toxoids can be made by treating with formalin | Toxoids cannot be made (poor antigen) |
| Fever Producing ( none)<br>Produce characteristic diseases | Fever Producing ( yes)<br>Weakness, aching |
| Small lethal dose | High lethal dose |
| Gas gangrene- Tetanus- Botulism | Typhoid fever- Urinary tract infections (UTI), meningitis |

## Review Questions

1- Compare between Endotoxins and Exotoxins?

2- Some pathogenic bacteria are inherently able to resist the bactericidal components of host tissues. Give 3 examples?

3- How can pathogenic bacteria avoid (overwhelming) host phagocyte defenses (points)?

4- Some pathogenic bacteria used antigenic disguises strategies against host defenses. Give 3 examples?